Mapping Mangrove Dynamics: Monitoring the Ayeyarwady Delta Region

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Introduction

- The Ayeyarwady Delta's mangrove forests are vital to the expansion of the area. They give vital resources like food and fuel for neighboring inhabitants, protect the coastline, and sustain a wide variety of plant and animal species.
- Mangroves are useful in reducing climate change since they also help to improve water quality and sequester carbon. For these ecosystems to continue to provide benefits to both nature and people, conservation and management are essential.
- **Cyclone Nargis in 2008 demonstrated the critical role of mangroves in safeguarding the coast.**
- However, the over-exploitation of mangroves has led to their decline, making the densely populated communities of the delta more vulnerable.
- Deforestation and land conversion in Myanmar pose ongoing threats to the mangroves, necessitating conservation, restoration, and improved management efforts to address these challenges.

Research question and objectives

- What is **the extent of mangrove cover change** in the Ayeyarwady Delta in Myanmar, and what are the main drivers behind this change?

- Assess the historical and current extent of mangrove cover in the Ayeyarwady Delta.
- Quantify and analyze the rate and patterns of mangrove cover change over a specific time period.

Inventory and summary of existing National-level mangrove datasets for Myanmar- July 2020

Author(s)	Year(s)	Spatial Extent/Resolution	Availability	Imagery Source(s)	Methods	Discrete/ Continuous
Giri et al. [70]	1975, 1990, 2000, 2005	6 tsunami-affected countries/30 m	Available from authors	Landsat	Hybrid supervised/unsupervised classification (ISODATA† clustering)	Discrete
SERVIR-Mekong Regional Land-Cover Monitoring System—Saah et al. [73]	1987–2018 (V3)	Greater Mekong region/30 m	Downloadable from SERVIR-Mekong website (at c. 120 m resolution; available from authors at 30 m)	Landsat, MODIS	Supervised classification (Support Vector Machine; Random Forest)	Discrete
Global Mangrove Watch—Bunting et al. [74]	1996, 2007–2010, 2015–2016	Global/25 m	Downloadable from Ocean Data Viewer	Jers-1, ALOS, ALOS-2, Landsat	Supervised classification (Random Forest); histogram thresholding [57]	Discrete
de Alban et al. [57]	1996, 2007, 2016	National/30 m	Available from authors	Landsat, JERS-1, ALOS, ALOS-2	Supervised classification (Random Forest)	Discrete
Stibig et al. [76]	1998–2000	S and SE Asia/1 km	Downloadable from JRC	SPOT-4	Unsupervised maximum likelihood classification	Discrete
Blasco et al. [77]	1999	Bangladesh and Myanmar/20 m	Not available	SPOT 1, 2, 3	Visual interpretation and supervised classification	Discrete
Clark Labs [75]	1999, 2014, 2018	Multi-national/30 m	Downloadable from Clark Labs website	Landsat	Mahalanobis classifier; hybrid supervised/ISOCLUST ‡ clustering	Discrete
World Atlas of Mangroves (WAM)—Spalding et al. * [5]	2000–2007	Global/30 m	Downloadable from Ocean Data Viewer	Landsat	Not disclosed	Discrete
Mangrove Forests of the World (MFW)—Giri et al. [44]	2000	Global/30 m	Downloadable from Ocean Data Viewer	Landsat	Hybrid supervised/unsupervised classification (ISODATA † clustering)	Discrete
CGMFC-21—Hamilton and Casey [78]	2000–2014	Global/30 m	2000–2012 data downloaded from CGMFC-21, 2013–2014 data available from authors	Landsat	Masked Global Forest Change (GFC) [47] maps using MFW [47]) to calculate dynamics	Continuous
Richards and Friess [47]	2000, 2012	SE Asia/30 m	Not available	Landsat	Masked GFC maps using MFW [56] to calculate loss	Continuous
Estoque et al. [56]	2000, 2014	National/30 m	Not available	Landsat	Unsupervised classification (ISODATA † clustering)	Discrete

* WAM data over Myanmar from Ministry of Forestry's Remote Sensing and GIS Section, derived from Landsat imagery 2000–2007. † Iterative Self-Organizing Data Analysis Techniques. ‡ Iterative Self-Organizing Clustering.

Source: The Google Earth Engine Mangrove Mapping Methodology (GEEMMM), J. Maxwell M. Yancho

Method: image pre-processing

De Alban, et al., 2020	Arsalan Ghorbanian, et al., 2021	MDO

• Landsat images
  • Median image
  • the standard reflectance bands (visible, near infrared, thermal, shortwave-infrared)
  • six indices (NDTI, EBI and BI, EVI, NDVI, and SAVI, LSWI)
• L-band SAR images
  • HH-polarization channel
  • Refined Lee filter
• Non-satellite data
  • Elevation data
	• Sentinel 2 images
	  • Time series data
	  • four seasons median images
	  • the standard reflectance bands (visible, near infrared)
	• Sentinel 1 images
	  • Time series data
	  • four seasons median images
	  • VV & HH-polarization channel
	  • Refined Lee filter
		• Sentinel 2 images
		  • Time series EVI
		  • Monthly median EVI
		• Sentinel 1 images
		  • Time series data
		  • three seasons median images
		  • VV & HH-polarization channel
		  • Refined Lee filter
		• Non-satellite data
		  • Elevation data
		  • Distance from coastal line
		  • Canopy height data

1996-2007-2016 (Myanmar)	2017-2019 (other area)	2000-2022, 2018-2022 (Myanmar)

FAO: Mangrove degradation monitoring training - The Continuous Change Detection and Classification (CCDC) algorithm.

Source: https://medium.com/@moraesd90/creating-monthly-ndvi-composites-sentinel-2-on-google-earth-engine-a5c2d49bc9ca

Method

1. image pre-processing
2. delineation of ROI (CEO)
3. image classification
4. accuracy assessment
5. change analysis

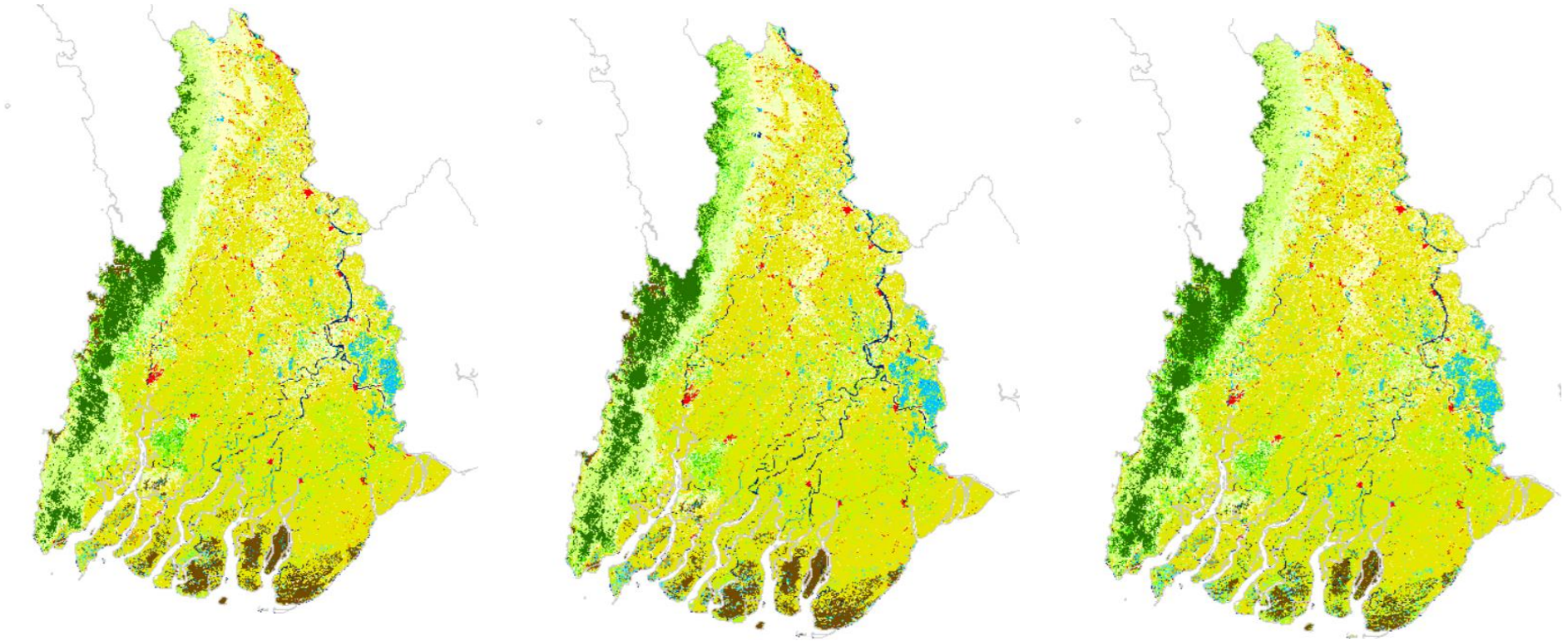
Class categories

Code	Class name	Defn.
1	Shrubs	Woody perennial plants with persistent and woody stems and without any defined main stem being less than 5 m tall. The shrub foliage can be either evergreen or deciduous.
2	Grassland	Grasslands are characterized as lands dominated by grasses rather than large shrubs or trees. It is crucial that the rainfall is concentrated in six or eight months of the year, followed by a long period of drought when fires can occur.
3	Crop land	Lands covered with temporary crops followed by harvest and a bare soil period (e.g., single and multiple cropping systems). Note that perennial woody crops will be classified as the appropriate forest or shrub land cover type.
4	Built-up area	Land covered by buildings and other man-made structures.
5	Bare / sparse vegetation	Lands with exposed soil, sand, or rocks and never has more than 10 % vegetated cover during any time of the year.
6	Permanent water bodies	Lakes, reservoirs, and rivers. Can be either fresh or salt-water bodies.
7	Herbaceous wetland	Lands with a permanent mixture of water and herbaceous or woody vegetation. The vegetation can be present in either salt, brackish, or fresh water.
8	Closed forest	Closed forest (evergreen needle leaf, evergreen broad leaf, deciduous needle leaf, deciduous broad leaf, mixed, not matching any of the other definitions)
9	Open forest	Open forest (evergreen needle leaf, evergreen broad leaf, deciduous needle leaf, deciduous broad leaf, mixed, not matching any of the other definitions)
10	Mangrove	Forested wetlands with a specific type of vegetation that is adapted to saline conditions and characterized by salt-tolerant trees and shrubs.
11	Rice Field	Land used for the cultivation of rice, a crop that is grown in dry land and flooded fields.
12	Aquaculture	Areas where aquatic organisms such as fish, shellfish, and seaweed are cultivated for commercial purposes.
13	Saltpan	The area where has saltpan
14	Tree	Any individual tree or stand of trees, regardless of size or forest type.

Ref: FAO (https://www.fao.org/documents/card/en/c/cc0730en/
https://www.fao.org/hih-geospatial-platform/ru/resources/land-cover-legend-registry/)

Output maps

2018 2020 2022

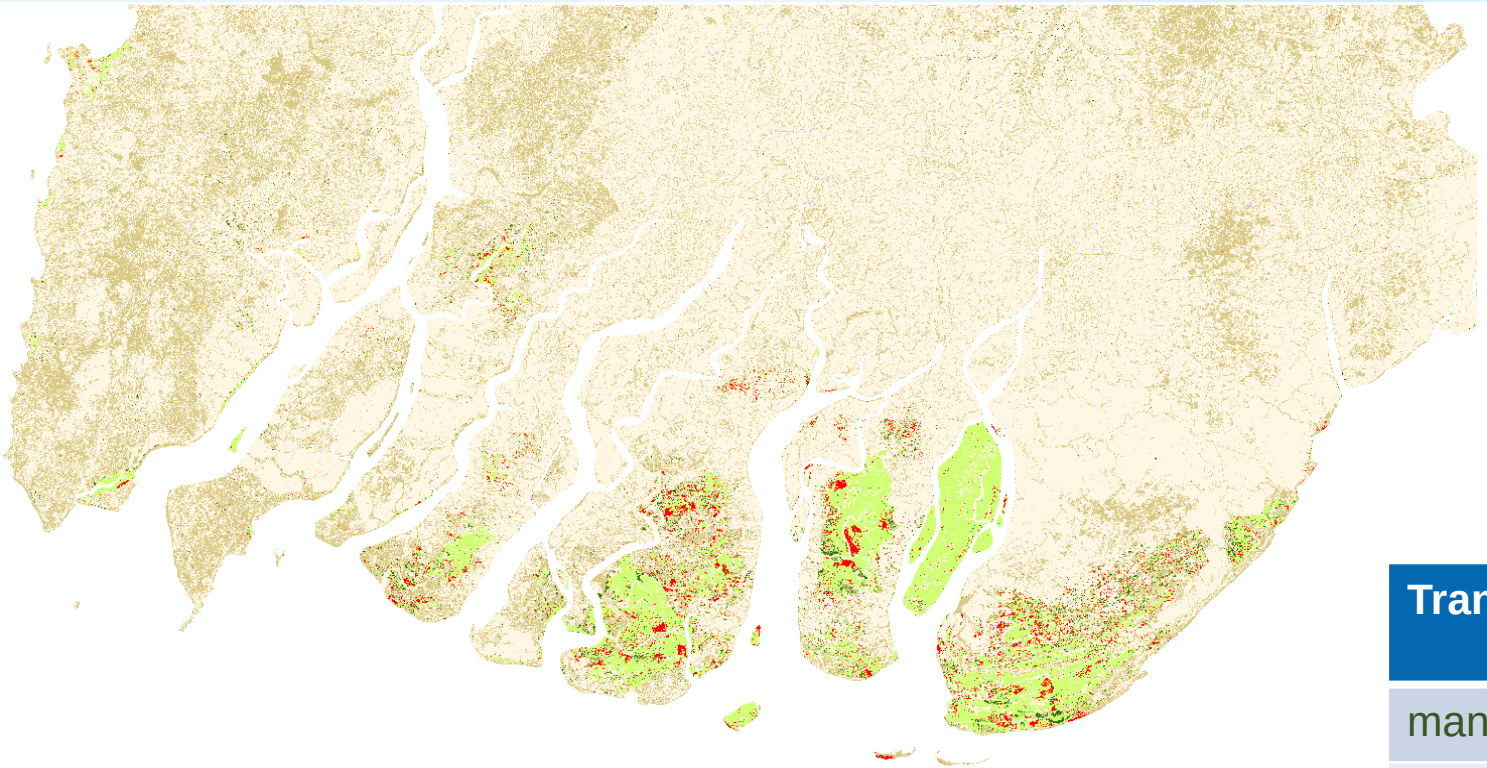


Land cover map of Ayeyarwady Region (2018, 2020 and 2022)

Output analysis

Region	AREA (SQKM)					Annual rate
	2018	2019	2020	2021	2022	annual rate (2018-2022)
Ayeyarwady Region	831	792	767	758	771	-1.88%
Pyapon DT	488	466	451	456	468	-1.08%
Labutta DT	248	240	230	219	223	-2.73%

Change analysis

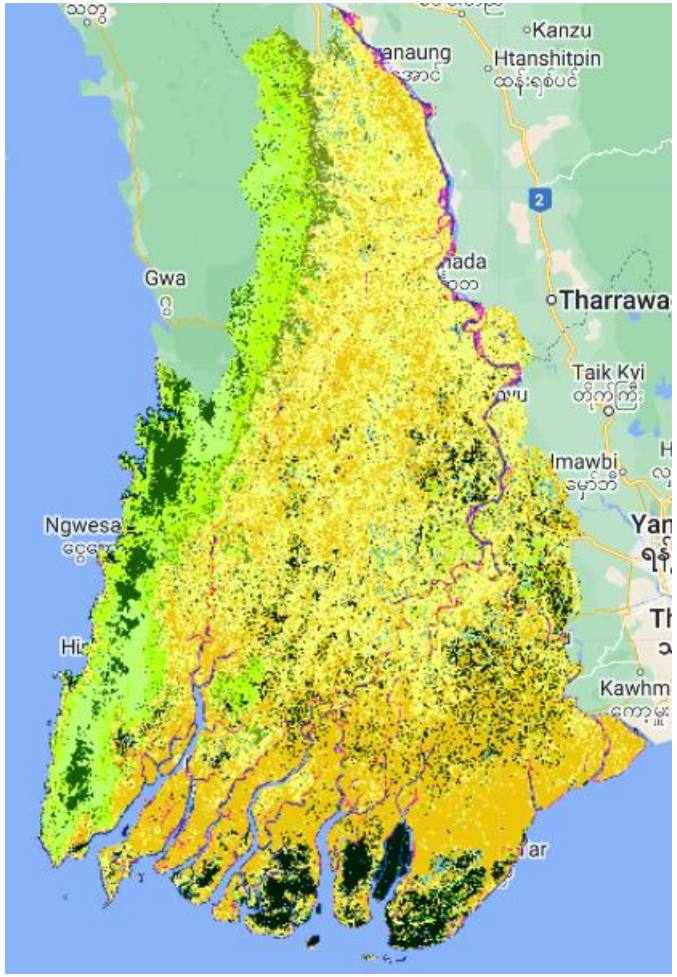


- Mangrove net change (2018-2022) : -60 sqkm
  - Mangrove to rice field: 31%
  - Mangrove to wetland: 20%
  - Mangrove to bare land: 17%
  - Mangrove to crop land: 11%

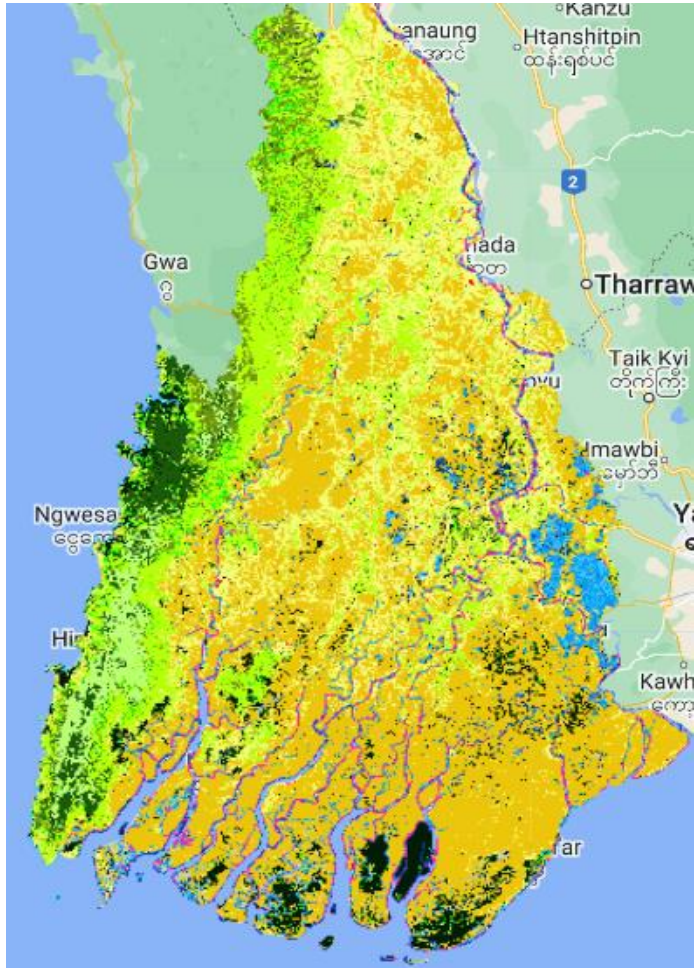
Transition class	Area (Sq km)	Percentage
mangrove gain area	67	0.2%
mangrove loss area	127	0.4%
mangrove unchanged area	704	2.0%
unchanged area	25,334	72%
changed area	9,102	26.0%

Output maps

2000



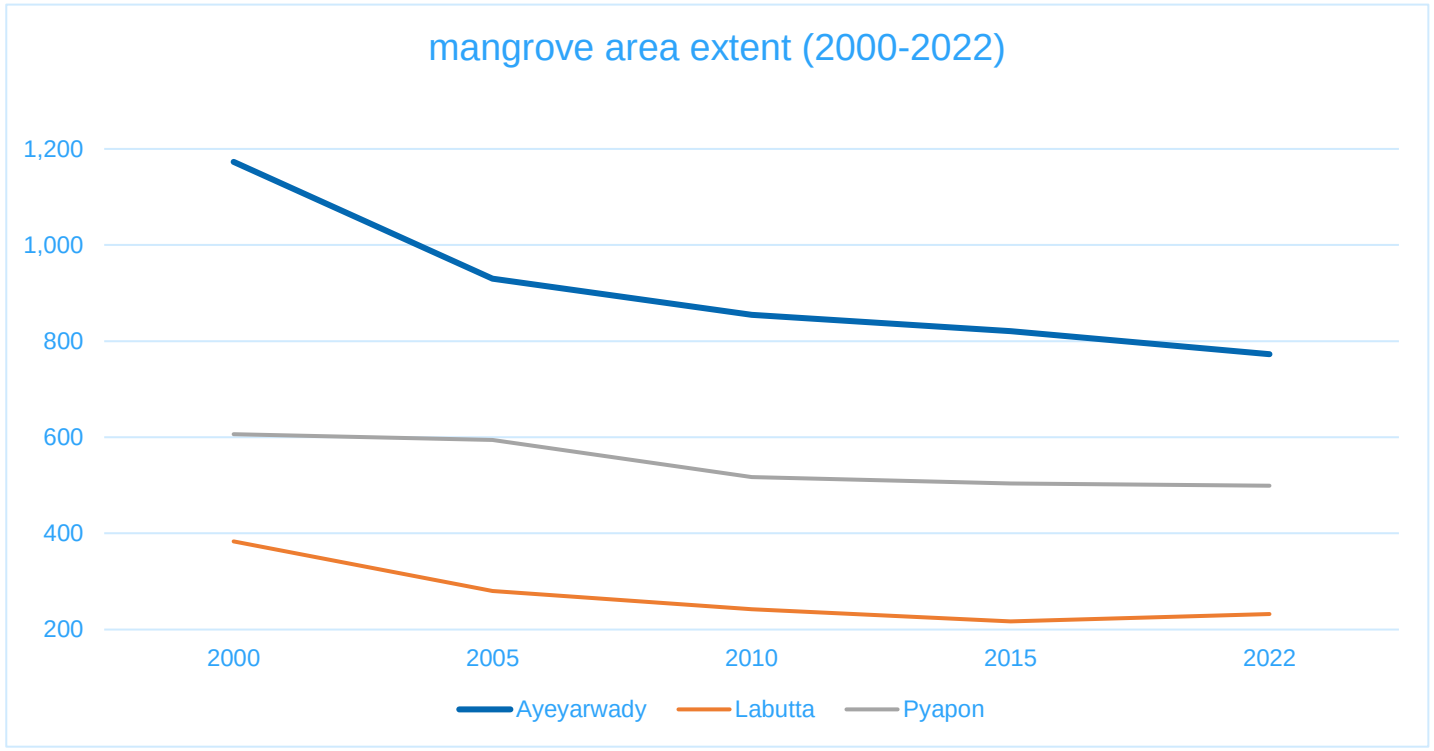
2022



- shrub
- grass land
- crop land
- built-up area/ settlement
- bare land
- snow/ ice/ cloud
- waterbody
- wetland
- mangrove
- rice field
- mining area
- aquaculture
- tree
- closed forest
- open forest
- shifting cultivation
- saltpan

https://kyawzayahtun.users.earthengine.app/view/land-cover-tracker-in-the-delta-region-2000-2022

Output analysis



Mangrove area extent from multi-temporal Landsat 8 images (2000-2022)

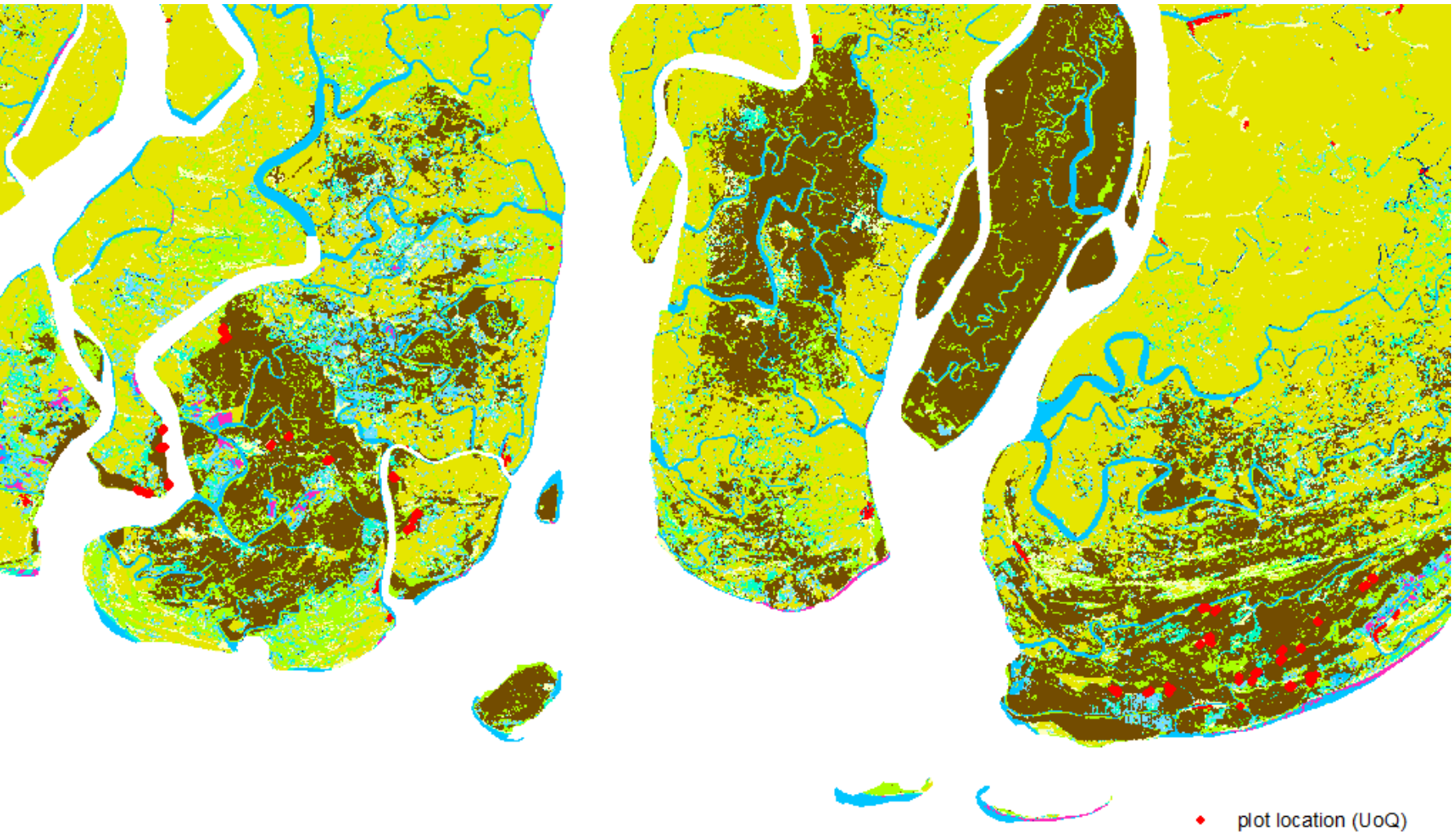
https://kyawzayahtun.users.earthengine.app/view/land-cover-tracker-in-the-delta-region-2000-2022

Output analysis

LC Class	AREA (SQKM)					Annual rate				
	2000	2005	2010	2015	2022	2000-2005	2005-2010	2010-2015	2015-2022	2000-2022
Ayeyarwady	1,173	930	855	821	773	-4.64%	-1.68%	-0.81%	-0.86%	-1.90%
Labutta DT	383	280	242	217	232	-6.26%	-2.92%	-2.18%	0.95%	-2.28%
Pyapon DT	606	594	517	504	499	-0.40%	-2.78%	-0.51%	-0.14%	-0.88%

Mangrove area extent and annual rate in 1) Ayeyarwady Region 2) Pyapon DT and 3) Labutta DT (2018 to 2022) (Landsat 8 Image).

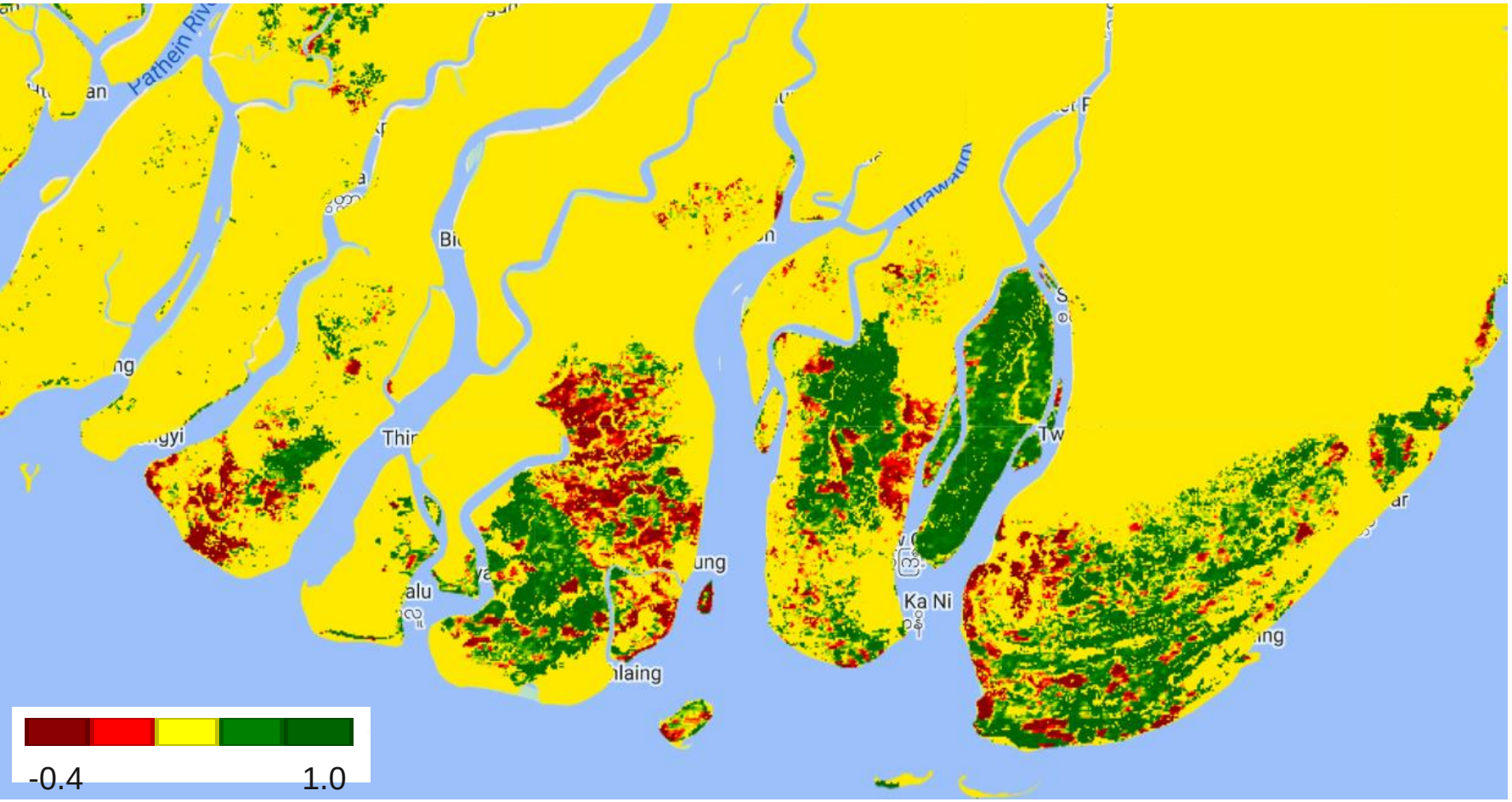
Accuracy assessment



The accuracy assessments of the land cover mapping were conducted for mangrove cover using field data provided by UoQ and the results indicate that the accuracy of the land cover classifications were more than 80%.

Source: GGKP (2020). Economic Appraisal of Ayeyarwady Delta Mangrove Forests. Seoul: Global Green Growth Institute & Andaman Capital Partners..

The Cumulative Enhanced Vegetation Index (EVI) Anomaly Analysis



- The **MODIS Time Series EVI dataset** with a resolution of 250m was used to identify **the ecological stress areas** in study area.
- The **reference period** for the analysis was from **January 1st, 2000 to December 31st, 2010**, while the recent period of interest was from **January 1st, 2022 to December 31st, 2022**.
- Brown & red areas on the map should be focused on restoration activities and conservation planning. **31% of mangrove is under eco system stress**.

Conclusion

- We estimated total mangrove was **1,173 sqkm in 2000** and **773 sqkm in 2022**, with annual rate of change is -1.9 %. (Landsat EVI time series analysis)
- We estimated total mangrove was **831 sqkm in 2018** and **771 sqkm in 2022**, with annual rate of change is -1.88 %. (Sentinel EVI time series analysis)
- The net change of mangrove is **-60 sqkm between 2018 & 2022.**
- The transition from **mangrove to agriculture extension** is the **highest.**
- **Illegal mangrove cutting** also detected in study area.
- Some villagers abandoned their rice crops and focused on reforestation as a result of Cyclone Nargis' **salt water incursion**.
- Locals are aware of their need to preserve these mangroves, but a **financial constraint prevents** many of them from concentrating on mangrove conservation.

Thank you so much!!!


UN
DP