浙江大学
ZHEJIANG UNIVERSITY

A Risk Assessment Framework for African Natural World Heritage Sites Based on Multi-Source Remote Sensing Data

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Study Areas

According to the United Nations Educational, Scientific and Cultural Organization (UESCO), there are 44 natural World Heritage sites in Africa, of which 11, or 25%, are in danger. It accounts for 69% of all endangered natural heritage. The area of nature reserves in Africa is about 373,000 square kilometers, accounting for 1.23% of the total area of Africa, among which the area of endangered reserves is 194,000 square kilometers, accounting for 52.0% of the total area of protected areas.

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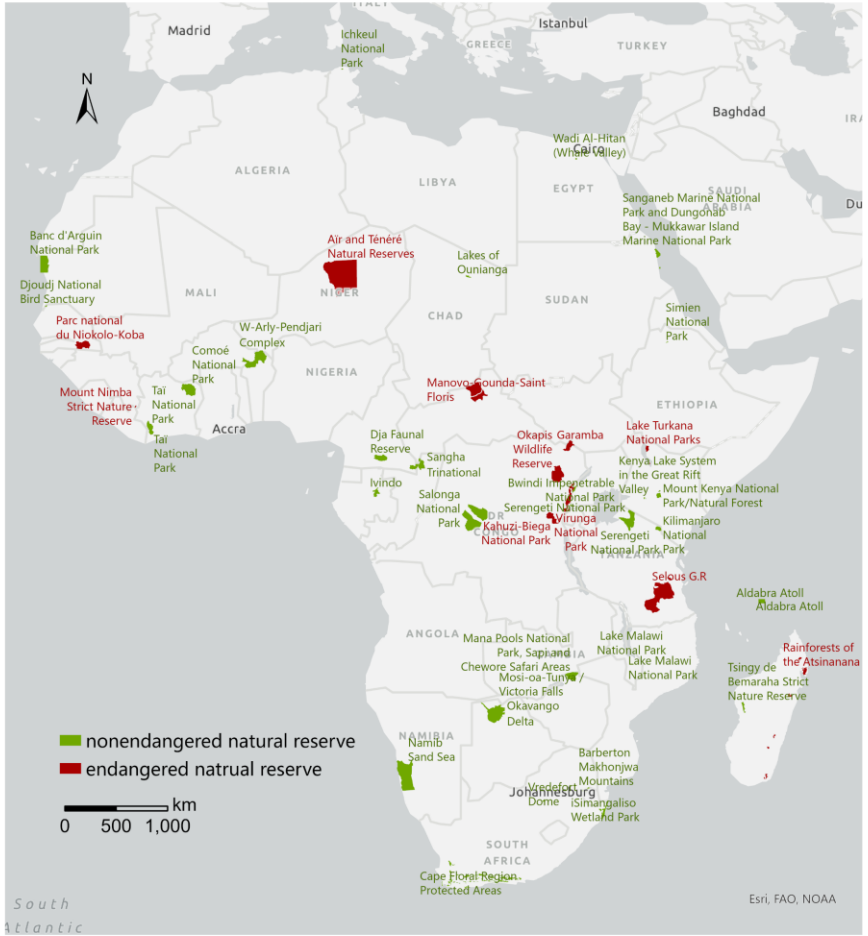
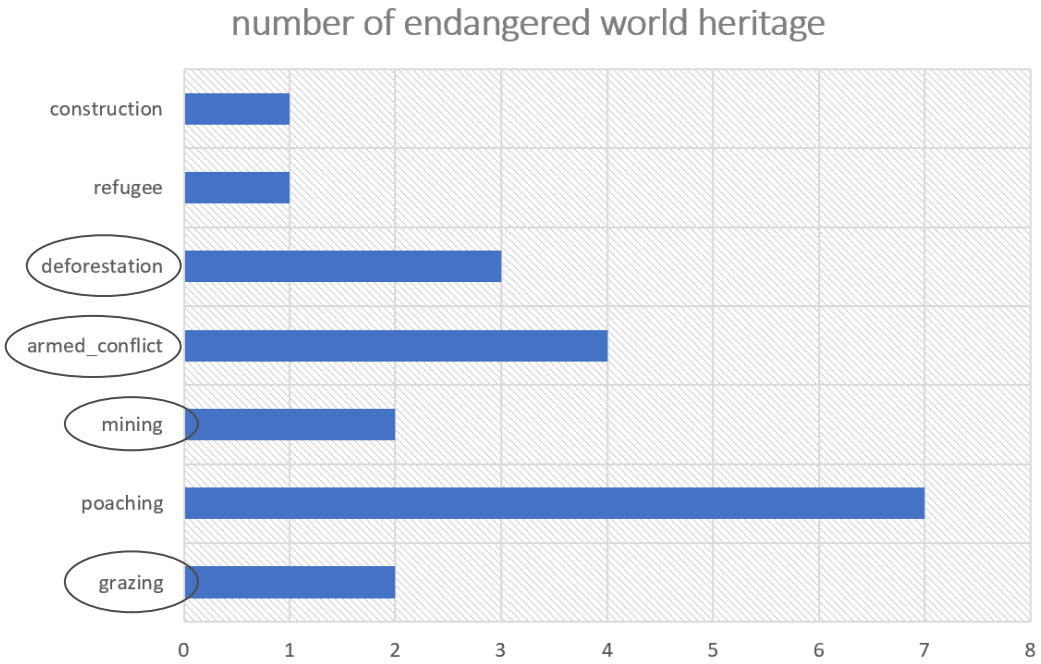


Current challenges

1. The assessment of endangered risk is highly dependent on self-declaration, and the updating of the endangered list is slow.

2. The management abilities of African governments are usually weak, so the current situation of individual WHS cannot be gotten easily.

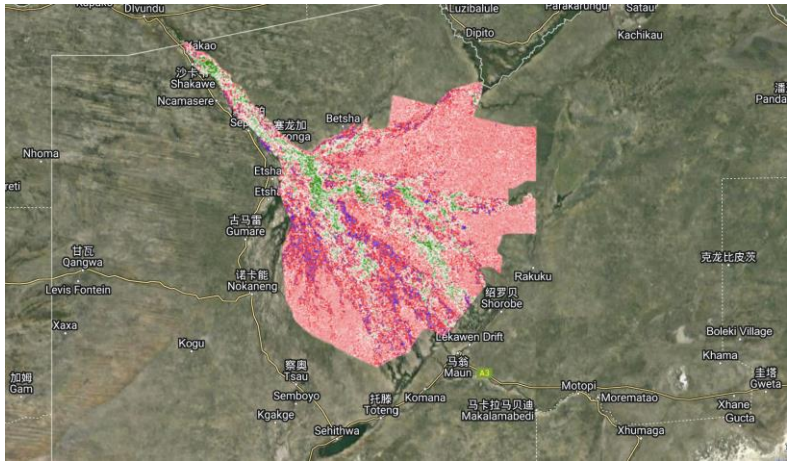
Ideas : reasons for endanger WHS in Africa



Grazing

Extract NDVI from Landsat Data between 2010 and 2020 → Time series dataset

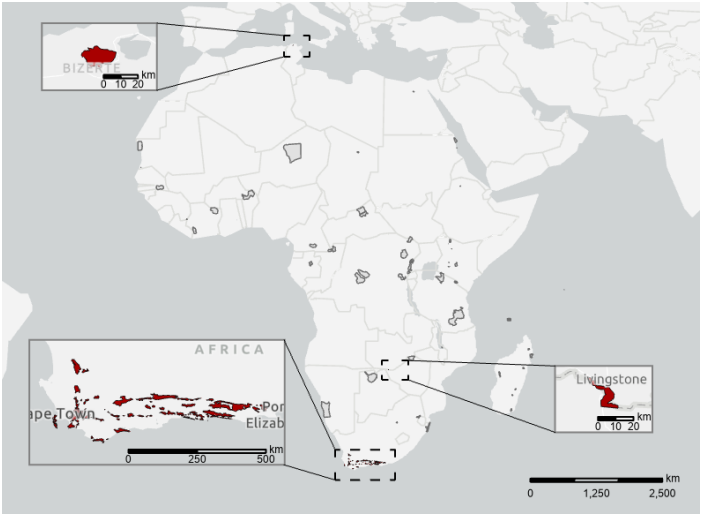
MK test → Extract areas of grass degradation with a confidence coefficient larger than 95%



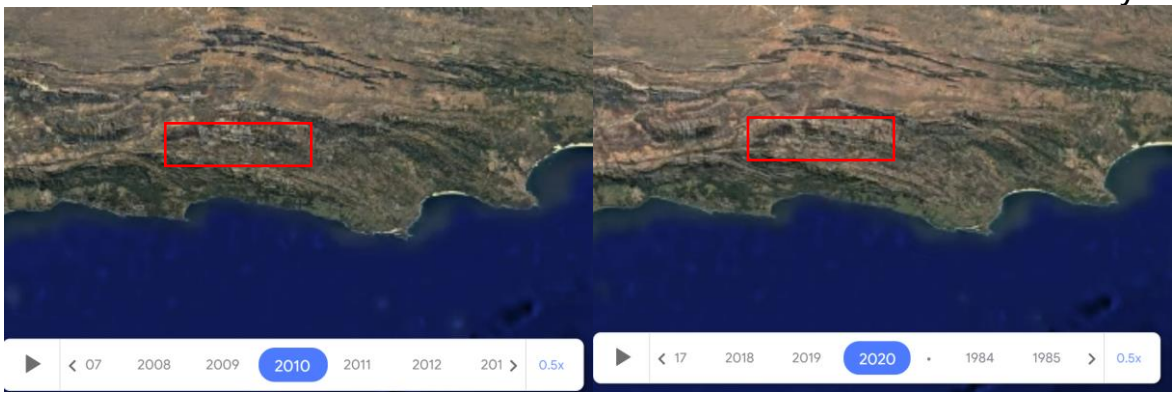
Okavango Delta

Only consider areas of superimposed grasslands and shrubs

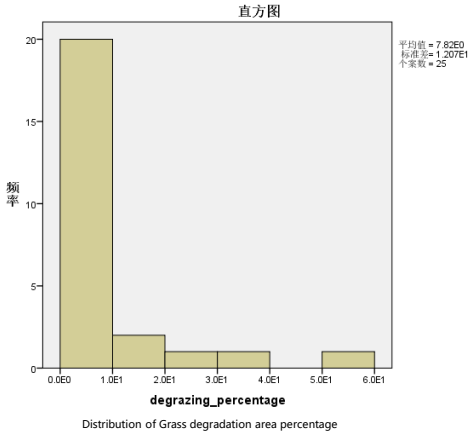
Grazing



Newly found endangered areas by us



Cape Floral Region Protected Areas



Distribution of Grass degradation area percentage

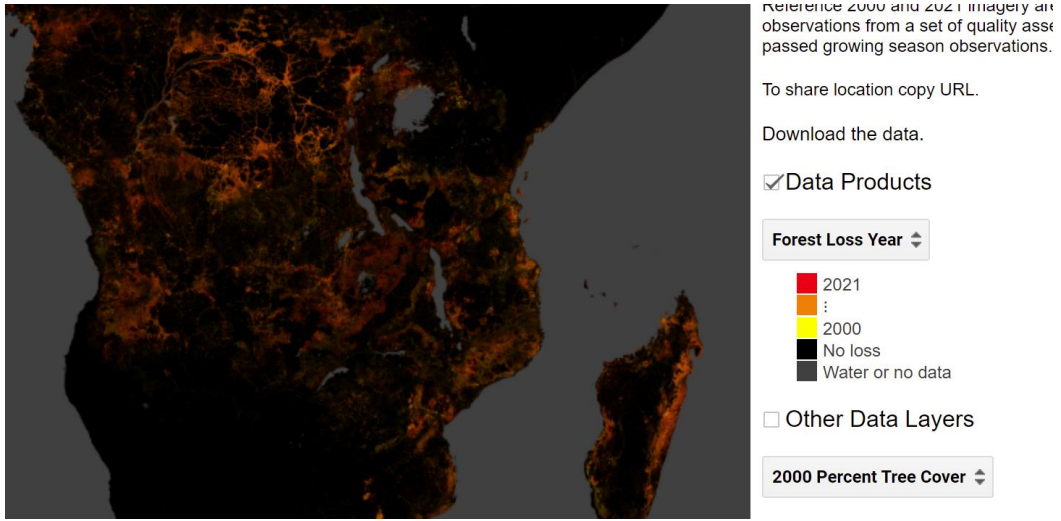
Deforestation

dataset：google earth engine (Hansen Global Forest Change v1.8)

- Satellite dataset：
  (1) landsat7 ETM+
  (2) Modis (3) QuickBird

- Deforestation area extraction：
  (1) time series analysis
  (2) bagged decision tree

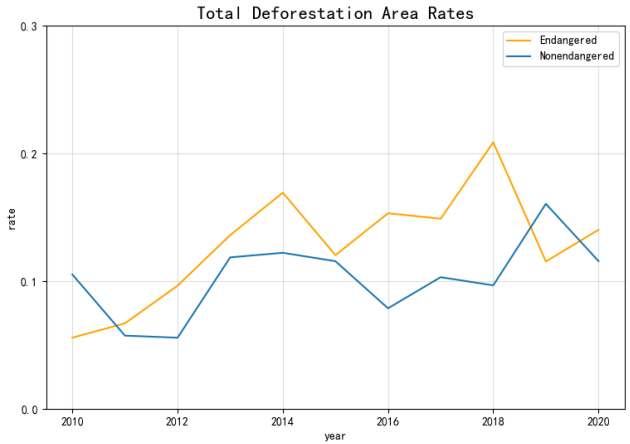
- Accuracy of the classification model: more than 90%



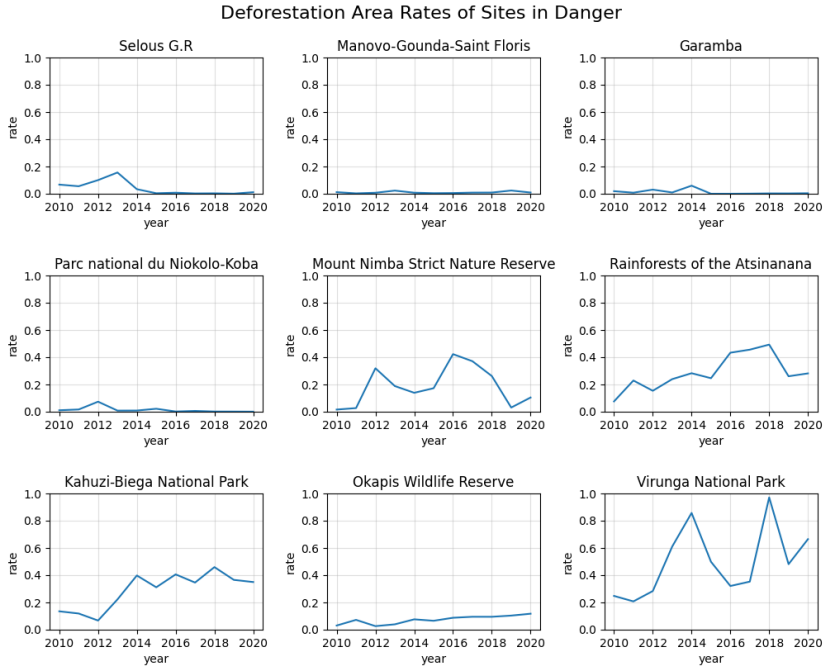
Examples of deforestation areas extracted

Deforestation

the contrast of annual deforestation rate

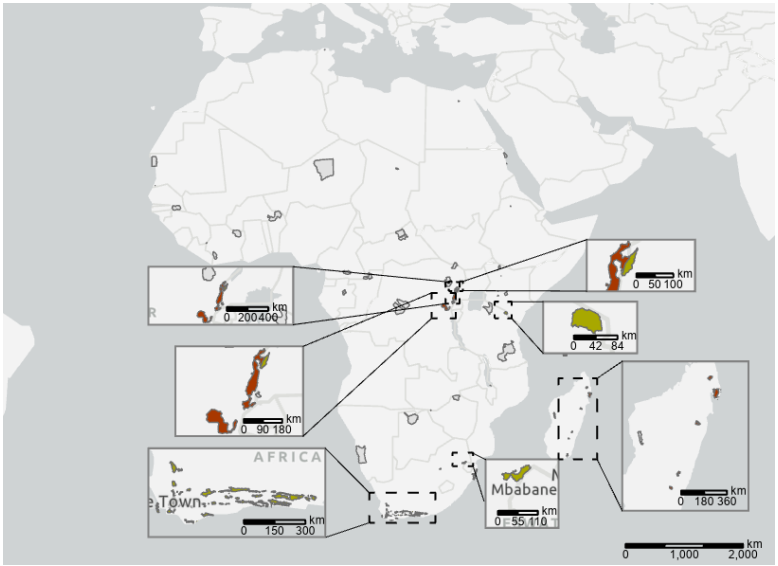


The contrast between
endangered and nonendangered

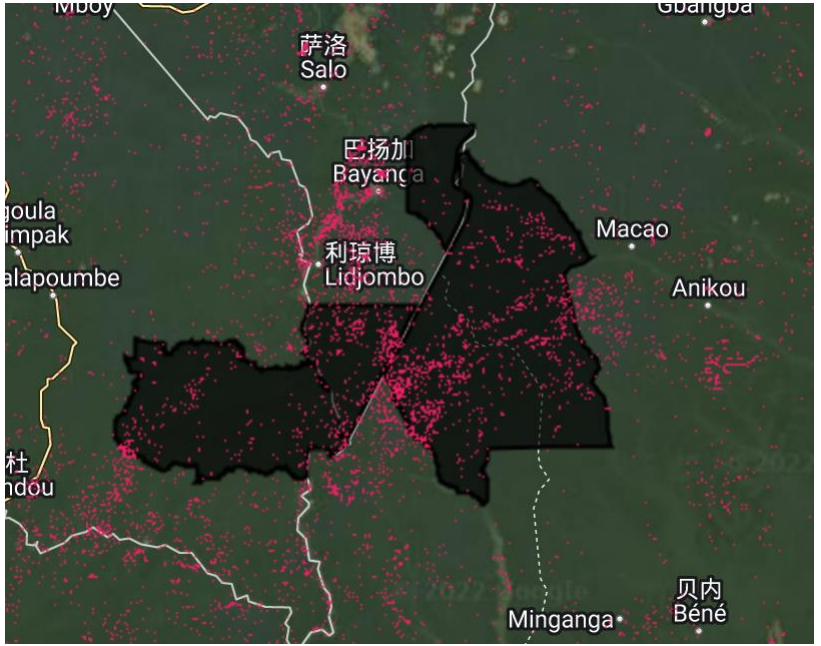


Nine endangered WHS

Deforestation



Newly found candidate endangered WHS by us

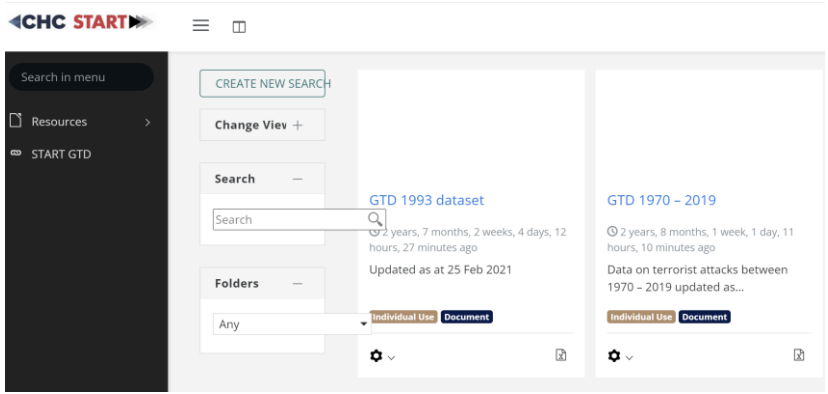


An example of a newly-found candidate endangered WHS

Armed-conflict

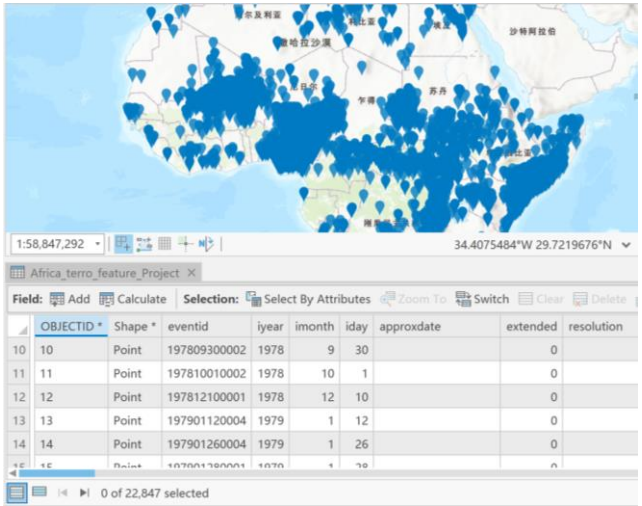
dataset

Global terrorism database
https://gtd.terrorismdata.com/files/gtd-1970-2019-4/



Projected Coordinate System	Africa Albers Equal Area Conic
Projection	Albers
WKID	102022
Authority	Esri
Linear Unit	Meters (1.0)
False Easting	0.0
False Northing	0.0
Central Meridian	25.0
Standard Parallel 1	20.0
Standard Parallel 2	-23.0
Latitude Of Origin	0.0

Projection(equal area projection)



22847 records of armed conflict in Africa are selected

Armed-conflict

Time-space cube analysis

Create Space Time Cube By Aggregating Po...

Parameters | Environments

Input Features
Africa_terro_feature_Project

Output Space Time Cube
D:\srtp\srtp\whs\arcGIS_Projects\MyProject\terro_feature

Time Field
date

Template Cube

Time Step Interval
1 | Years

Time Step Alignment
End time

Aggregation Shape Type
Fishnet grid

Distance Interval
50 | Kilometers

Summary Fields

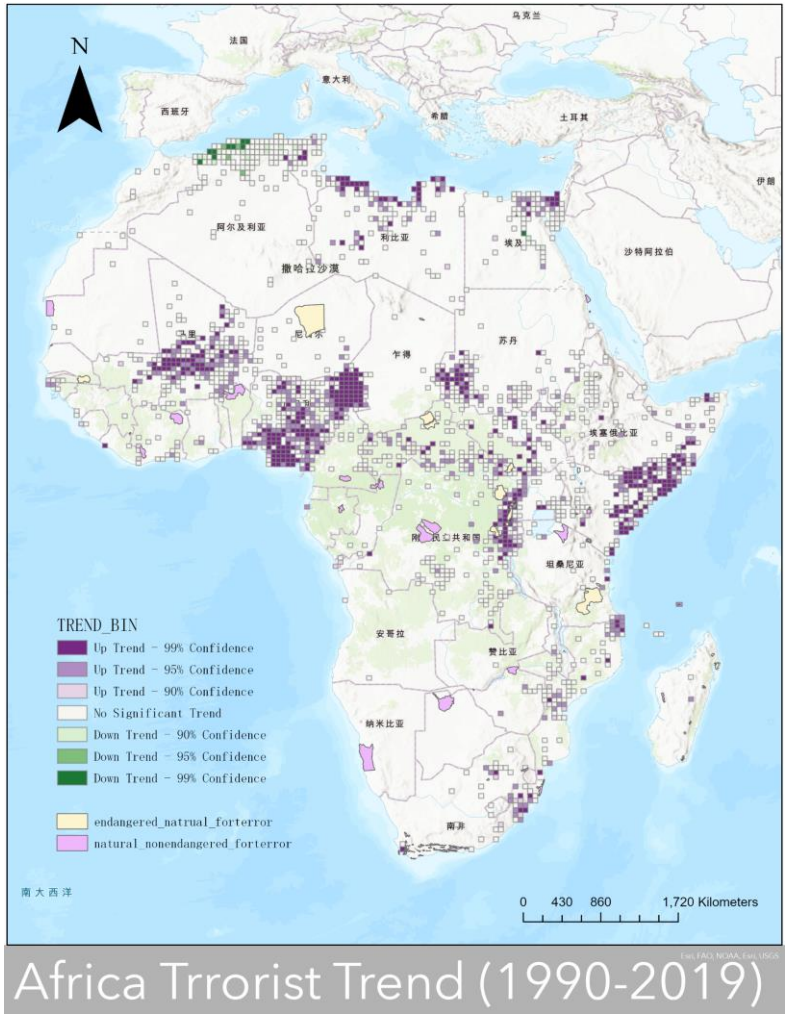
Field

Statistic

Fill Empty Bins with

Add another

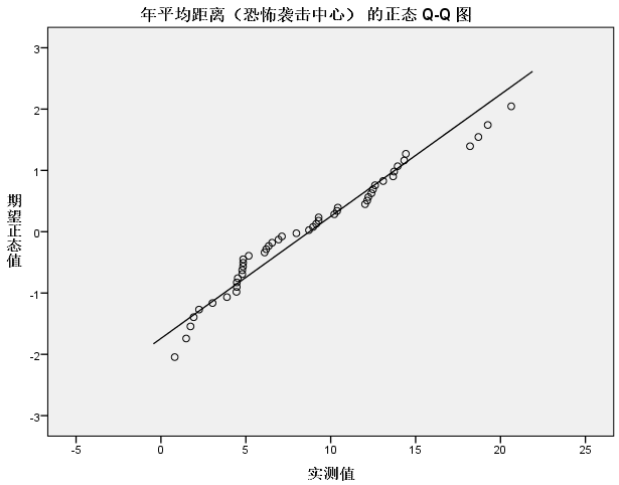
Parameters for the time-space cube

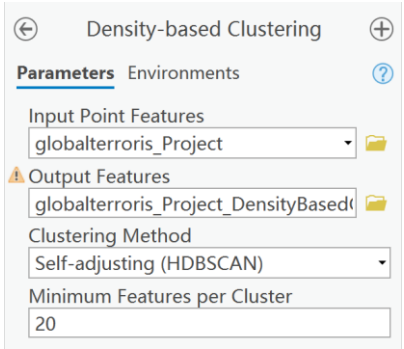


Africa Trrorist Trend (1990-2019)

Armed-conflict

Year by year density-based analysis





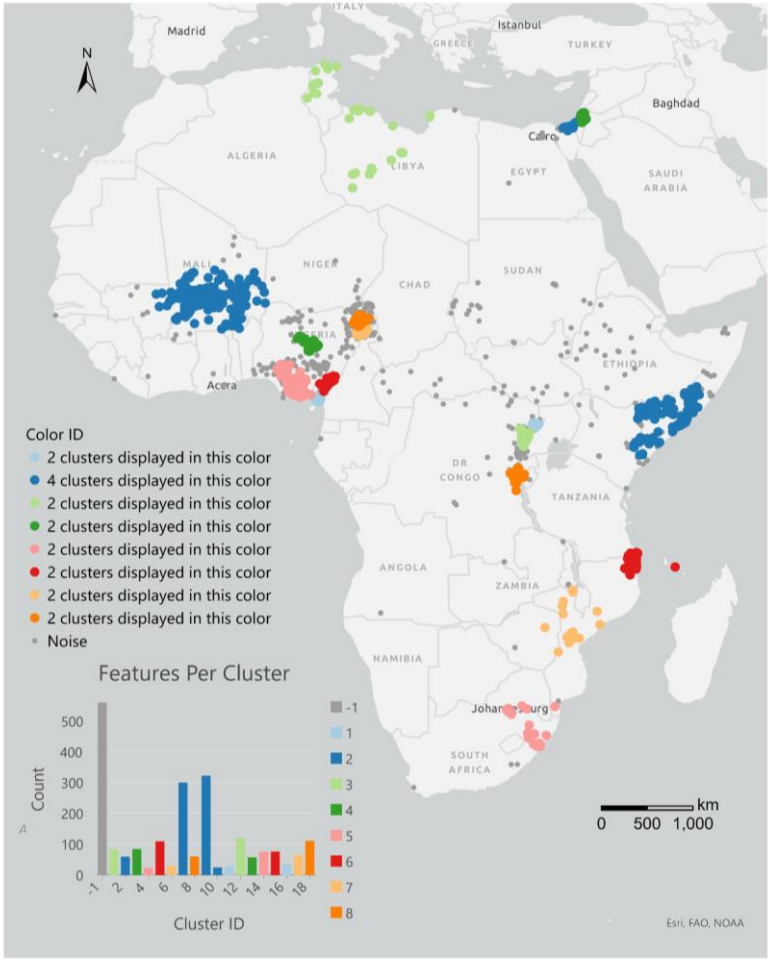
Parameter settings

正态性检验

	柯尔莫戈洛夫-斯米诺夫[a]			夏皮洛-威尔克		
	统计	自由度	显著性	统计	自由度	显著性
年平均距离（恐怖袭击中心）	.116	48	.116	.953	48	.051

a. 里利氏显著性修正

Normality test in SPSS

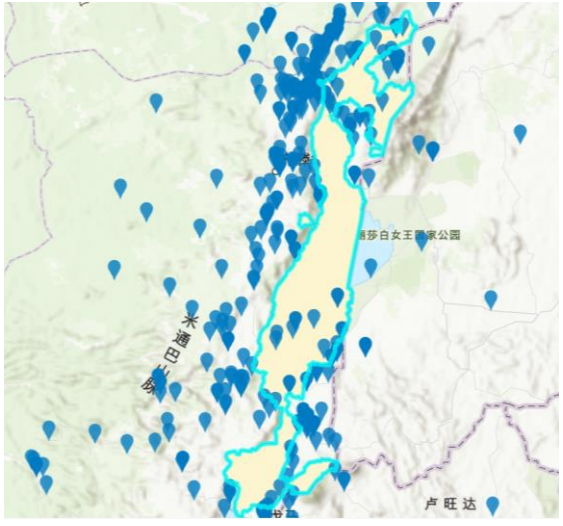


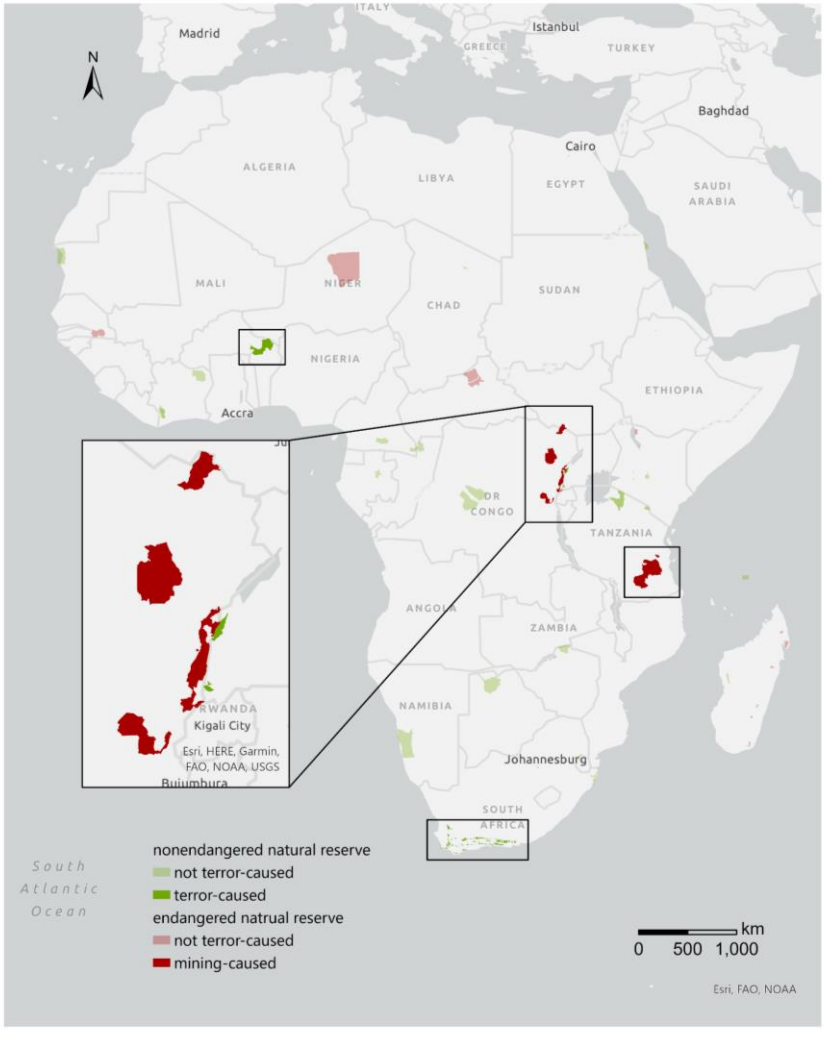
Density-based clustering result of 2019

Armed-conflict

Newly founded potential endangered WHS:

Virunga National Park

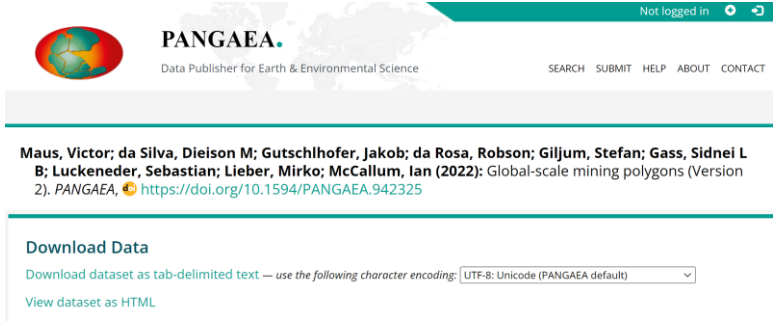


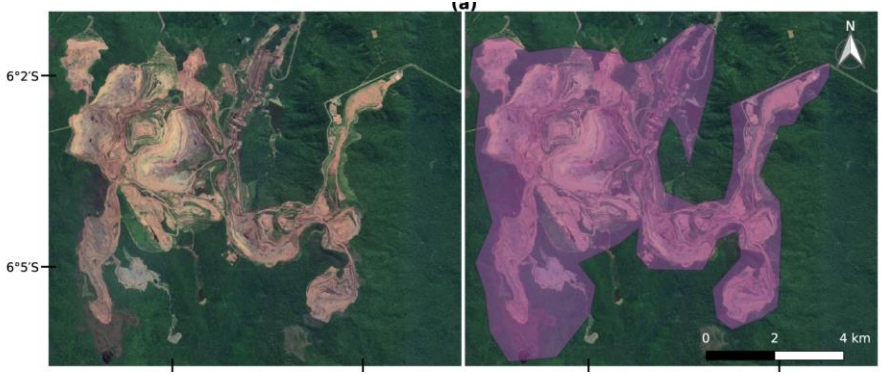


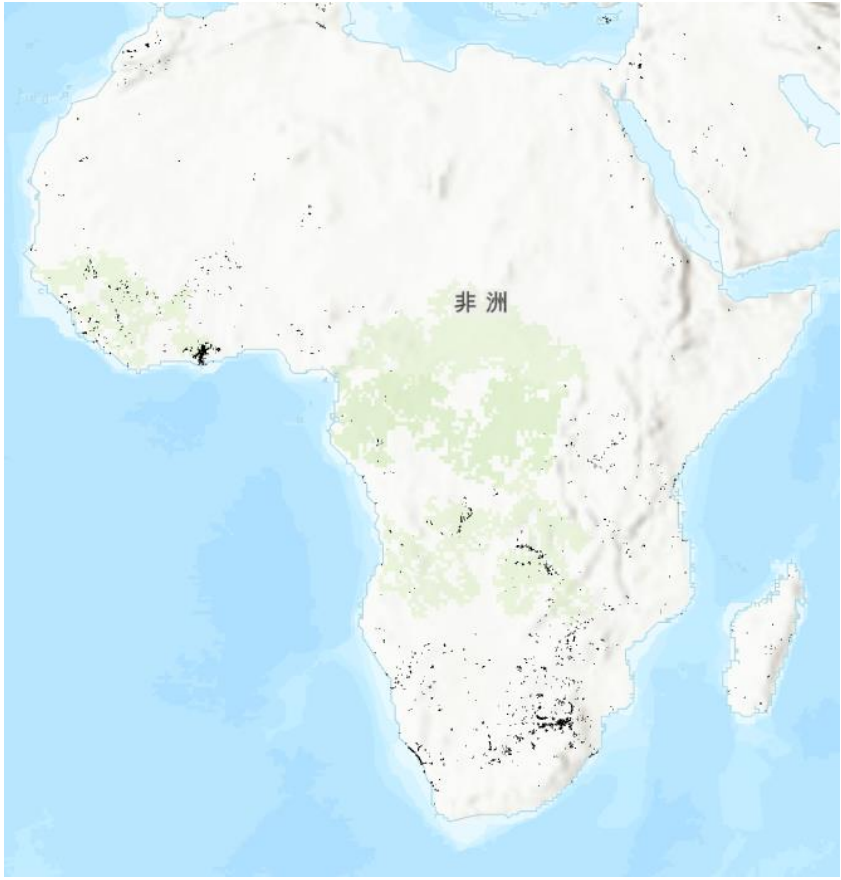
Mining

Data source

https://doi.pangaea.de/10.1594/PANGAEA.942325

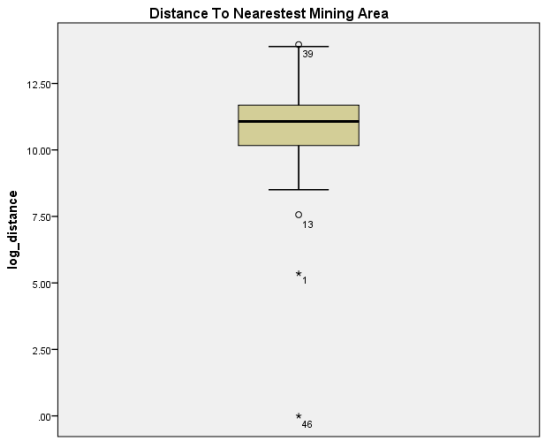


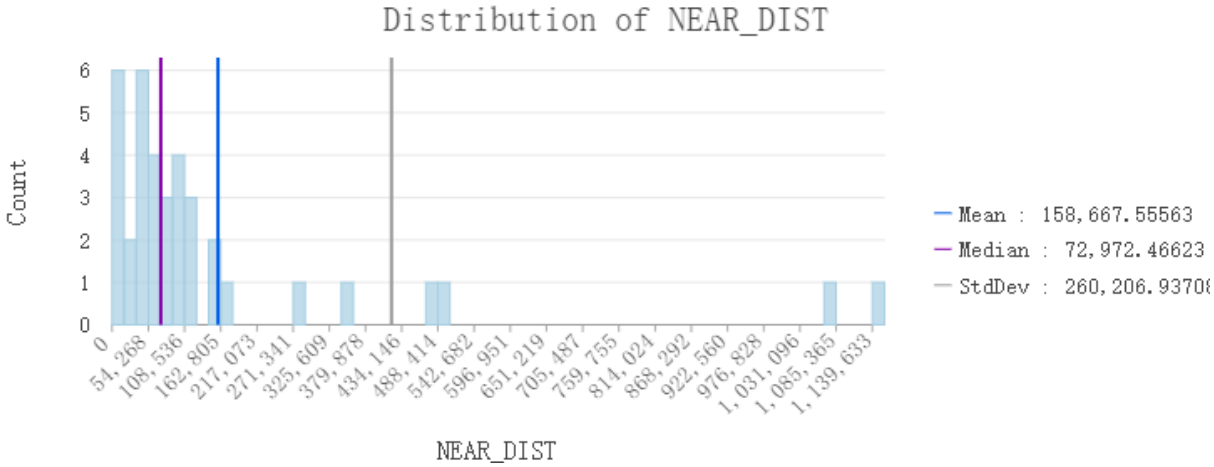




Mining

- Compute the distance from WHS to the nearest mining area
- Take the log of the distance
- Find the anomaly by the box graph

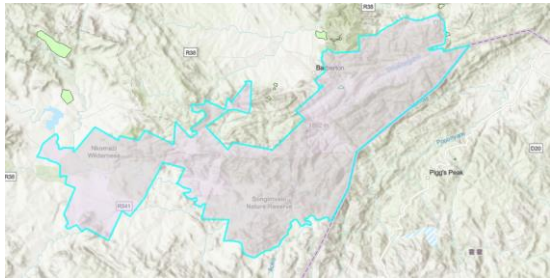


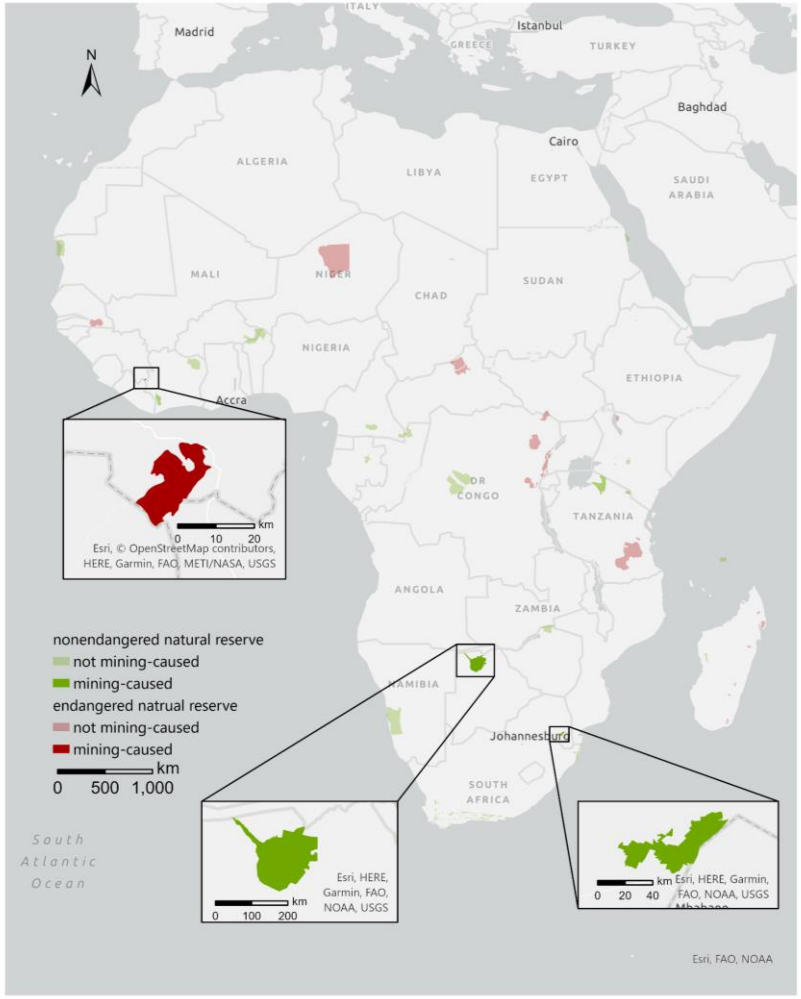


Mining

Newly founded potential endangered WHS:

Barberton Makhonjwa Mountains





Result conclusions

- Code links on GEE: https://code.earthengine.google.com/?accept_repo=users/3190100837/SRTP

- To Download code: git clone https://earthengine.googlesource.com/users/3190100837/SRTP

Reason	Site	Listed or not	Shooting rate
Mining	Mount Nimba Strict Nature Reserve	√	50%
	Okavango Delta	×	
	Barberton Makhonjwa Mountains	×	
Armed Conflicts	Kahuzi-Biega National Park	√	75%
	Okapis Wildlife Reserve	√	
	Virunga National Park	×	
	Selous G.R	×	
	Garamba	√	
	Bwindi Impenetrable National Park	×	
	Rwenzori Mountains National Park	×	
	W-Arly-Pendjari Complex	×	
	Cape Floral Region Protected Areas	×	
Deforestation	Barberton Makhonjwa Mountains	×	100%
	Cape Floral Region Protected Areas	×	
	Virunga National Park	√	
	Rwenzori Mountains National Park	×	
	Kilimanjaro National Park	×	
	Kahuzi-Biega National Park	√	
	Rainforests of the Atsinanana	√	
Grazing	Ichkeul National Park	×	0%
	Cape Floral Region Protected Areas	×	
	Mosi-oa-Tunya / Victoria Falls	×	

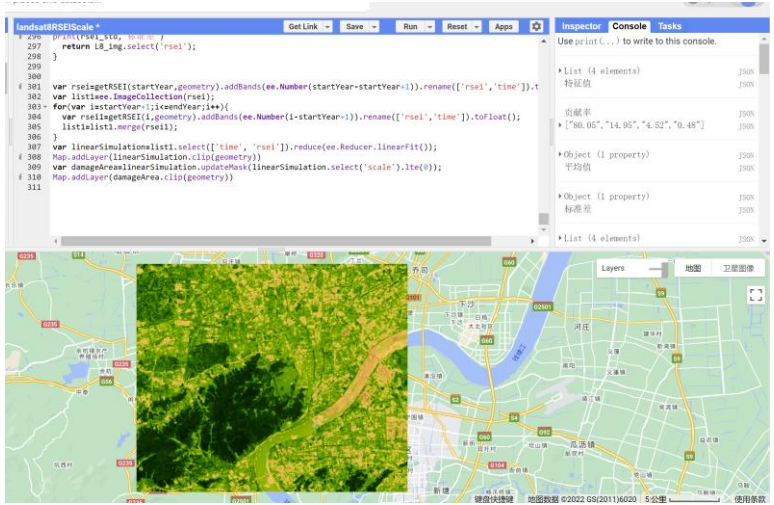
结果汇总

contributions

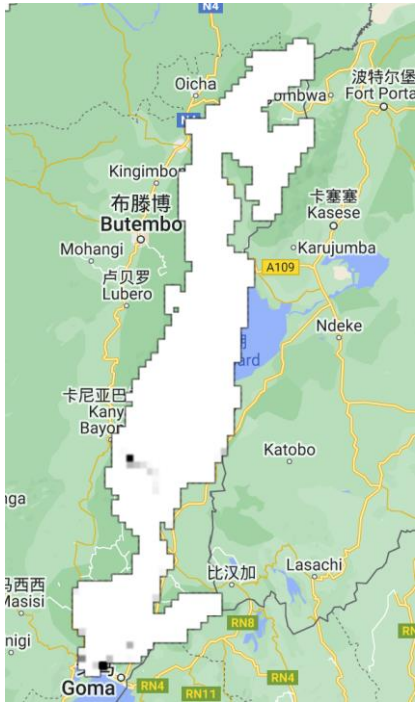
1. Put Forward A rapid endanger-risk assessment framework for WHS in Africa based on multi-source data; It considers all the main reasons for endangering in Africa.
2. Compared with previous studies, we first realized a comprehensive evaluation of all the WHS in Africa。

Extra Contributions

- a program that can get a cloud-free NDVI (Normalized Difference Vegetation Index) image with a time resolution of 1 day by integrating images from six satellites
- An automatic computing tool for RSEI (remote sensing based ecology index)



RSEI



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- Code and download methods:
  https://code.earthengine.google.com/?accept_repo=users/3190100837/GEEtools
  git clone https://earthengine.googlesource.com/users/3190100837/GEEtools

THANKS!