Using InVEST models combined with Sentinel-2 products to quantify mangrove changes over the Kenyan coast

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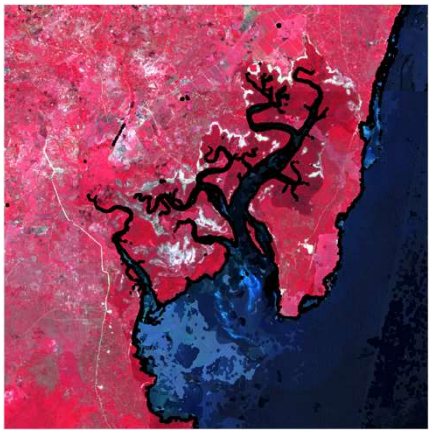


Fig.1 – False colour image of Kenyan mangroves

Abstract

Why Kenyan mangroves?

- Mangroves are the dominant vegetation along many tropical and subtropical coasts. They provide a wide range of **ecosystem goods and services** of immense value to local, national and global communities.
- Despite this importance, these unique coastal forests are among **the most threatened habitats** in the world (FAO, 2007). Mangroves have been overexploited or converted to various other forms of land use.
- In Kenya, estimates of mangrove cover vary between **46,000 and 52,980 ha**, finding in creeks, estuaries, bays and river deltas. As in many parts of the world, mangrove ecosystems in Kenya face a number of challenges that threaten their existence (ex. clearing for development, agri/aquaculture, salt production).

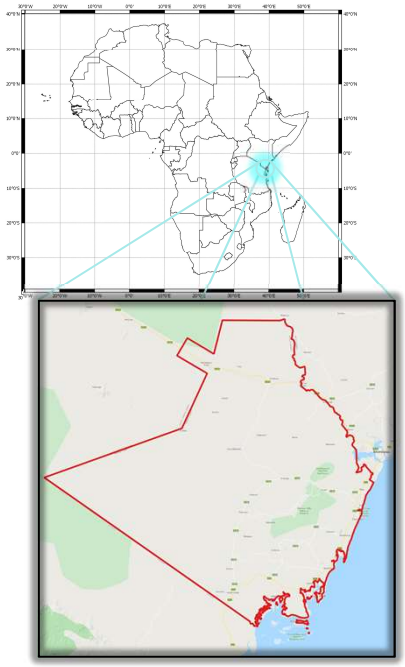


Fig.2 – Area of interest

Part 1 – Classification

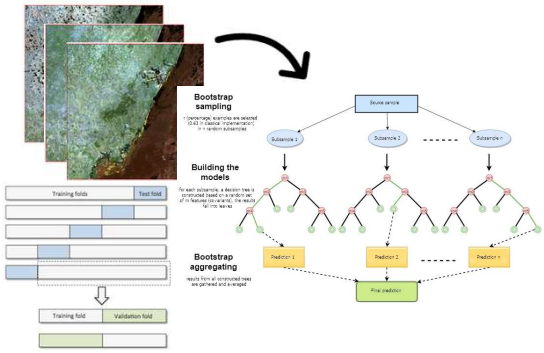


Fig.3 – Process implemented for classify S2 images

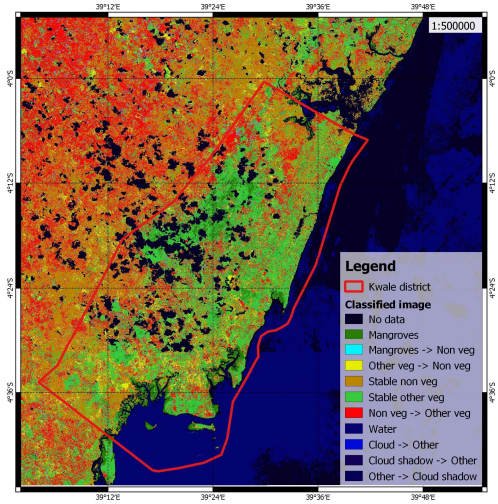
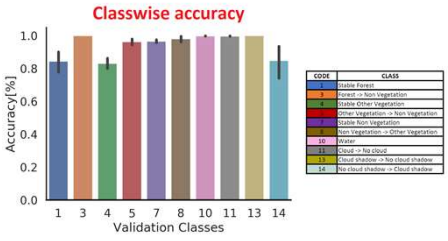


Fig.4 – Thematic map obtained from the classification

In this study, an overall accuracy around 93%, a k-statistic of 91% and an OOB score of 0.9918 were achieved.



Confusion Matrix Normalized

Map's prediction \ Reference data	1	3	4	5	7	8	10	11	13	14	PA
1	0.796	0	0.188	0	0	0	0	0	0.016		79.59%
3	0	1	0	0	0	0	0	0	0		100%
4	0.054	0	0.875	0.037	0.031	0.003	0	0	0		87.54%
5	0	0	0.149	0.78	0.068	0	0	0	0		78.38%
7	0	0	0.003	0	0.991	0	0.005	0	0		99.13%
8	0	0	0.022	0	0.007	0.971	0.000	0	0		97.06%
10	0	0	0	0	0.022	0	0.967	0.011	0		96.68%
11	0	0	0	0	0	0	0.018	0.982	0		98.20%
13	0	0	0	0	0.333	0.111	0	0	0.556		55.56%
14	0	0	0	0	0	0.027	0	0	0	0.973	97.30%
UA	94.81%	100%	75.92%	81.69%	92.80%	97.06%	99.01%	97.03%	100%	83.72%	

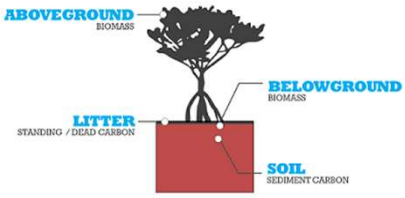
Fig.5 – Accuracy assessment of the classification

Sum of pixels		Total mangroves area in Kwale county	
228		8354	ha
		83540000	m^2
Pixel dimensions		83.54	km^2
100	m^2		
		Percentage	
Total area		0.027%	
22800	m^2		
0.02	km^2		
245416.92	ft^2		
2.28	ha		

Tab.1 – Changes from mangrove to non vegetated areas

Part 2 - InVEST Coastal Blue Carbon model

InVEST Coastal Blue Carbon models the carbon cycle through a bookkeeping-type approach.



$$S_{total} = S_{biomass} + S_{soil} + S_{litter}$$

Fig.6 – Idea behind Coastal Blue Carbon model

Data Needs

The Coastal Blue Carbon model is run in two steps, the Coastal Blue Carbon Preprocessor and the main Coastal Blue Carbon model.

Inputs

- LULC Lookup Table:

lulc-class	code	is_coastal_blue_carbon_habitat
no_data	0	FALSE
mangrove	1	TRUE
stable_other_vegetation	2	FALSE
stable_non_vegetation	3	FALSE
water	4	FALSE
cloud	5	FALSE

- LULC transition effect of carbon table.
- Carbon pool initial and transient variables tables.
- LULC Rasters (baseline and snapshots).
- Other optional inputs (present value, interest rate, discount rate, etc.).

Outputs

- Amount of carbon accumulated between the two specified years.
- Amount of carbon lost to disturbance between the two specified years.
- Sum of the 3 carbon pools for each LULC for the specified year.
- Total carbon sequestration between the two specified years.
- Total carbon sequestration over the whole time period between the Baseline and either the latest Snapshot Year.

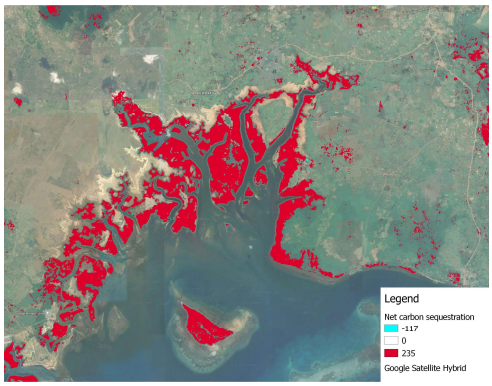


Fig.7 – Net carbon sequestration between 2018 and 2050 in Gazi Bay

Key references: "National Mangrove Ecosystem Management Plan 2017-2027", Ministry of Environment, Natural Resources and Reginal Development Authorities, Republic of Kenya.
B. K. Kirui, "Importance and Dynamics of the Mangroves in Kenya", Department of Natural Resources, Egerton University, Kenya, and Joint Research Centre - European Commission, Italy.