



MONITORING AND SIMULATING COASTAL CHANGES BASED ON REMOTELY SENSED OBSERVATIONS OF MANGROVES

CHRISTOPHE PROISY, IRD-UMR AMAP
Cayenne, French Guiana
christophe.proisy@ird.fr



CLIMATE CHANGE : WHAT FUTURE FOR (MANGROVE) COASTS ?



Chapter 3: Oceans and
Coastal Ecosystems
and their Services

1. Understanding: Linking biological responses of coastal (mangrove) ecosystems to climate-induced multiple drivers

2. Anticipating: Vulnerability and adaptive capacity of social–ecological coastal (mangrove) systems

3. Adapting: (mangrove) nature-based solutions

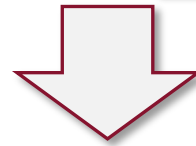
MANGROVES AND COASTAL CHANGES

Definition: “A diverse assemblage of trees and shrubs that form the dominant plant communities in tidal, saline wetlands along sheltered tropical and subtropical coasts”.

Blasco & Saenger, 1996. CATENA

“Mangroves have demonstrated an exceptional ability to adapt to sea-level fluctuations. They found refuge on continental shelves subjected to massive sediment supply.”

Proisy et al, 2021, Elsevier.



“An history which deserves to be told”.

P. Saenger, 1996

**Can we take lessons from mangroves to adapt ourselves right now ?
What are the tipping points of mangrove resilience?**

OUTLINE

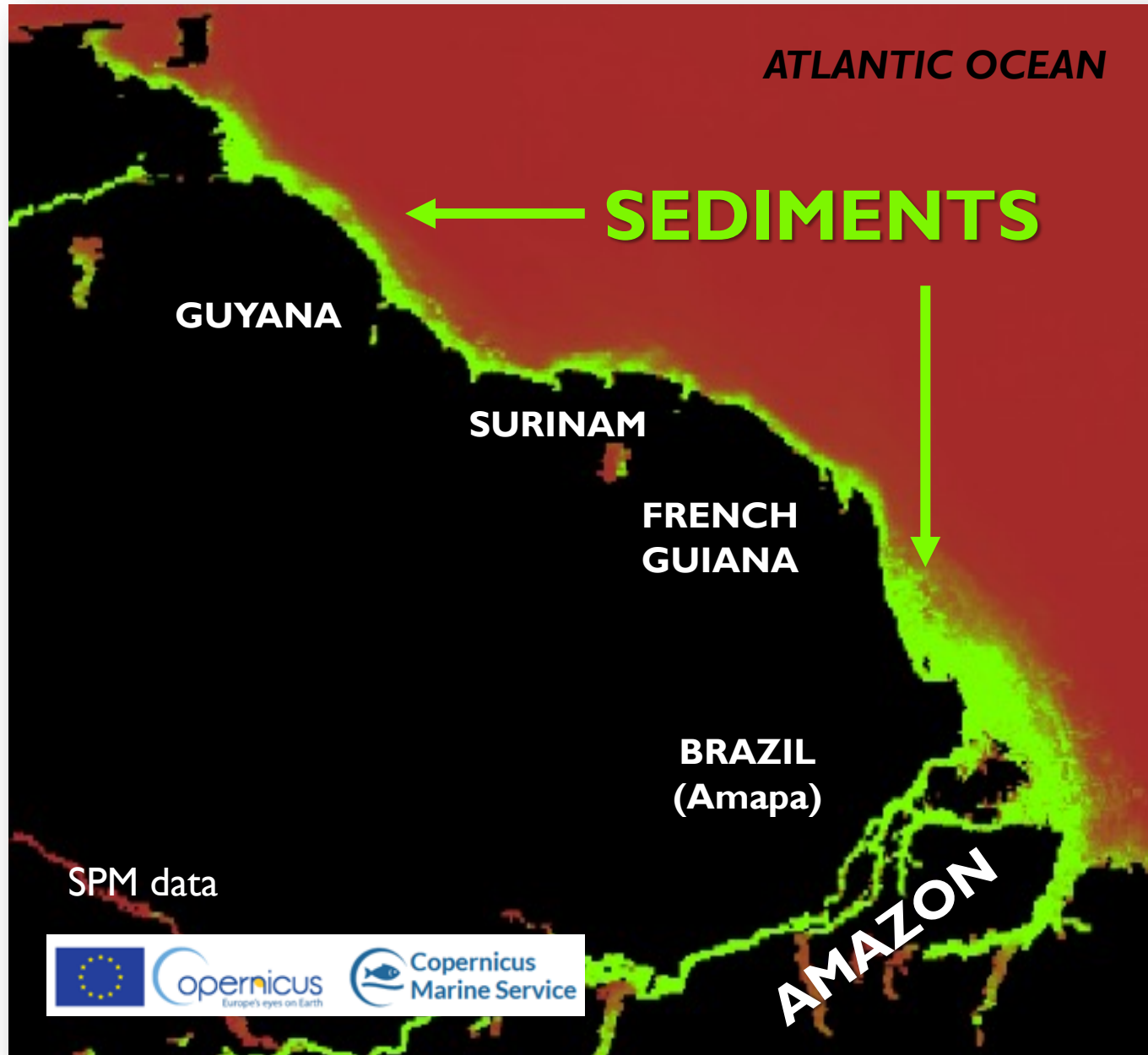


**1.THE INVALUABLE CASE STUDY OF
THE AMAZON-INFLUENCED
MANGROVE COAST**

**2.THE LEADING ROLE OF REMOTE
SENSING-BASED STUDIES FOR THIS
REGION**

3.TOWARD A REGIONAL STRATEGY ?

COASTAL CHANGES ALONG THE 'SUPERLATIVE' GUIANAS' COAST



- The **world's longest (1500 km) muddy coast** : longshore redistribution of **sediments** from the Amazon
- Drifting of giant mudbanks: prevailing **macroscale geological controls**
- Leading to considerable ecological and socio-economic impacts.

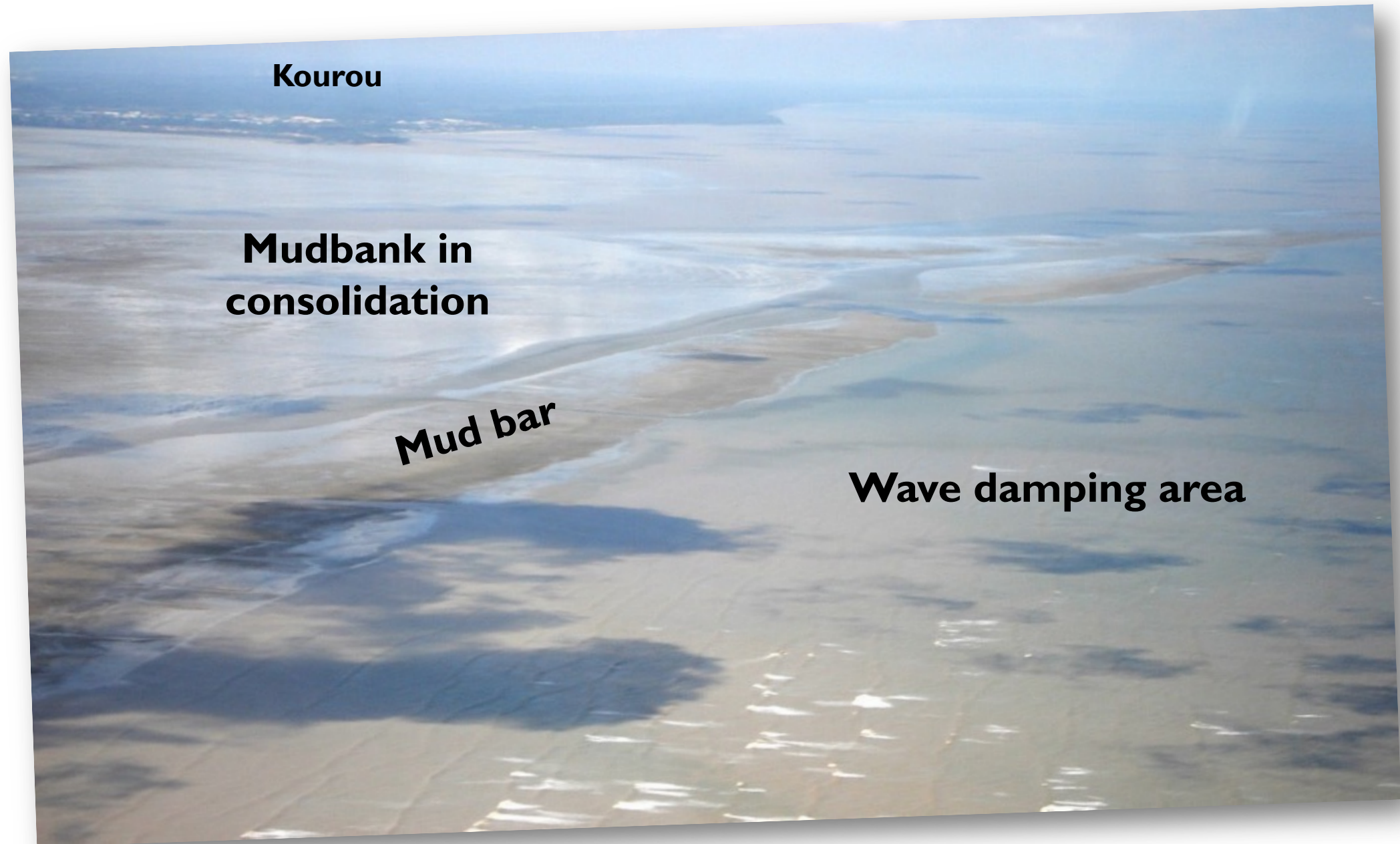
MUDBANKS DRIFT ALONG THE GUIANAS' COAST



SEDIMENTS AND MUDBANKS



THE COAST IS SHELTERED BY MUDBANKS



THE COAST IS SHELTERED BY MUDBANKS

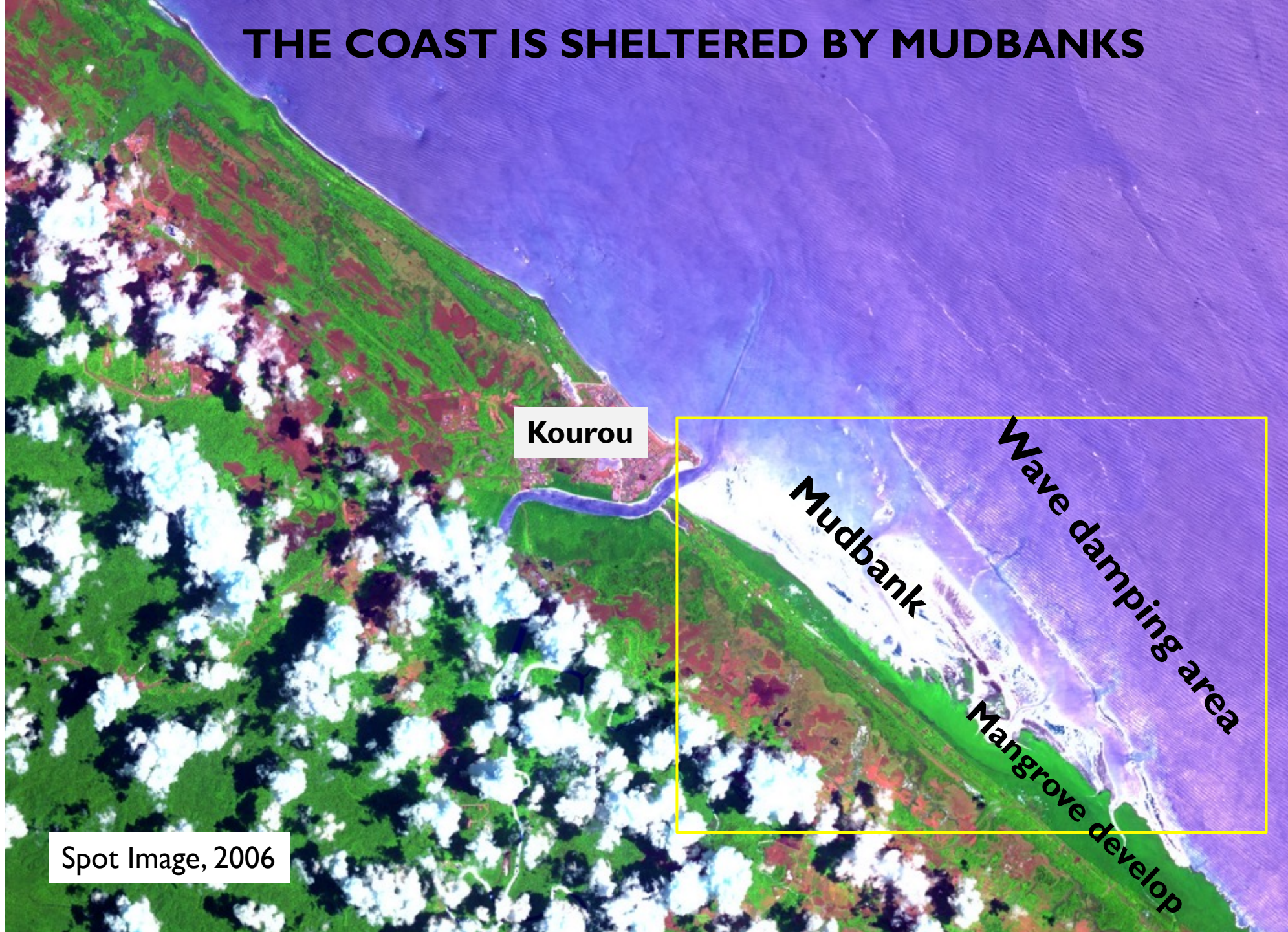
Kourou

Mudbank

Wave damping area

Mangrove develop

Spot Image, 2006



EROSION MAY RAGE DURING 'INTERBANK' PHASE



Habitations on the beach (Cayenne)



Coastal artificialization and rice fields (Mana)

EROSION MAY RAGE DURING 'INTERBANK' PHASE



Mangrove shoreline in erosion (Kourou, 2008)

MANGROVES AS INDICATORS OF COASTAL CHANGES

**ENTIRE MANGROVE AREAS CAN BE
DESTROYED DURING INTERBANK PHASES**



**MANGROVES MAY DEVELOP
DURING MUDBANK PHASES**



MANGROVES AS INDICATORS OF COASTAL CHANGES

From the tree to the landscape scales



Diversity of mangrove habitats

© C. Prady, IRD UMR AMAP, 2014

Typical mangrove landscape in French Guiana



THE INVALUABLE ROLE OF REMOTE SENSING-BASED STUDIES

**COASTAL AND MANGROVE PROCESSES ARE DIVERSE AND COMPLEX
ON ALL TEMPORAL AND SPATIAL SCALES OF OBSERVATIONS.**

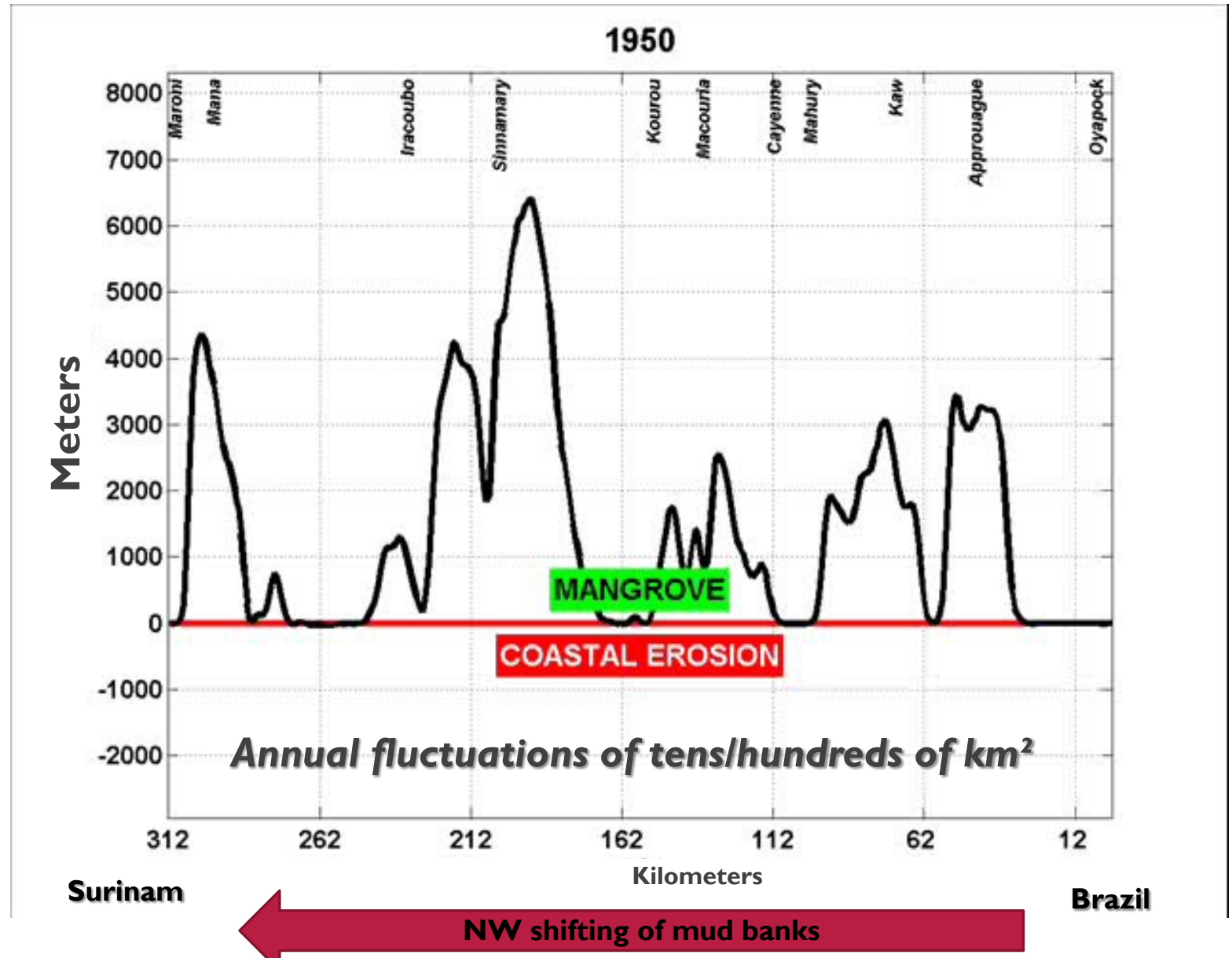
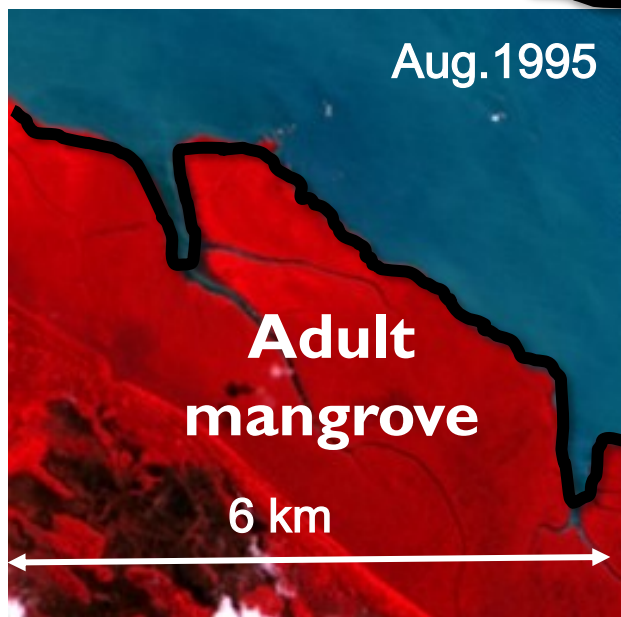
- ⇒ Combining LiDAR, **Optical**, Radar data
- ⇒ **Multi-spatial scale analysis**

**EVERYTHING IS CHANGING RAPIDLY ON THE AMAZON-INFLUENCED
COAST**

- ⇒ **Multitemporal analysis**
- ⇒ Physical interpretation of remote-sensing signatures for the robustness
- ⇒ Field experiments (hydrodynamics, mangrove ecology) – ground truth

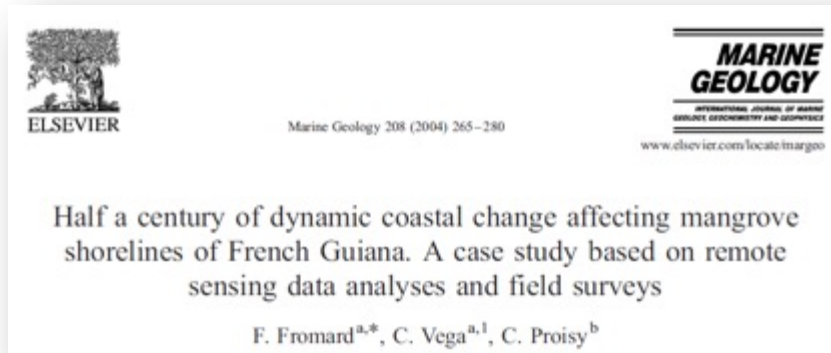
MULTITEMPORAL STUDIES

Using a time series of moderate spatial resolution images, from **1950 onwards**



SOME RESULTS FROM MULTITEMPORAL ANALYSES

Highlighting ecological behaviors



Mud bank colonization by opportunistic mangroves: A case study from French Guiana using lidar data

Christophe Proisy^{a,*}, Nicolas Gratiot^b, Edward J. Anthony^c, Antoine Gardel^c, François Fromard^d, Patrick Heuret^e

Modelling for understanding and anticipating

| | | | | | |
|-----------------------------|----|----|---------|------------------------|------|
| Journal of Coastal Research | SI | 75 | 810-814 | Coconut Creek, Florida | 2016 |
|-----------------------------|----|----|---------|------------------------|------|

A Multiscale Simulation Approach for Linking Mangrove Dynamics to Coastal Processes using Remote Sensing Observations

Christophe Proisy[†], Pascal Degenne[‡], Edward J. Anthony^{††}, Uta Berger[§], Elodie Blanchard[†], François Fromard[§], Antoine Gardel[¶], Adewole Olagoke^{§†}, Valdenira Santos[¶], Romain Walcker^{1§}, Danny Lo Seen[‡]



Mangroves: a natural early-warning system of erosion on open muddy coasts in French Guiana

Christophe Proisy^{1,2}, Romain Walcker³, Elodie Blanchard¹, Antoine Gardel⁴, Edward J. Anthony^{4,5}



Exploring potential links to climate driven forces

Journal of Biogeography (J. Biogeogr.) (2015) 42, 2209–2219



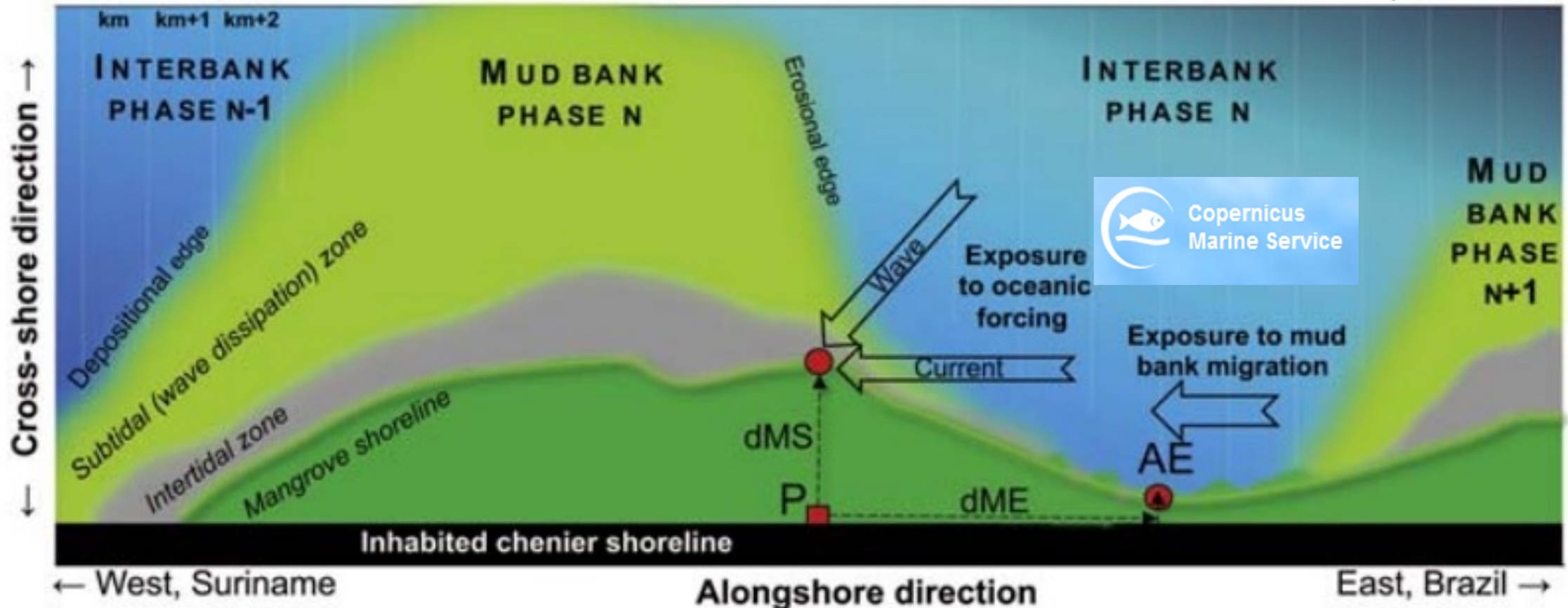
Fluctuations in the extent of mangroves driven by multi-decadal changes in North Atlantic waves

Romain Walcker^{1,2*}, Edward Jamal Anthony³, Christophe Cassou⁴, Robert Curwood Aller⁵, Antoine Gardel⁶, Christophe Proisy⁷, Jean-Michel Martinez⁸ and François Fromard^{1,2}

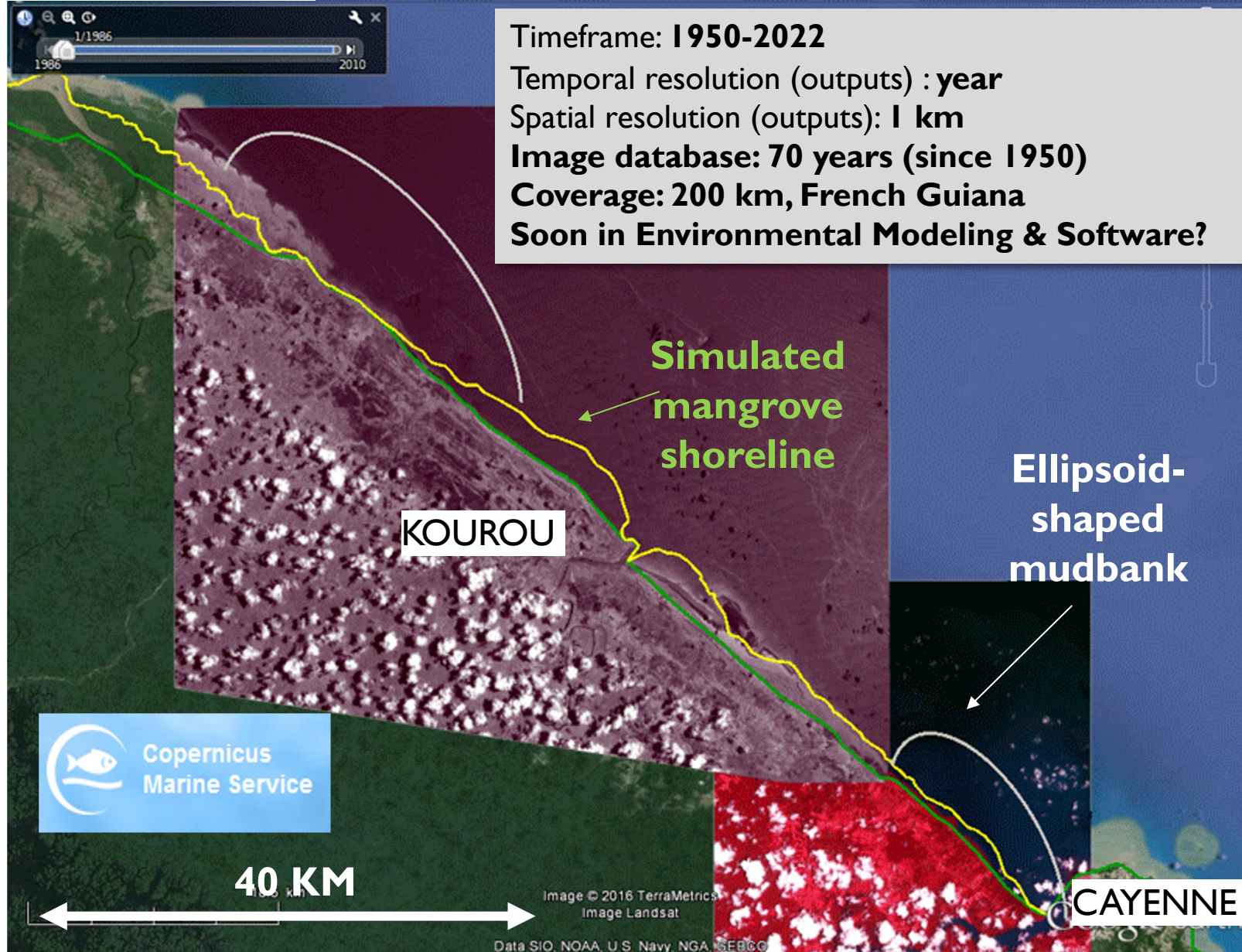
A MODELLING INTEGRATIVE APPROACH OF COASTAL VULNERABILITY

Remote sensing observations of changes in mangrove shorelines
inform of interwoven multiscale coastal processes

From Proisy et al. 2021



THE MANG@COAST MULTISCALE AND SEMI-EMPIRICAL APPROACH



A PhD work granted by
ADEME and DGTM
2021-2024

Result:

A wave-dominated mangrove coast, sensitive to high-energy wave regimes !

Applications:

C sequestration rates and coastal vulnerability to erosion predictions

CONCLUSION AND PERSPECTIVES

An example (among others)

- Of ground-breaking research on mangrove coast dynamics in response to oceanic and climatic processes
- Based on multiscale, **field-validated, physically-understood** remote sensing imagery
- Applied to the fascinating Guianas' coast

For a regional coastal strategy

- From Amapá to Guyana
- Based on a **research network** consolidated by exchanges of students and visiting scientists (who is interested?)
- To help **co-building our adaptation with stakeholders** of the coastal zone.
- In which remote sensing studies will be the core of any projects
- **SEAS (S6-S7 times series + Pléiades) = a great asset!**

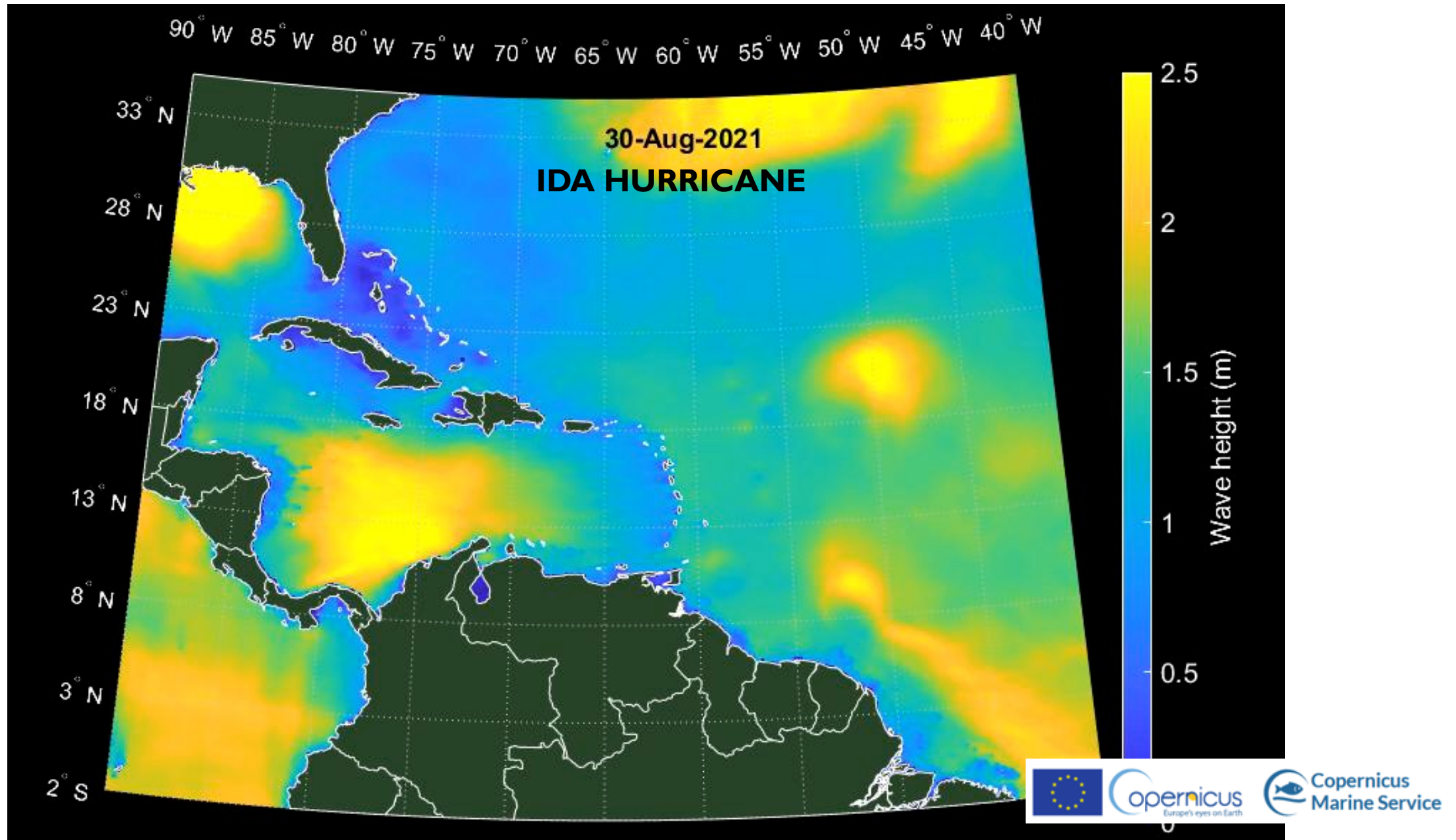
**You will enjoy
field experiments
in mangroves.**

**Do not hesitate:
join us!**

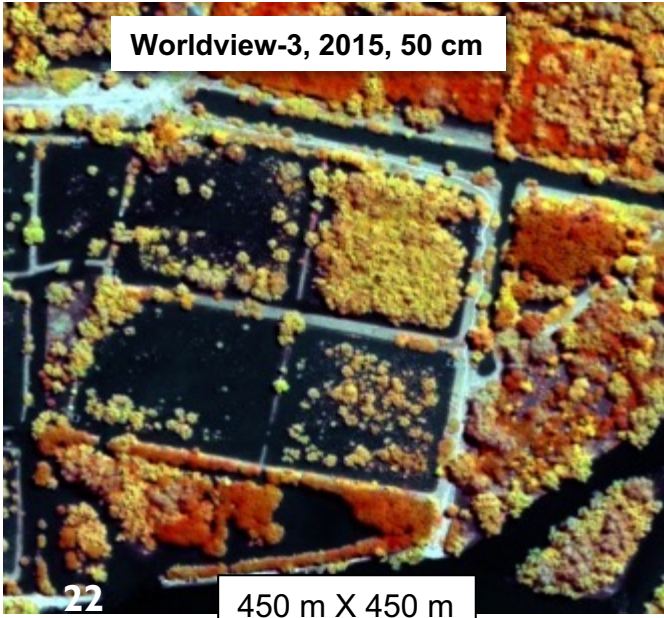
**Thank you.
Obrigado.
Merci.**



UNDER THE INFLUENCE OF THE ATLANTIC OCEAN AND CLIMATE



SUBMETRIC RESOLUTION IS NEEDED TO UNDERSTAND TRANSFORMATION WITHIN MANGROVES FORESTS



TOWARDS FINE SCALE MAPPING OF MANGROVE FOREST HABITATS AND BIOMASS



Available online at www.sciencedirect.com



Remote Sensing of Environment 109 (2007) 379–392

Remote Sensing
of
Environment

www.elsevier.com/locate/rse

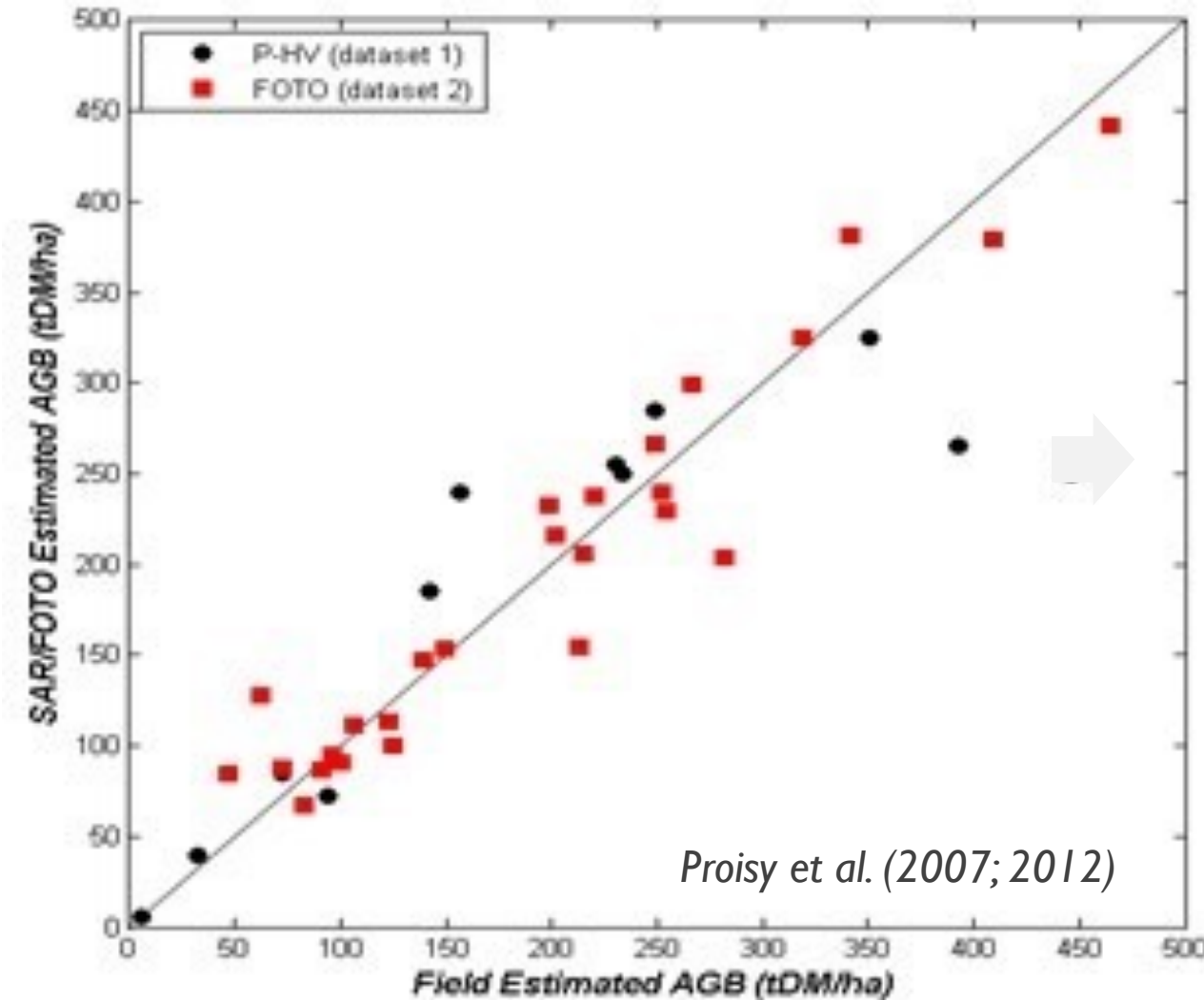
Predicting and mapping mangrove biomass from canopy grain analysis using
Fourier-based textural ordination of IKONOS images

Christophe Proisy ^{a,*}, Pierre Couteron ^b, François Fromard ^c

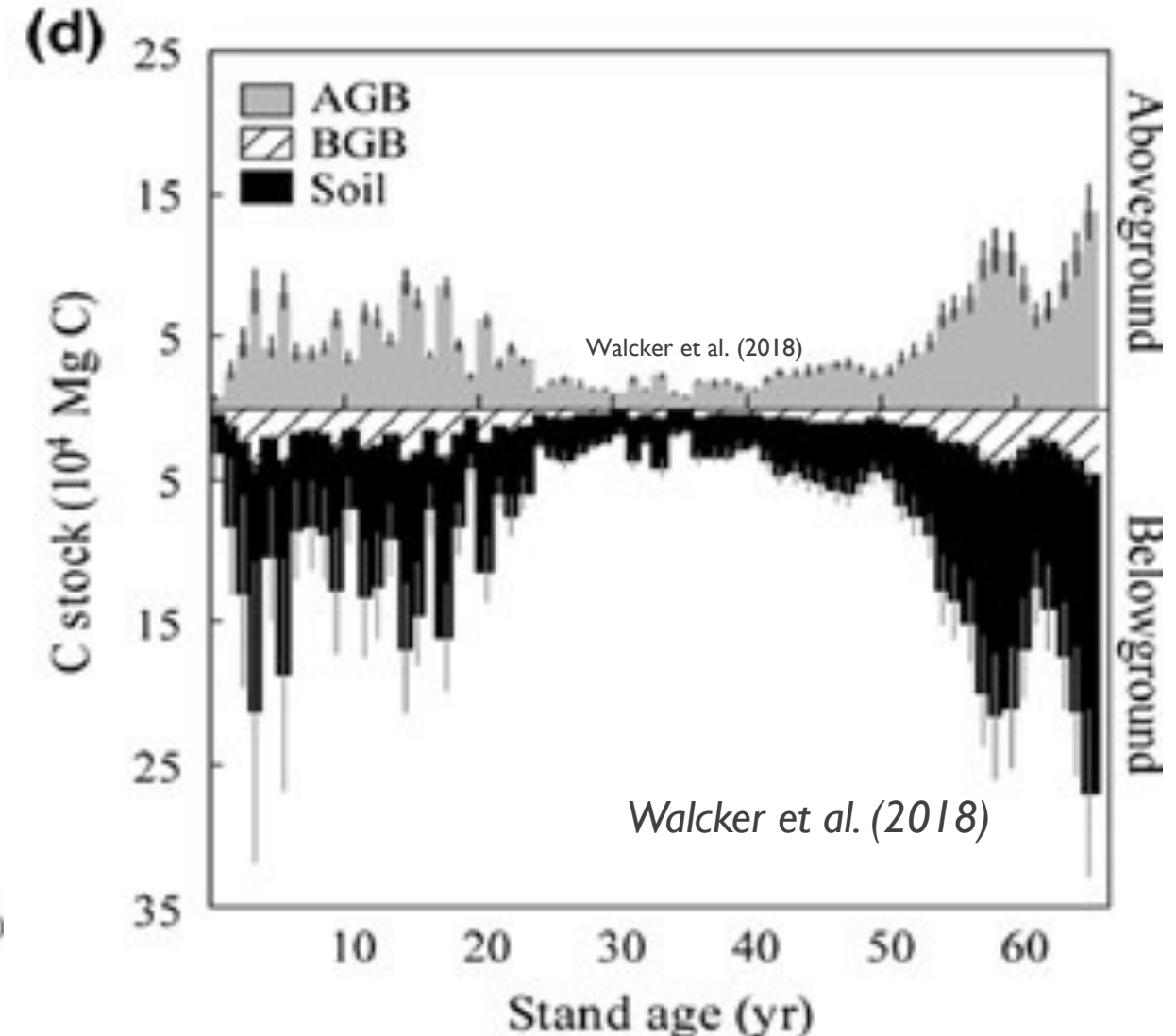


TOWARDS FINE SCALE MAPPING OF MANGROVE FOREST STRUCTURES, BIOMASS AND CARBON

AGB = f(texture vs. P-band)



C storage = f(mangrove age)



TOWARDS FINE SCALE ROBUST DIAGNOSIS OF MANGROVE SPECIES AND STATUS USING TIME SERIES OF VHRSR IMAGERY

INDONESIA

3680 IEEE JOURNAL OF SELECTED TOPICS IN APPLIED EARTH OBSERVATIONS AND REMOTE SENSING, VOL. 9, NO. 8, AUGUST 2016

Multitemporal Analysis of High-Spatial-Resolution Optical Satellite Imagery for Mangrove Species Mapping in Bali, Indonesia

Gaëlle Viennois, Christophe Proisy, Jean-Baptiste Féret, Juliana Prosperi, Frida Sidik, Suhardjono, Rinny Rahmania, Nicolas Longépé, Olivier Germain, and Philippe Gaspar



Contents lists available at ScienceDirect

Marine Pollution Bulletin

journal homepage: www.elsevier.com/locate/marpolbul



Monitoring mangrove forests after aquaculture abandonment using time series of very high spatial resolution satellite images: A case study from the Perancak estuary, Bali, Indonesia



Christophe Proisy^{a,b,*}, Gaëlle Viennois^a, Frida Sidik^{c,d}, Ariani Andayani^d, James Anthony Enright^e, Stéphane Guitet^f, Niken Gusmawati^{d,g,h}, Hugues Lemonnier^h, Gowrappan Muthusankar^b, Adewole Olagoke^{a,i}, Juliana Prosperi^a, Rinny Rahmania^{a,d}, Anaïs Ricout^b, Benoit Soulard^h, Suhardjono^j



remote sensing

INDIA



Article

Multiscale Diagnosis of Mangrove Status in Data-Poor Context Using Very High Spatial Resolution Satellite Images: A Case Study in Pichavaram Mangrove Forest, Tamil Nadu, India

Shuvankar Ghosh^{1,2}, Christophe Proisy^{1,3,4,*}, Gowrappan Muthusankar¹, Christiane Hassenrück^{5,6}, Véronique Helfer⁵, Raphaël Mathevet^{1,7}, Julien Andrieu^{1,8}, Natesan Balachandran¹ and Rajendran Narendran⁹