

MAMAFOREST

Monitoring system for mangrove forests using optical and radar data

VIVIANA OTERO

LABORATORY OF SYSTEMS ECOLOGY AND RESOURCE
MANAGEMENT, ULB



UNSW
AUSTRALIA



PRIFYSGOL
ABERYSTWYTH
UNIVERSITY

Mangrove forests

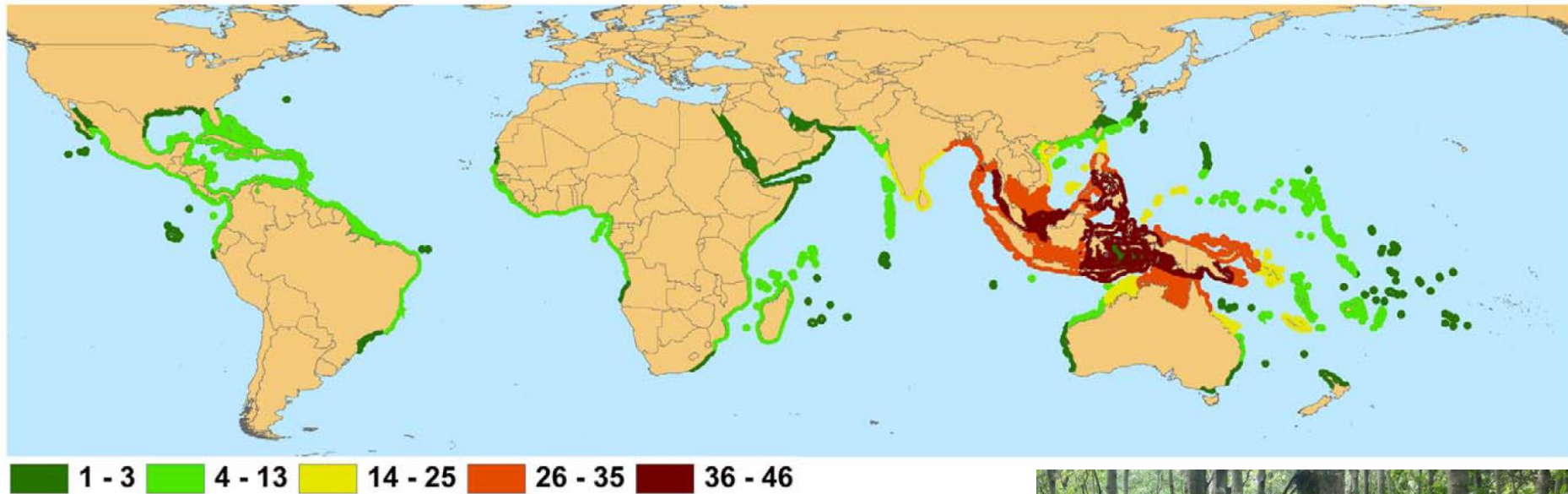


Figure 1. Mangrove Species Richness: Native distributions of mangrove species
Taken from Polidoro *et al.* (2010). doi:10.1371/journal.pone.0010095

Carbon storage (Donato *et al.*, 2011)

Coastal protection (Walters *et al.*, 2008)

Support of fisheries (Walters *et al.*, 2008)

Source of wood and other forestry products (Spalding *et al.*, 2010)



Mangrove forests

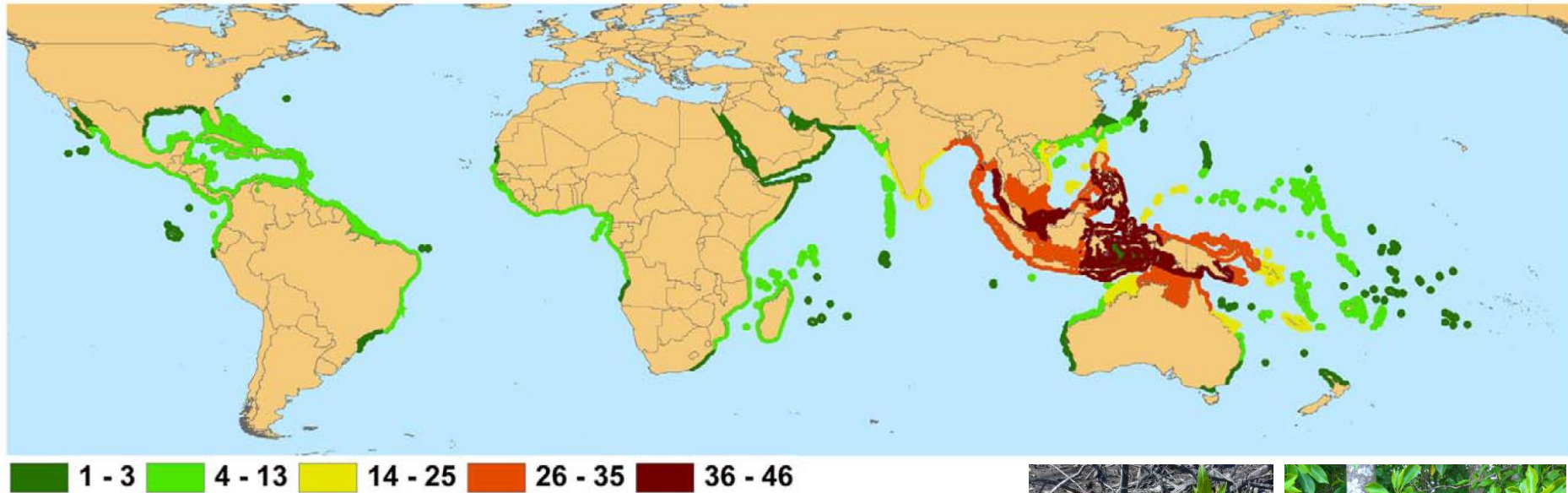
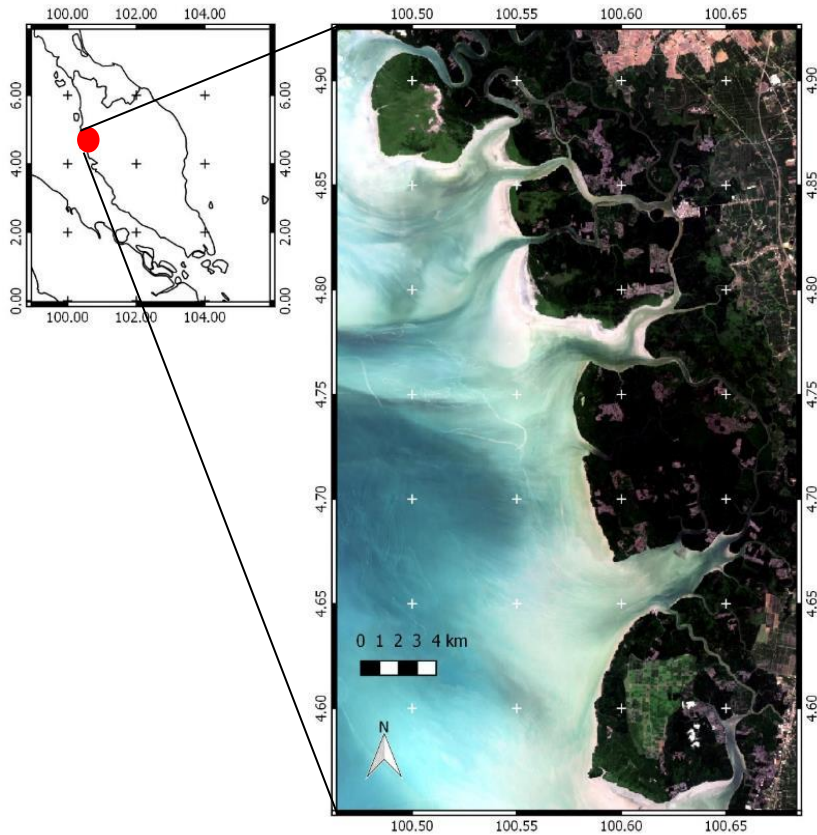


Figure 1. Mangrove Species Richness: Native distributions of mangrove species
Taken from Polidoro *et al.* (2010). doi:10.1371/journal.pone.0010095

- Land conversion
- Deforestation
- Disruption hydrological cycles
- Climate change

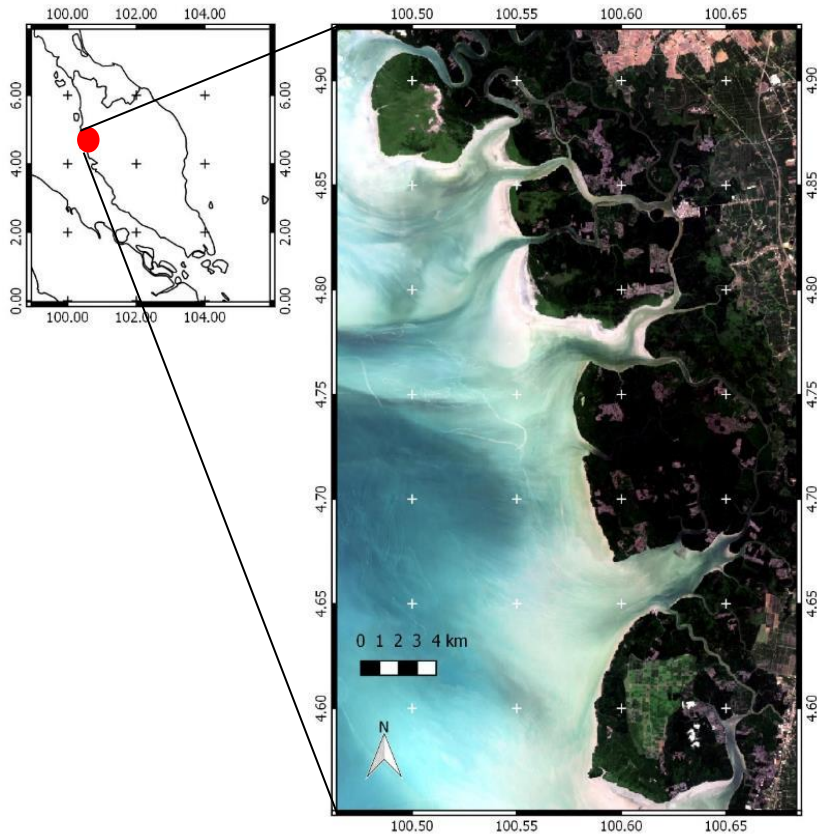


Matang Mangrove Forest Reserve



Location Matang Mangrove Forest Reserve (MMFR), Peninsular Malaysia. Taken from Weidmann *et al.* (2010) and Landsat 8 (February 2014) USGS Products

Matang Mangrove Forest Reserve



Location Matang Mangrove Forest Reserve (MMFR), Peninsular Malaysia. Taken from Weidmann *et al.* (2010) and Landsat 8 (February 2014) USGS Products

Managed for charcoal and pole production since 1902 with a 30-year rotation cycle



Charcoal production at Matang Mangrove Forest Reserve.
© Behara Satyanarayana

Harvest is focused on:
Rhizophora apiculata Bl.
Rhizophora mucronata Lamk



Objective

Integrate time series of optical and radar remote sensing data to evaluate the viability and sustainability of logging within the Matang Mangrove Forest Reserve (MMFR)

MMFR



DATA



Field data

Local Management
MMFR



DJI Phantom 3
Professional



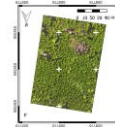
Optical RS:
Landsat 4,5,7 and 8
WorldView-2 stereo
data

Radar RS:
JERS-1, ALOS-
PALSAR,
TanDEM-X, SRTM

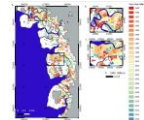


REMOTE SENSING PRODUCTS

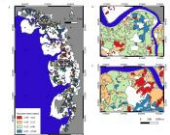
UAV protocol



Clear-felling map



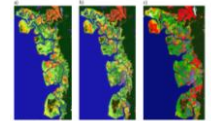
Recovery time map



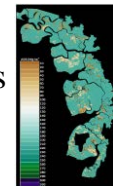
Age forest maps



Canopy height and
canopy cover maps

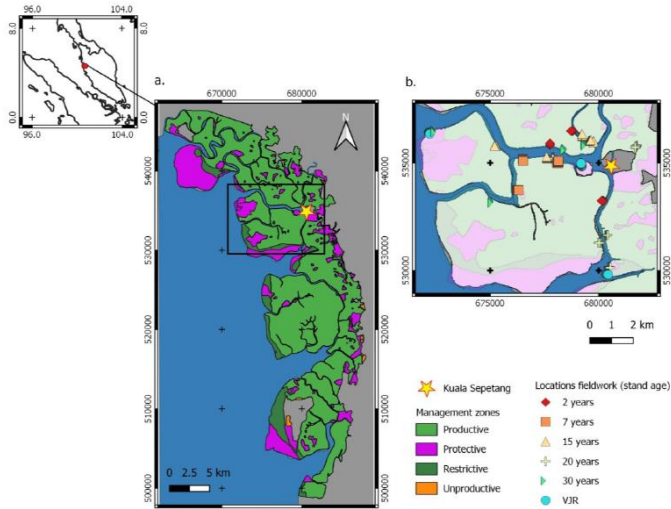


Above ground biomass
maps



Field-work and UAV data collection

Field-work and UAV data collection

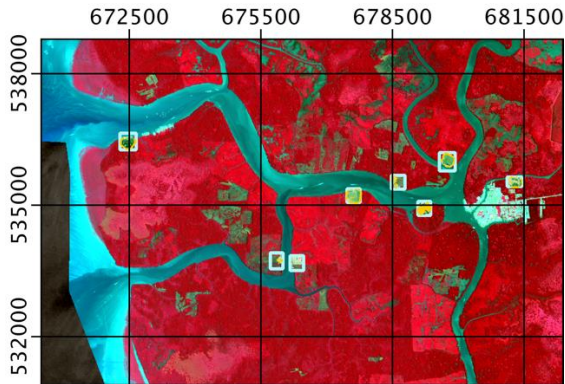


Otero (2019)



© Otero 2016 © Amir 2017

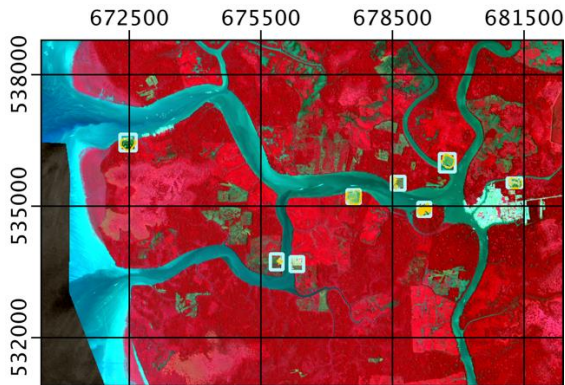
Field-work and UAV data collection



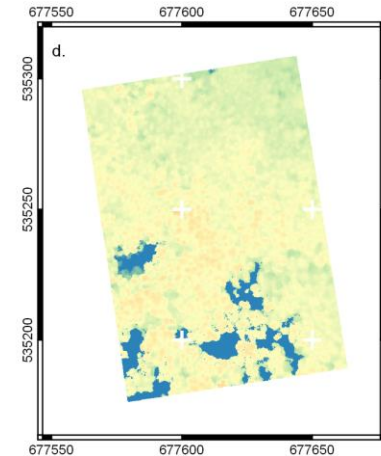
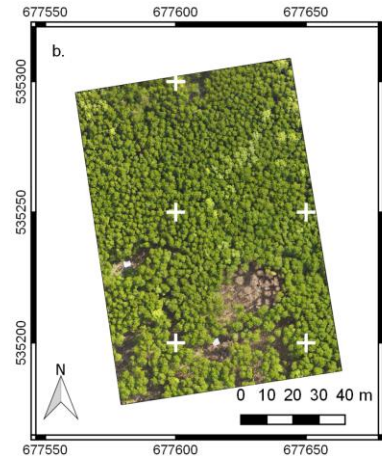
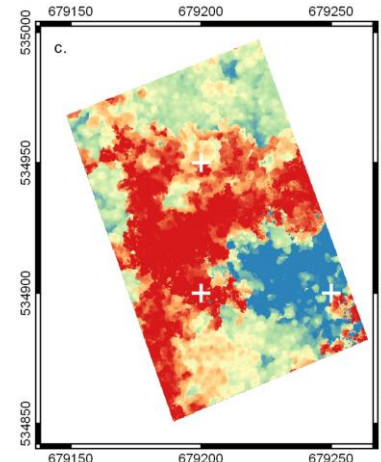
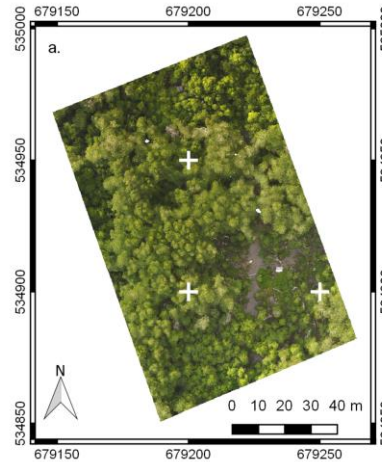
Lucas *et al.* (2019)



Field-work and UAV data collection



Lucas *et al.* (2019)

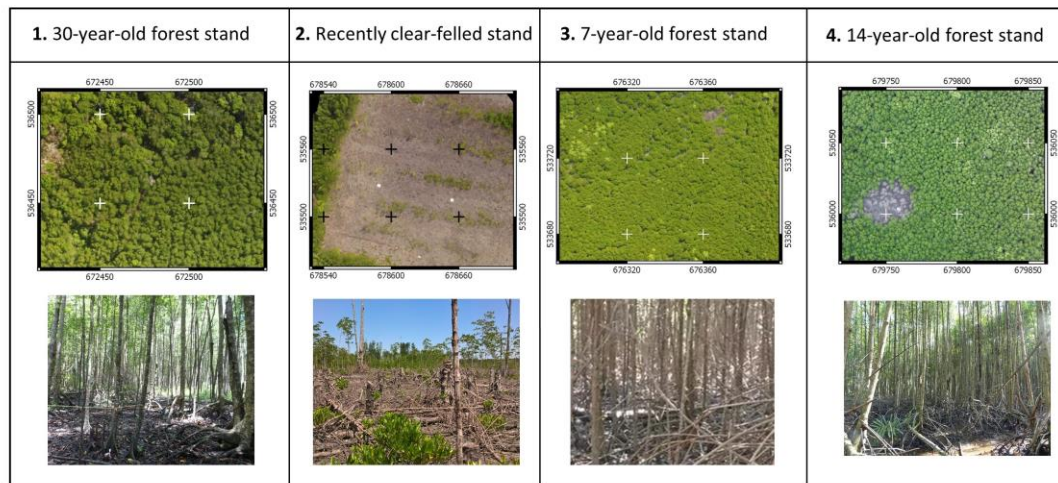
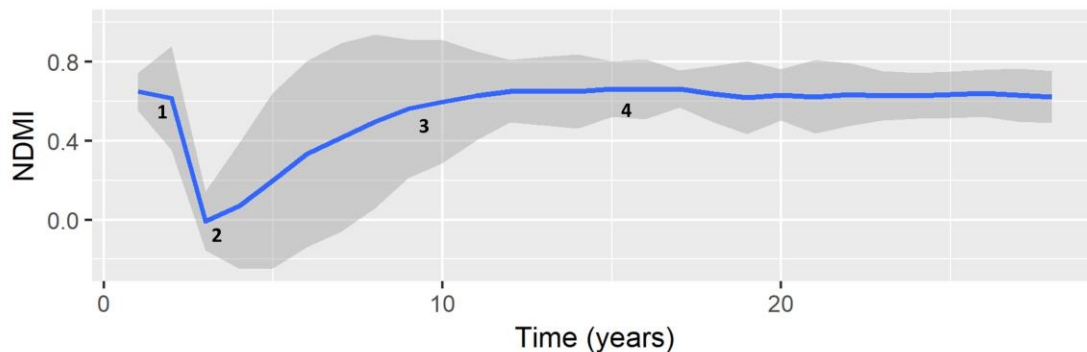


Analysis of clear-felling and regeneration using Landsat data

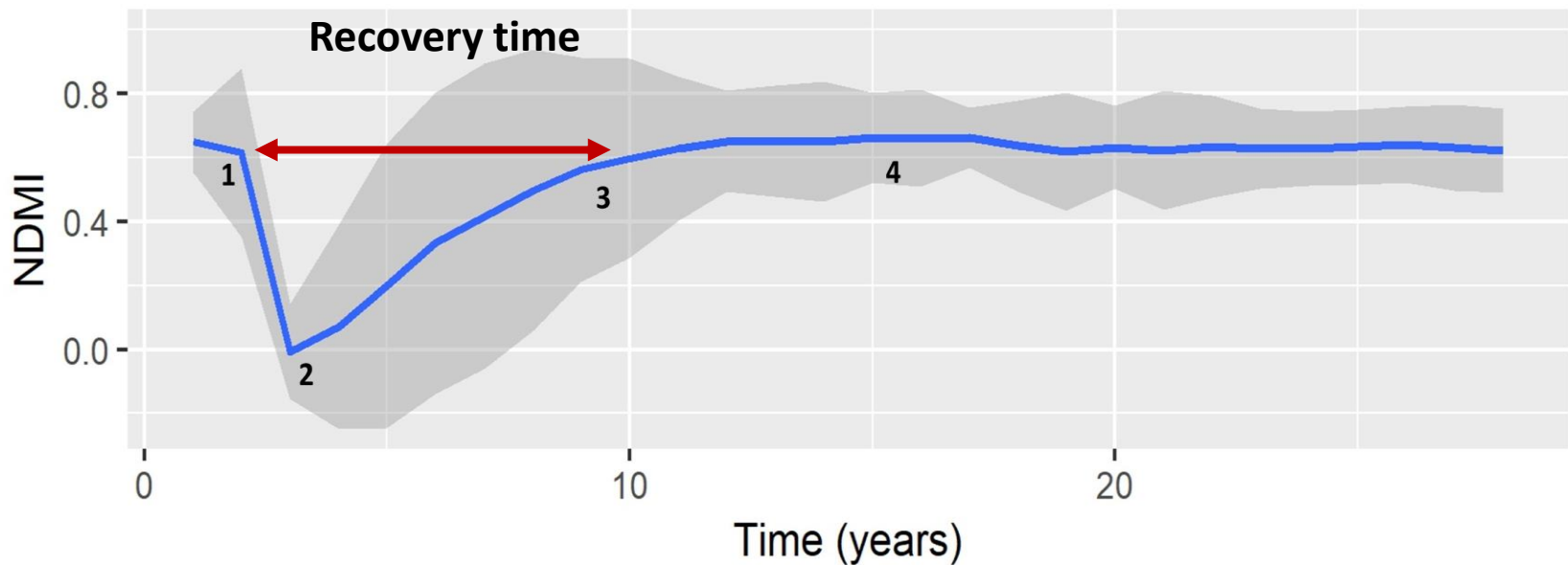
Detection clear-felling events

Landsat annual time-series
from 1988 to 2015

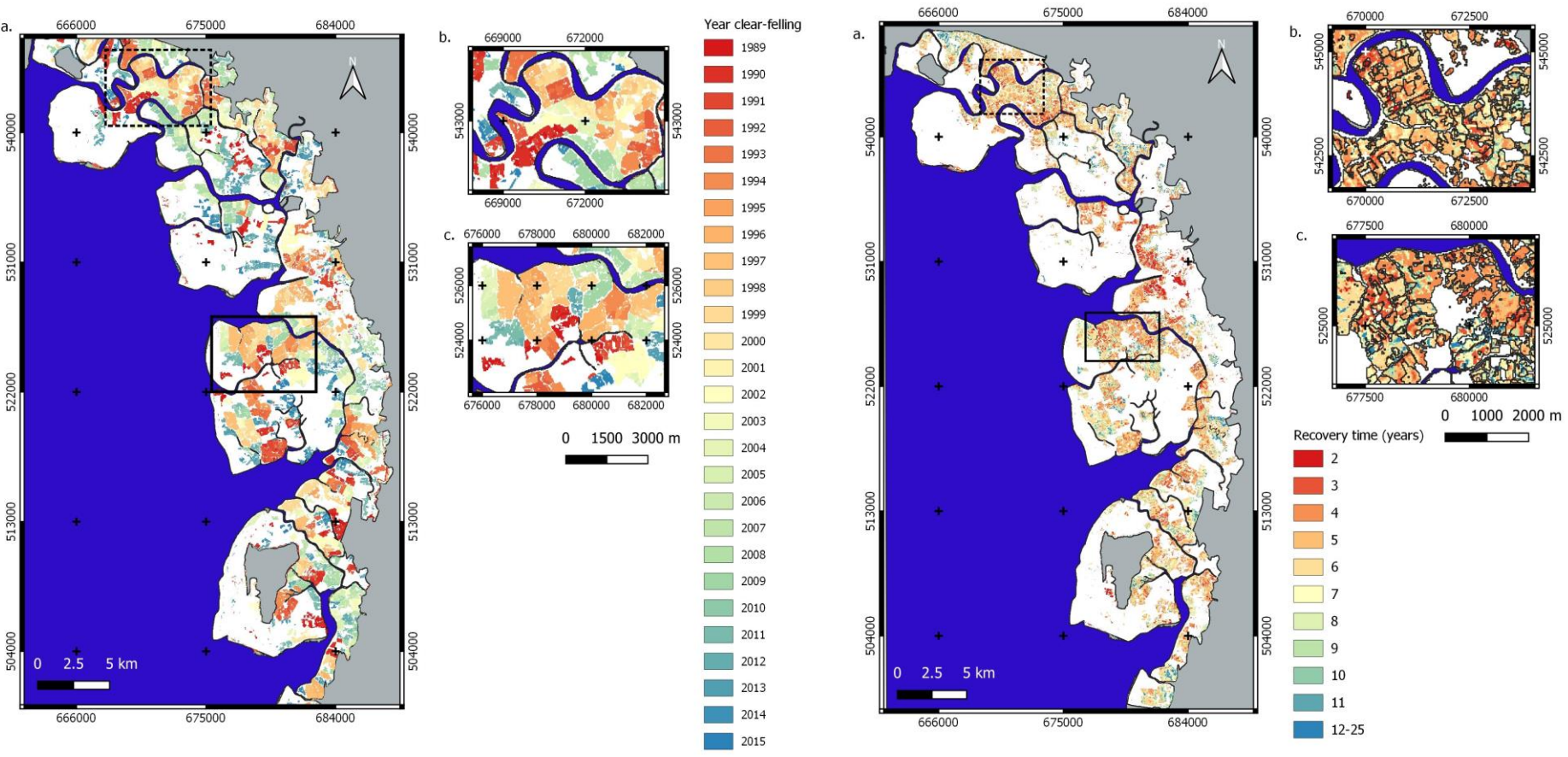
NDMI and NDVI time series
from 1988 to 2015



Recovery time quantification

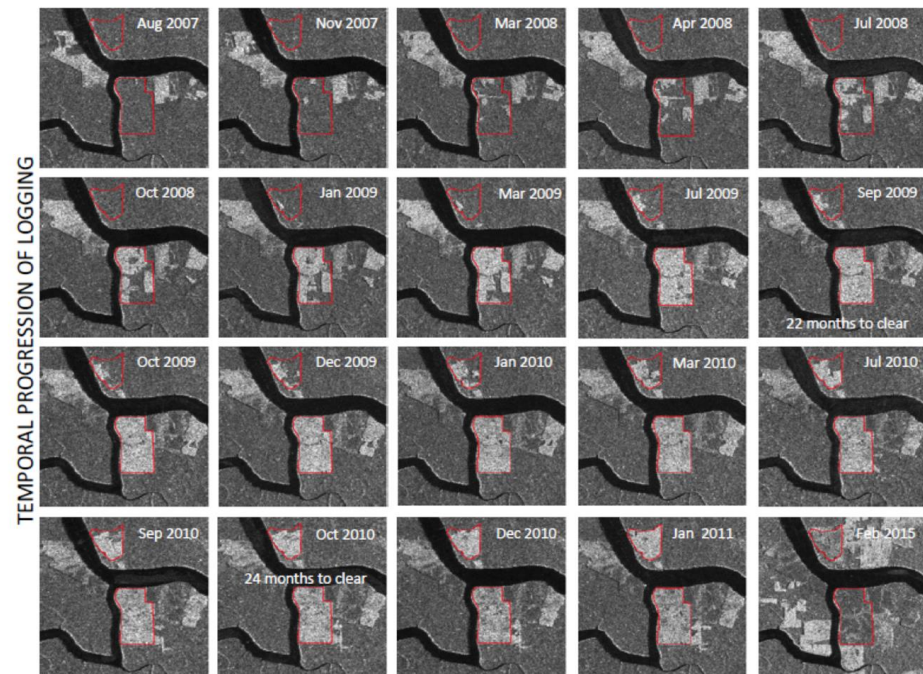
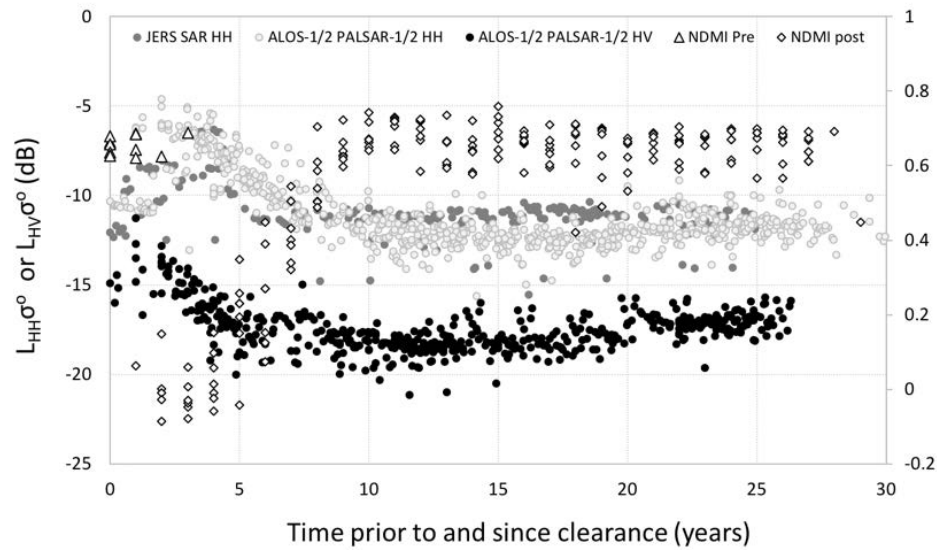


Clear-felling and recovery time maps

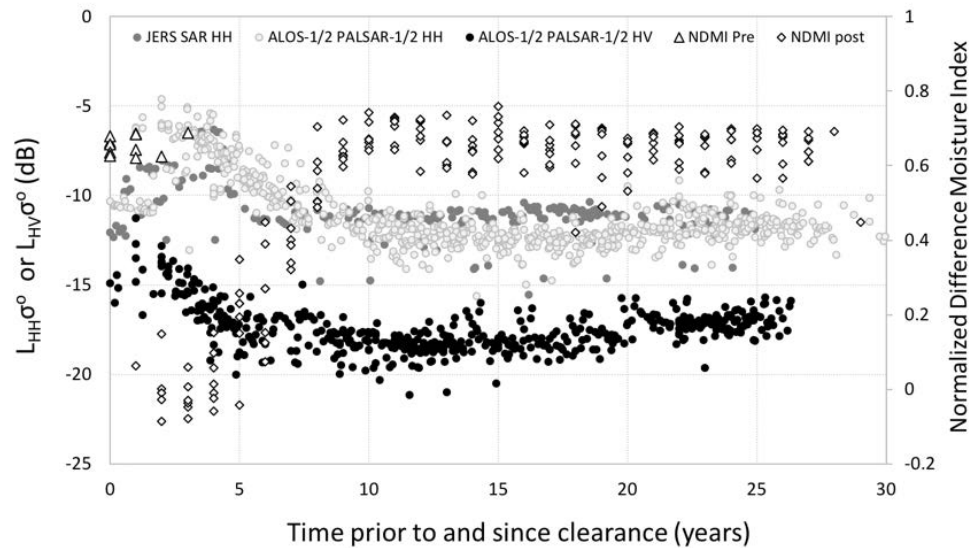


Structural Composition of Mangroves Achieved Through Combining Multiple Sources of Remote Sensing Data

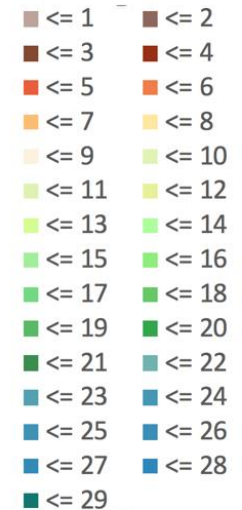
Age estimation using optical and radar data



Age estimation using optical and radar data

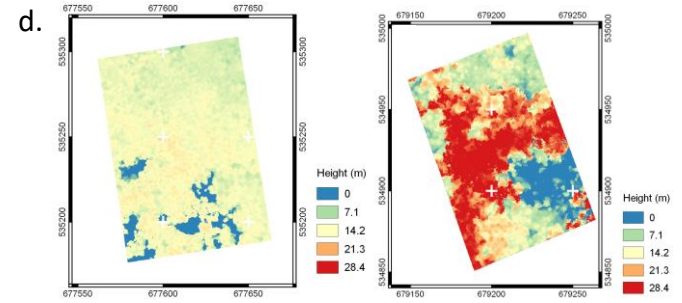
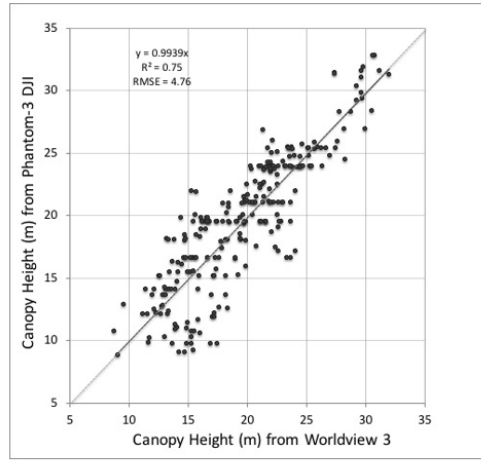
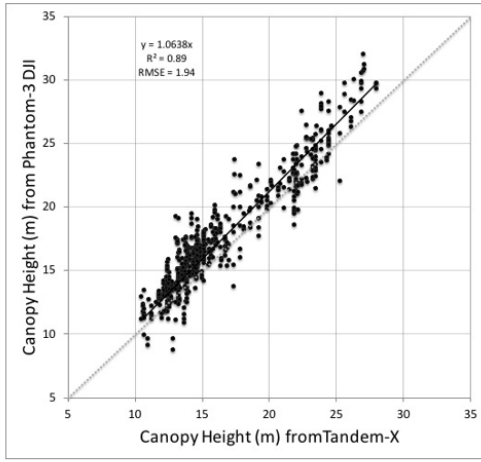
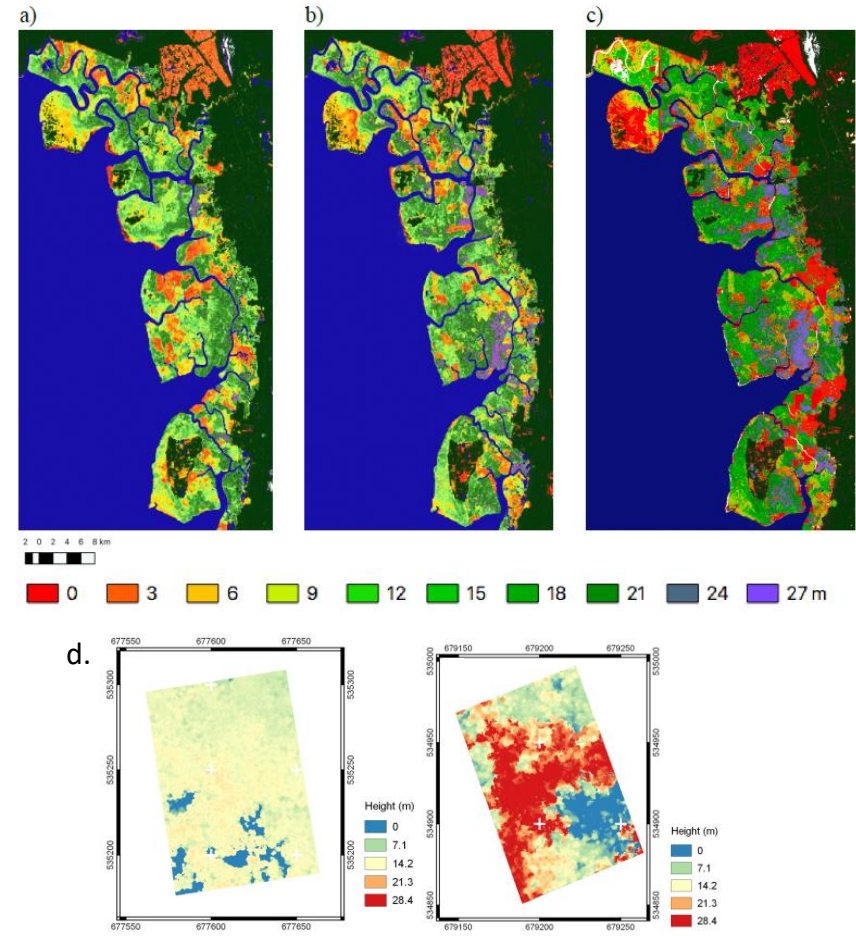


Time since clearance (Years)

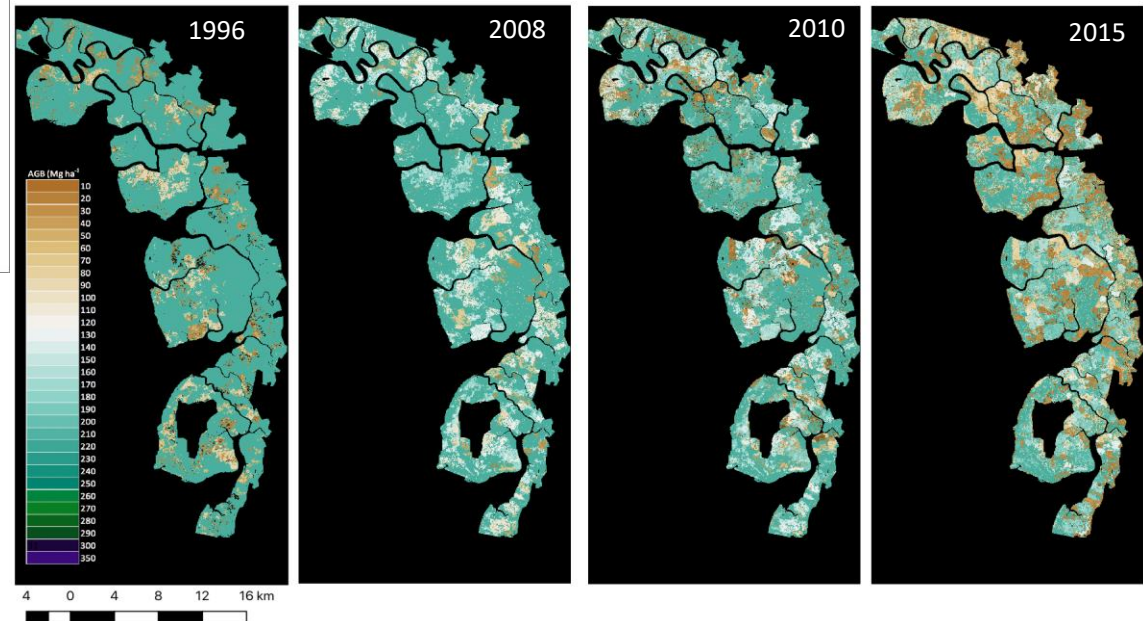
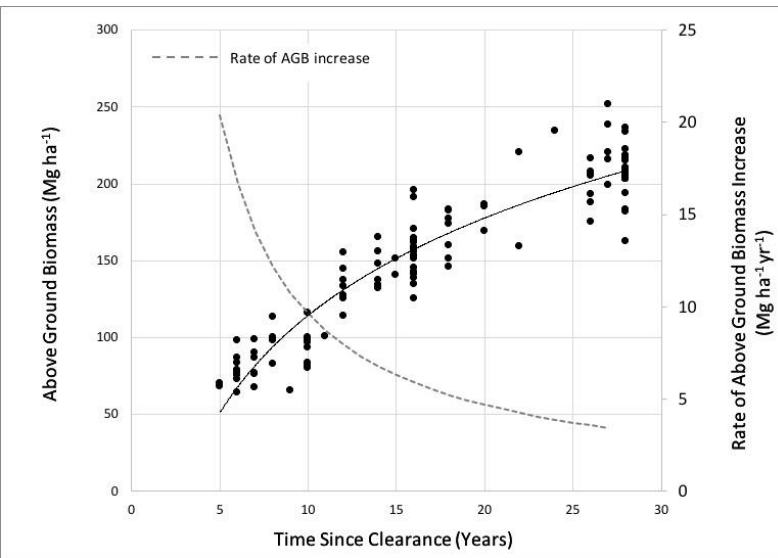


Canopy height estimation

- a. SRTM (2000)
- b. TanDEM-X (2015)
- c. WorldView-2 (2016)
- d. DJI Phantom 3 Pro (2016)

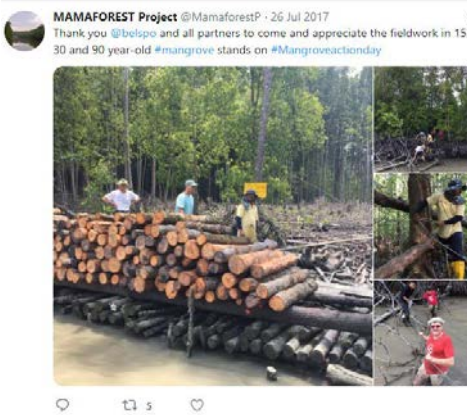


Above ground biomass

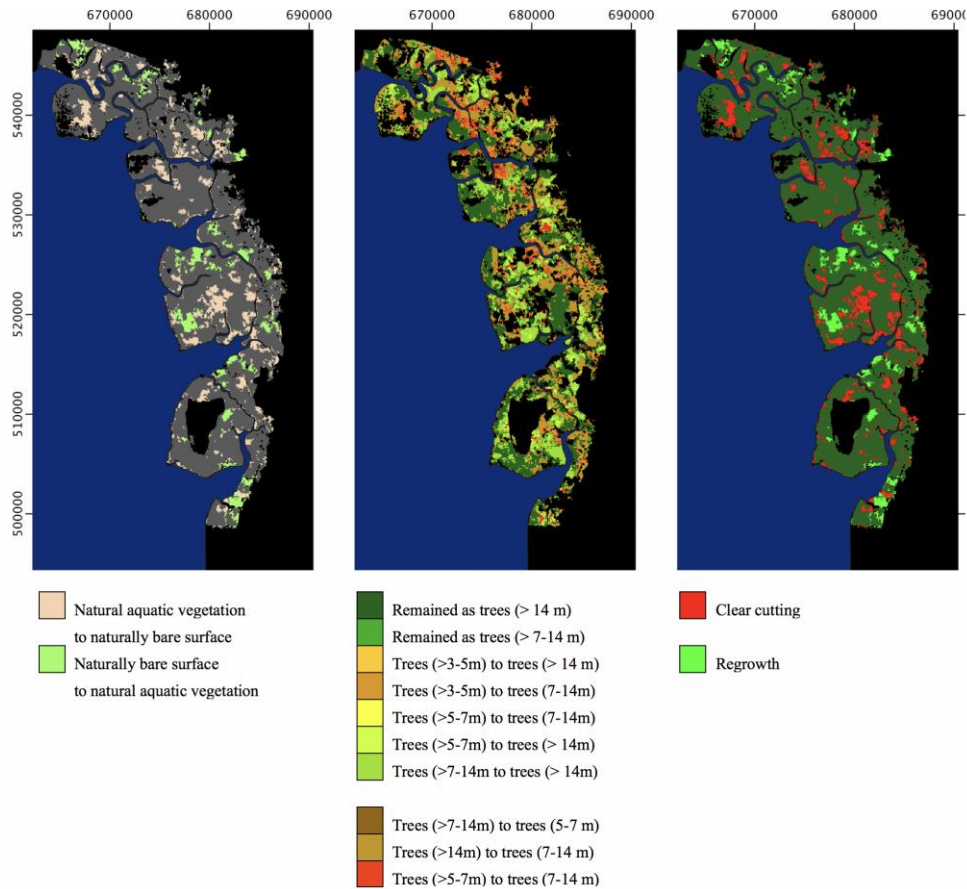


Dissemination

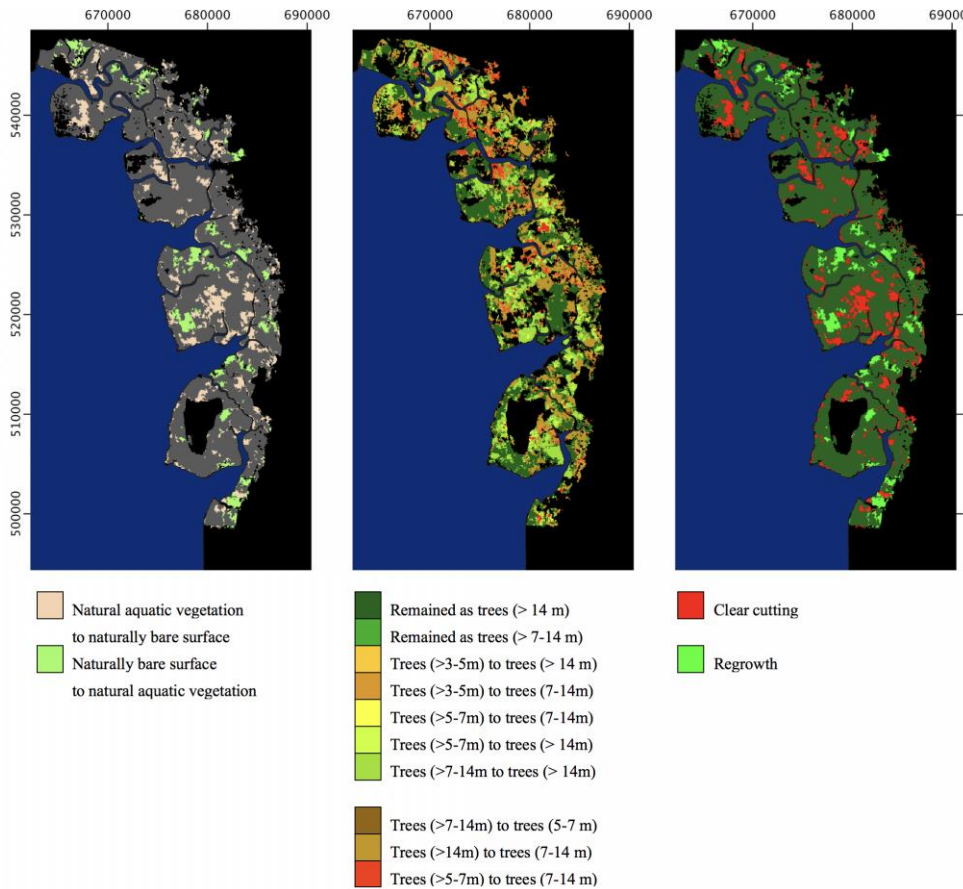
Workshops with Forestry Department of Malaysia and local stakeholders



Dissemination



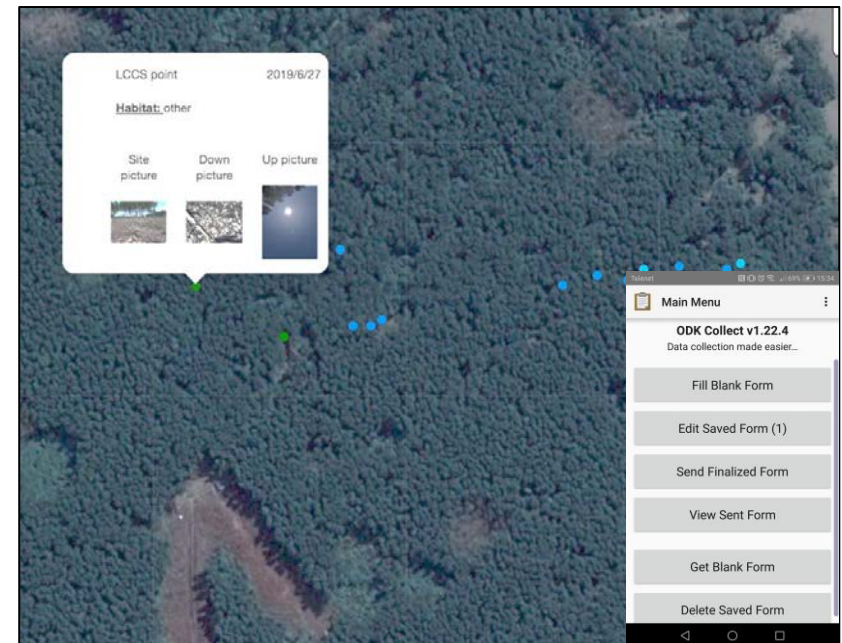
Dissemination



MAMAFORST Project @MamaforestP · Jun 27
 Richard Lucas from @UNSW & @AberUni demonstrating EarthTrack #mangrove Mobile App to record land cover and individual trees on our @MamaforestP Workshop. We are happy to teach @jpsmhq foresters to combine this with the latest free remote sensing imagery to calculate forest age.

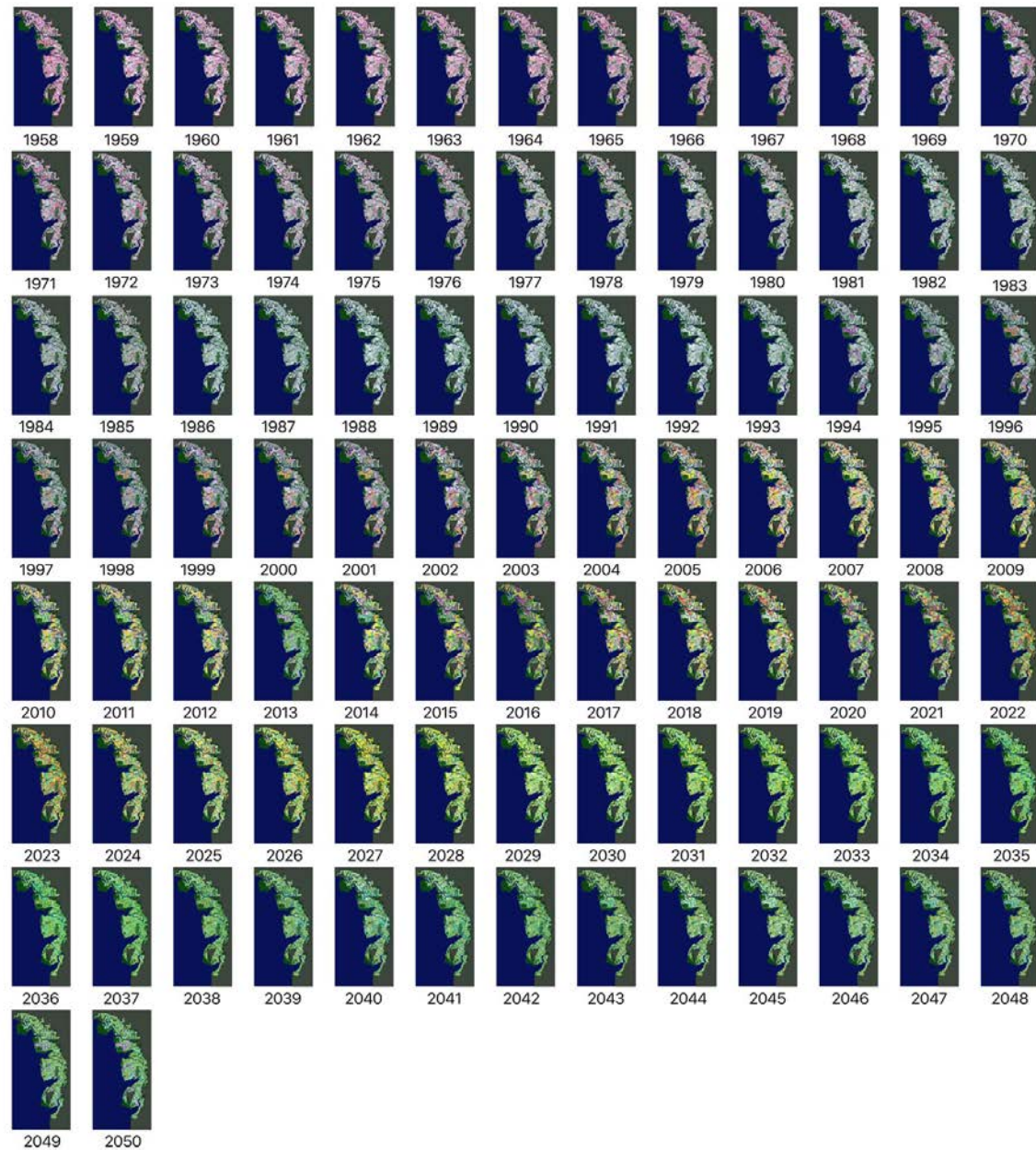


2



Logging cycles at Matang: 1958 to 2050

On the assumption of the 30 year logging cycle, estimates of forest age were generated back in time (to 1958) and forward (to 2050) giving the most comprehensive assessment for the MMFR.



Scientific dissemination

Otero, V., Van De Kerchove, R., Satyanarayana, B., Mohd-Lokman, M., Lucas, R. and Dahdouh-Guebas, F (2019). An Analysis of the Early Regeneration of Mangrove Forests using Landsat Time Series in the Matang Mangrove Forest Reserve, Peninsular Malaysia. *Remote Sensing* 11, 774; <https://doi.org/10.3390/rs11070774>

Otero, V., Van De Kerchove, R., Satyanarayana, B., Martínez-Espinosa, C., Amir Bin Fisol, M., Rodila Bin Ibrahim, M., Sulong, I., Mohd-Lokman, M., Lucas, R. and Dahdouh-Guebas, F (2018). Managing mangrove forests from the sky: forest inventory using field data and Unmanned Aerial Vehicle (UAV) imagery in the Matang Mangrove Forest Reserve, peninsular Malaysia. *Forest Ecology and Management* 411, 35 – 45. <https://doi.org/10.1016/j.foreco.2017.12.049>

Lucas, R., Van De Kerchove, R., Otero, V., Lagomasino, D., Fatoyinbo, L., Satyanarayana, B., and Dahdouh-Guebas, F (2019). New Insights into the Structural Composition of Mangroves Achieved Through Combining Multiple Sources of Remote Sensing Data. *Remote Sensing of Environment*. *In Press*.

Otero, V., Lucas, R. Van De Kerchove, R., Satyanarayana, B., Mohd-Lokman, M. and Dahdouh-Guebas, F (2019). Spatial analysis of early mangrove regeneration in the Matang Mangrove Forest Reserve, peninsular Malaysia. *Forest Ecology and Management*. *In Review*.

Lucas, R., Otero, V., Van De Kerchove, R., Lagomasino, D., Fatoyinbo, L., Satyanarayana, B., and Dahdouh-Guebas, F (2019). Monitoring the Matang Mangroves in Peninsular Malaysia through Earth Observations: A Globally Relevant Approach. *Land Degradation & Development*. *In Review*.

Hugé, J., Vande Velde, K., Mukherjee, N., Benitez-Capistros, F., Satyanarayana B., Otero, V. and Dahdouh-Guebas, F. (2019). Mapping research gaps for sustainable mangrove management in Matang, Malaysia, using the Nominal Group Technique. *Environment, Development & Sustainability*. *In Review*.

MAMAFOREST



Prof.
Dahdouh-
Guebas,
Viviana
Otero

Prof.
Satyanara-
yana, Prof.
Lokman



Ruben Van
De
Kerchove

Prof. Richard
Lucas



UNSW
AUSTRALIA



PRIFYSGOL
ABERYSTWYTH
UNIVERSITY