Summer 2024 Project Summary

Iona Ecological Conservation

Utilizing Earth Observations to Understand Landscape Patterns and Assist in Wildlife Management in Iona National Park, Angola

Project Team

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Project Overview

Project Synopsis:
Angola's Iona National Park faces conservation issues due to livestock population growth and drought which this study addresses. African Parks, which has co-managed the park since 2019, requires historical and present land cover data to develop effective management strategies. The NASA DEVELOP team at Athens, GA created a 1990–2023 landcover time series with a random forest classifier using Landsat and Sentinel satellite data in Google Earth Engine. Despite sensor resolution inconsistencies and arid-specific index limitations, the research demonstrates that Earth observations can provide wildlife managers with valuable ecological information for arid locations with scant ground truth data.

Abstract:
Following the end of the Angolan civil war in 2002, human and livestock populations have increased exponentially within Iona National Park. An ongoing drought since 2017 has brought these people and livestock into increasing competition with local wildlife for resources – highlighting a conservation challenge that will become more entrenched as the effects of anthropogenic climate change increase. In 2019, African Parks began co-managing Iona National Park in Angola with the Angolan government, hoping to enact scientifically grounded management strategies to meet this challenge. To accomplish this, African Parks needed contemporary and historic information on the spatial distribution of landcover types within Iona and adjacent areas. We constructed and applied a random forest classifier in Google Earth Engine to spectral data gathered from Landsat 5, 7, 8 and Sentinel-1 and 2 to meet this need. Using the classifier, we generated a time-series of land cover maps between 1990–2023, from which several landscape metrics were calculated to show how certain habitats and formations had changed over time. Notably, we observed a decrease in the park's diversity as per the Shannon Diversity Index – the index considers the richness of classes, as well the evenness of their distribution. The poorer resolution of earlier sensors and a lack of arid specific land cover indices limited the accuracy and resolution of our landcover maps. However, this project still demonstrates

that Earth observations can be used to form the basis of conservation policy in arid environments, where ground-truth data may be difficult to obtain or non-existent.

Key Terms:
Landcover classification, Google Earth Engine, random forest classifier, arid environment, Landsat, Sentinel, landscape metrics, change detection

Application Area: Ecological Conservation
Study Location: Iona National Park, Angola
Study Period: 1990 – 2023
Community Concerns:

- Iona National Park has experienced exponential growth of human and livestock populations, increasing competition between wild and domesticated species for resources.
- An on-going drought since 2017 has exacerbated human-wildlife competition, and potentially foreshadows how anthropogenic climate change will affect the region.
- Human-wildlife land use competition pushes wildlife into suboptimal habitats, which may eventually lead to local extinction and overall biodiversity loss in the park.

Project Objectives:

- Create a Land Use/Land Cover (LULC) map with vegetation details for 2023
- Generate a time-series of LULC maps between 1990-2023 that analyzes change overtime
- Produce a short video highlighting the importance of the project, methods, and results

Partner Overview

Partner Organization:

Organization	Contact (Name, Position/Title)	Partner Type	Sector
African Parks	Dr. Pedro Monterroso, Park Manager	End User	Non-profit

Decision-Making Practices & Policies:
As part of their co-management agreement with the Angolan national government, African Parks is responsible for the day-to-day operations of Iona National Park, as well as the development of long-term management plans in conjunction with local communities. Since 2019, African Parks has successfully set up management structures, recruited and trained security and wildlife observers, and improved the physical infrastructure of the park. They are now seeking to formalize a Land Use Plan, which will uphold their three pillars of management: biodiversity conservation, community development, and park revenue generation. Current landscape monitoring techniques include ground and aerial wildlife surveys, camera-trapping programs, and perimeter patrols.

Earth Observations & End Products Overview

Earth Observations:

Platform & Sensor	Parameters	Use
Landsat 5 TM	NDVI, SAVI, NDWI, RGB, NIR	Classified land use / land cover for 1990
Landsat 7 ETM+	NDVI, SAVI, NDWI, RGB, NIR	Classified land use / land cover for 2002

Landsat 8 OLI	NDVI, SAVI, NDWI, RGB, NIR	Classified land use / land cover for 2016
Sentinel-1 SAR	Ground Range Detected Spectral Inputs	Provided additional active sensor land use / land cover information for 2016 and 2022
Sentinel-2 MSI	NDVI, SAVI, NDWI, RGB, NIR	Classified land use / land cover for 2016
Endeavour SRTM	Global 1-arc second Digital Elevation Model (DEM), Slope, Aspect	Used to produce DEM and topographic variables

Ancillary Datasets:

- World Wildlife Fund (WWF) HydroSHEDS (RIV) – Used to create a .distance() band to help classify drainage line vegetation
- Ground Truth Vegetation Regions (provided by African Parks) – Used to collect manual and random training points

Model:

- Random Forest (POC: Wei Lun Tay, University of Arkansas) – Land cover classifications

Software & Coding Languages:

- Google Earth Engine – Create and implement random forest classifier to map land cover classification and calculate SAVI, NDVI, NDWI.
- Google Earth Pro 7.3 – Manually collect training points
- Esri ArcGIS Pro 3.3 – Visualize classified images, create layouts, and perform change detection analysis
- R version 4.4.1 – Calculate landscape metrics
    - Terra
    - Raster
    - Sf
    - Landscapemetrics
- CapCut 12.4.0 - Edit and produce creative communication video

End Products:

End Products	Earth Observations Used	Partner Benefit & Use
LULC Time Series	Landsat 5 TM, Landsat 7 ETM+, Landsat 8 OLI, Sentinel-1 SAR, Senintel-2 MSI, Endeavour SRTM	Will help understand how landcover types are visually arranged in Iona National Park and how this has changed over the past 30 years
Landscape Metrics	Landsat 5 TM, Landsat 7 ETM+, Landsat 8 OLI, Sentinel-1 SAR, Senintel-2 MSI, Endeavour SRTM	Will quantify landscape condition, diversity, and changes therein over past 30 years

Change Detection Analysis	Landsat 5 TM, Landsat 7 ETM+, Landsat 8 OLI, Sentinel-1 SAR, Senintel-2 MSI, Endeavour SRTM	Will quantify pixel level changes in landcover classes between maps, with detailed information about environmental succession patterns.

Product Benefit to End User:

This study will help African Parks and the Angolan government understand Iona National Park's land cover patterns. The time series of land cover maps and landscape metrics will help managers identify and prioritize conservation actions by showing habitat changes over the previous thirty years. Understanding long-term vegetation cover, water availability, and human impact helps decision-makers develop more targeted and successful management methods. They may use this data to inform their future Land Use Plan, that will involve finding important habitat restoration locations, arranging sustainable grazing, and solving water management problems. Future satellite imagery can leverage this project's technologies for continual monitoring and adaptive management. This data-driven approach will help park managers combine conservation goals with local needs, potentially inform resource usage, climate change adaptability, and sustainable development policies within and surrounding the park. Overall, this study will provide a great tool for scientific conservation approaches to protect Iona National Park's unique ecosystem from human and environmental threats.

References

African Parks (2024). *Iona National Park*. African Parks. Retrieved 06/26/2024 from https://www.africanparks.org/the-parks/iona

Huntley, B. J., Beja, P., Vaz Pinto, P., Russo, V., Veríssimo, L., & Morais, M. (2019). Biodiversity Conservation: History, Protected Areas and Hotspots. In B. J. Huntley, V. Russo, F. Lages, & N. Ferrand (Eds.), *Biodiversity of Angola: Science & Conservation: A Modern Synthesis* (pp. 495-512). Springer International Publishing. https://doi.org/10.1007/978-3-030-03083-4_18

Kadri, N., Jebari, S., Augusseau, X., Mahdhi, N., Lestrelin, G., & Berndtsson, R. (2023). Analysis of Four Decades of Land Use and Land Cover Change in Semiarid Tunisia Using Google Earth Engine. *Remote Sensing, 15*(13), 3257. https://www.mdpi.com/2072-4292/15/13/3257

Oglethorpe, J., V., R., J., N., & A., C. (2018). *Communities and Biodiversity in Angola: Analysis of the legal and institutional framework for community-based approaches to conservation and natural resource management.* WWF US, National Geographic Society, ACADIR and Kissama Foundation.