

National Aeronautics and Space Administration



Africa Food Security & Agriculture

Predicting the Likelihood of Human-elephant Conflict and Assessing Elephant Habitat Conditions During Extreme Drought and Crop Deficit in the Kavango-Zambezi Area

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Basemap by ESRI

Kavango-Zambezi Area

- Conservation lands in 5
 African countries
- 75% of the African
 elephant population &
 >3 million people
- Subsistence farming dependent on seasonal rainfall





Project Partners

Connected Conservation

"Conserving animals, enhancing livelihoods in areas of human – animal conflict"

Focus Area: Victoria Falls, Zimbabwe



The Ecoexist Project

"Reducing conflict and fostering coexistence between elephants and people"

Focus Area: Okavango Delta, Botswana



Victoria Falls, Zimbabwe

- Deciduous savanna woodland that receives
 ~668 mm rainfall per year
- UNESCO World Heritage Site
- 13 bull elephants collared 2017-2020



Okavango Delta, Botswana

- Semi-arid savanna region that receives
 ~500mm rainfall per year
- Ramsar Wetland of International Importance & UNESCO World Heritage Site
- 20 elephants collared between 2014-2020





Community Concerns



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Objectives

- Analyze the relationship between elephant movement, vegetation health, & climate conditions
- Develop reusable codes for partners to replicate our analysis as more elephant data becomes available
- Create elephant kernel density heatmaps to identify human-elephant conflict risk areas



Data Sources: Satellites and Sensors

Landsat 8 Operational Land Imager (OLI)



- Spatial Resolution: 30 m
- Temporal Resolution: 16 days
- Used for: Vegetation Indices (NDVI, SAVI)

Global Precipitation Measurement Core Observatory (GPM)



- Spatial Resolution: 10,000 m
- Temporal Resolution: 30 minutes
- Used for: Precipitation



Elephant GPS tracking data for 13 bulls in the Victoria Falls area (2017-2020). Data provided by Connected Conservation.

METHODOLOGY







Elephant Tracking Data: R Studio



Elephant Tracking Data: Summary



Elephant Tracking Data: R Studio



Data Integration and Synthesis



RESULTS: NDVI vs SAVI



SAVI Dry Season 2019



RESULTS: NDVI





Mean: ~0.54

Mean: ~0.45

RESULTS: Vegetation Health

NDVI Change Dry Season 2017-2019



NDVI Change Wet Season 2017-2019

Mean: ~0.11

Mean: ~0.012

RESULTS: PDSI

RESULTS: Temperature

RESULTS: Monthly Precipitation

RESULTS: Kernel Density Heatmaps

2018 Dry

2019 Dry

RESULTS: Kernel Density Heatmaps

2019 Dry

2019 Wet

RESULTS: Kernel Density Heatmaps

RESULTS: Bivariate Analysis

High

RESULTS: Bivariate Analysis

Conclusions

- Kernel density heatmaps show that elephants travel greater distances during the wet season and congregate around water sources and agricultural land during the dry season
- The produced code showed wide-spread increases in NDVI, SAVI, and precipitation measurements in the wet seasons compared to dry, directly observing yearly fluctuations that likely influence elephants' different movements between the seasons
- The study area experienced a 19.6% decrease in mean NDVI from 2017 to 2019, indicating strong drought conditions that may have had an impact on elephant movements

Data Limitations

- Lack of high-resolution imagery
- Climate data not available for 2020
- GPS data gaps
- Monthly composite cloud cover

GPS Data Gaps

Monthly Composite Cloud Cover

Future Work

- High-resolution imagery (PLANET)
- Updated land use & land cover maps
- Predictive model
- Additional movement drivers:
 - Mating behavior
 - Bush fires
 - Land surface temperature
 - Ephemeral water sources
 - Crop foraging preference
- Cyanobacteria

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