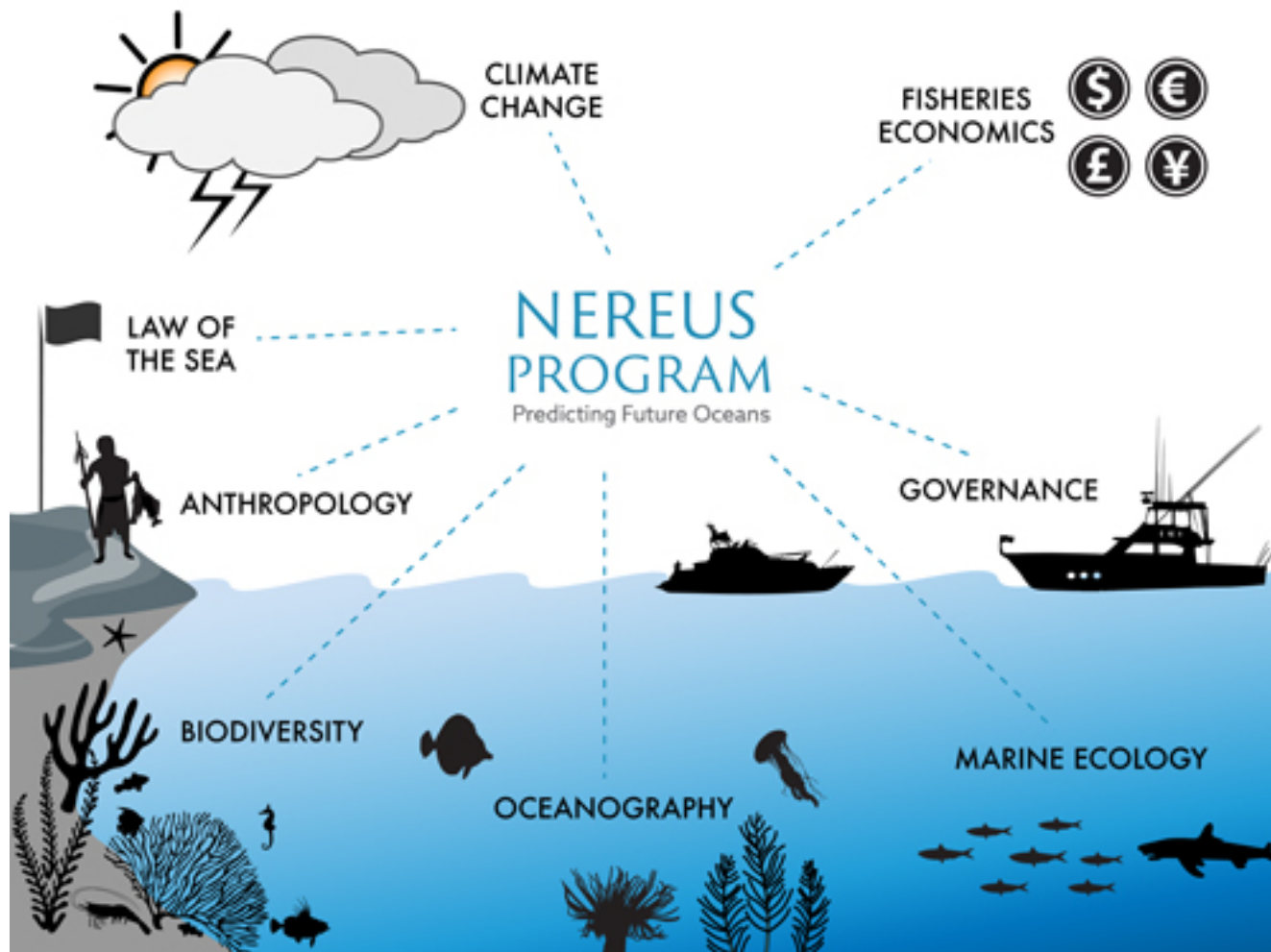# Exploring the impacts of future global change on mangrove-fishery-community linkages

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Photograph: Mangrove forest
of Wakatobi Marine Park, SE
Sulawesi, Indonesia.

Introduction: Why are mangroves important?

- Present in 123 tropical and subtropical countries
- Ecologically and economically valuable
- Provide vital ecosystem services to coastal communities
- Valued at almost $ 200,000 ha/year (Costanza et al., 2014)

Direct use values:
- Capture fisheries
- Timber and forest products

Indirect values:
- Coastal protection
- Effective blue carbon sinks
- Nursery ground
- Fisheries enhancement

Myanmar mangrove fisheries
Photograph: Christopher Zockler from UNEP (2014)

How mangroves enhance fisheries

Within mangroves:

- Direct capture fisheries and harvesting

- Provision of shelter ⎤
                      ⎬ Nursery function
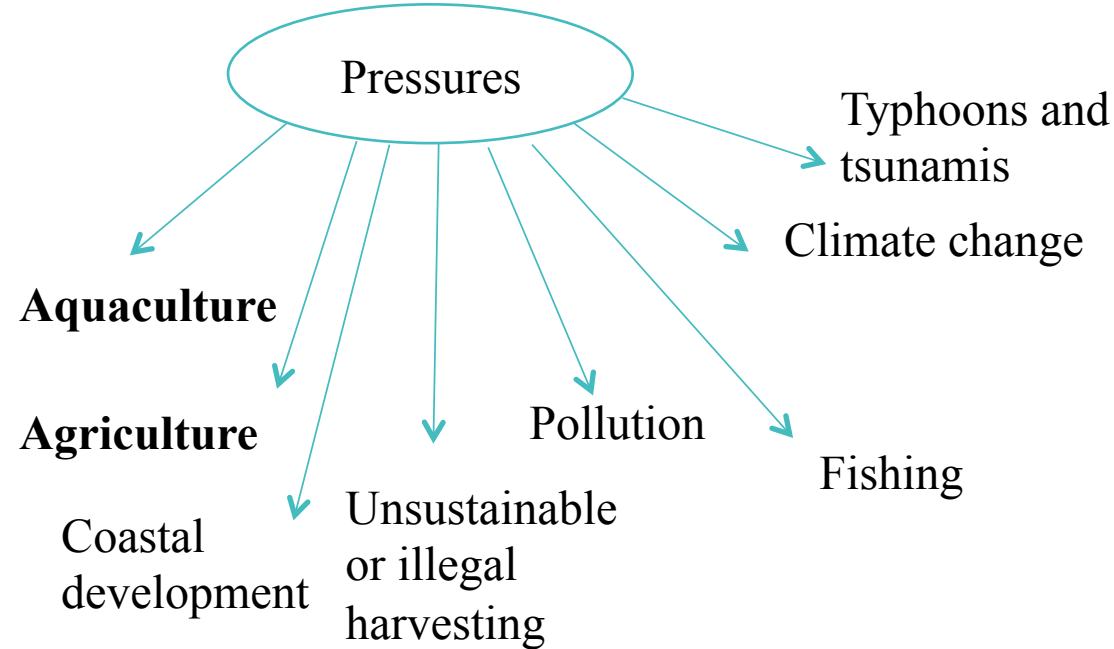- Provision of food ⎦

- Primary productivity

Externally:

- Nutrient export

- Recruit to adult populations

Top: Fyke net fishing near mangrove forest, Wakatobi National Park, Indonesia. Photograph: Rachel Seary
Bottom: Mangrove off West Papua province, Indonesia. Photograph: Diana Himmelspach/Breathholdphotography.com

Mangrove loss

Pressures

Typhoons and tsunamis

Climate change

Aquaculture

Agriculture

Pollution

Fishing

Coastal development

Unsustainable or illegal harvesting

Failed aquaculture pond in Gazi Bay, Kenya. Photograph: Hanneke Van Lavieren from UNEP (2014)

- 1-2 % global decline annually

- 3-5 times faster than terrestrial forest

- Critically endangered or approaching extinction in 26 countries

- Concern for loss of ecosystem services

- 90 % of mangroves are in developing countries

- > 40 % loss in some countries (e.g. Pakistan) vs.1 % in others (e.g. Australia)

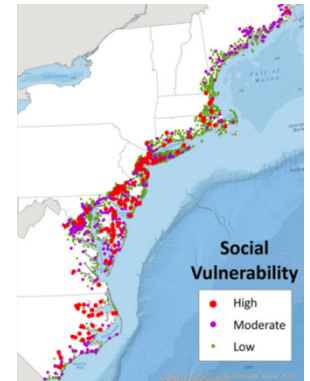- Disproportionate loss - varying levels of pressure/ management

Mangroves and people
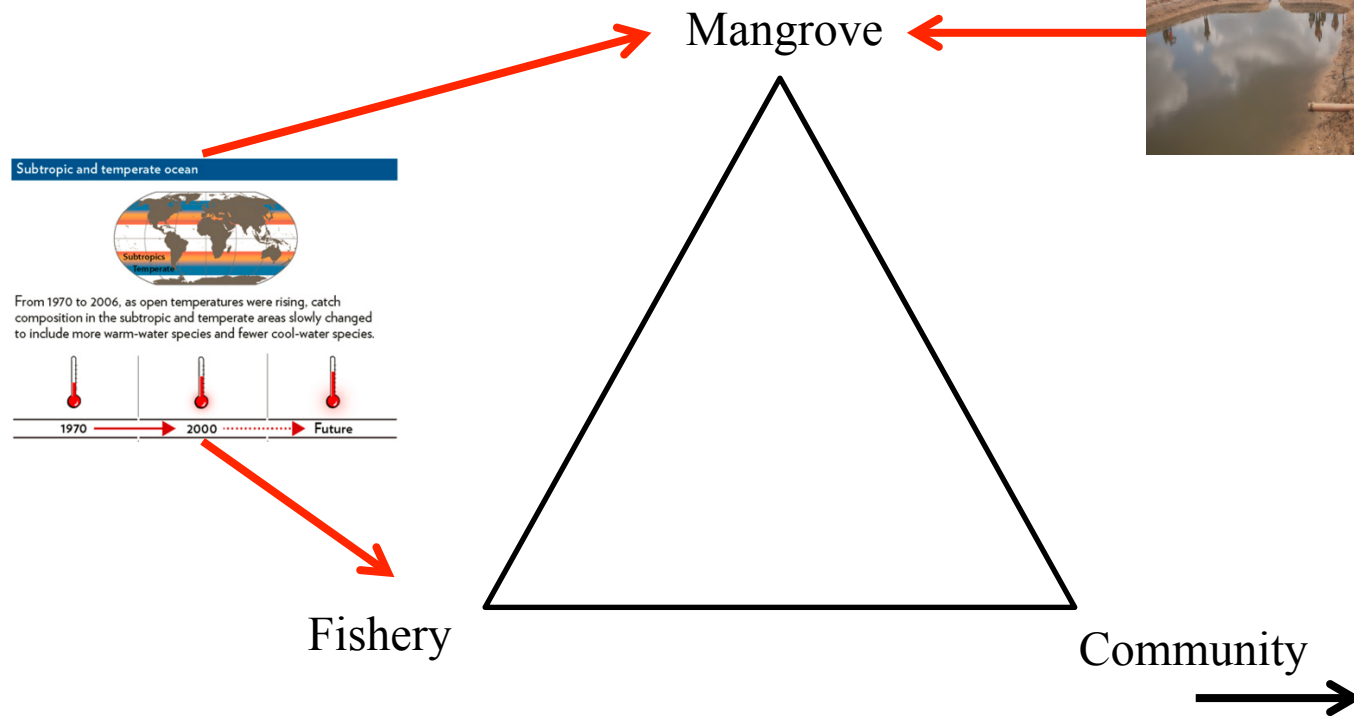
The response of mangrove soil surface elevation to sea level rise

Anna McIvor, Tom Spencer, Iris Möller and Mark Spalding

Subtropic and temperate ocean

From 1970 to 2006, as open temperatures were rising, catch composition in the subtropic and temperate areas slowly changed to include more warm-water species and fewer cool-water species.

1970 → 2000 ·····→ Future

Mangrove

Fishery

Community

Social Vulnerability
- High
- Moderate
- Low

- > 100 million people within 10 km of a large mangrove forest
- Basic subsistence products have a role in poverty alleviation
- Mangrove degradation and loss = vulnerability for coastal communities

Open questions

- Lack of large scale data means the importance of mangrove-fishery linkages is not understood in global context

- Are coastal fisheries actually dependent on mangroves?

- What makes one mangrove forest more suitable for fisheries production than another?

- How will mangroves respond to climate change and sea level rise?

- How will future mangrove change impact fisheries production and therefore communities reliant on them?

Aim

To investigate the potential impacts of future global change on mangrove-fisheries and therefore economies and food security from a community to global scale.

Objectives

1) To understand current mangrove-fishery linkages and determine which attributes related to the presence of mangroves are important to fisheries.

2) To determine whether global and regional catch data suggests a link between mangrove presence and fisheries productivity.

3) To relate resulting conclusions to a number of fine-scale local case studies which investigate the link between mangrove attributes to local artisanal fisheries and community livelihoods.

4) To estimate the potential impacts of global change (including mangrove loss by climate related and anthropogenic impacts) over a range of spatial scales on artisanal fisheries and subsequently the communities dependent on them.

Data sources- Global to regional

- Sea Around Us (Nereus)

  - Large scale fisheries data

- World Mangrove Atlas (Spalding, 2010; Giri, 2011; Hamilton and Casey, 2016)

  - Mapped 99 % of worlds mangroves

  - Available through UNEP-WCMC

- Commercial species distribution models (Laurens Geffert)

Global mangrove distribution in 2000 (Giri, 2011)

Data sources - Local scale

- **Madagascar**: Blue Ventures (Adrian Levrel/Ivan Scales)
  - Artisanal fisheries catch data (2 sites + more in future)
  - Maps of mangrove change over time (5 sites)

- **Gazi Bay, Kenya**: Mark Huxham (Edinburgh Napier University)
  - Fish landings data
  - Mangrove fish species and mangrove dependency data
  - Forest quality

- **Hanain Island, China**: Wenqing Wang (Tsinghua University)
  - All data required other than total catch and effort data

- **Bali, Indonesia**: Frida Sidik (Institute for Marine Research and Observation, Bali)

- **Thailand/Cambodia**: Dan Friess (University of Singapore)

- **Mexico**: Possible connections through Andres

Methods – Preliminary work

• Literature review to investigate mangrove-fishery-linkages focused upon:
1) Drivers of potential fishable biomass
2) Human impacts on actual fishable biomass
3) Socioeconomic drivers of fishing effort in mangroves
4) Future climate change impacts on mangroves and subsequently fisheries

Following on from and modifying conceptual model by Hutchison et al. (2015) describing the drivers of mangrove-fishery productivity:
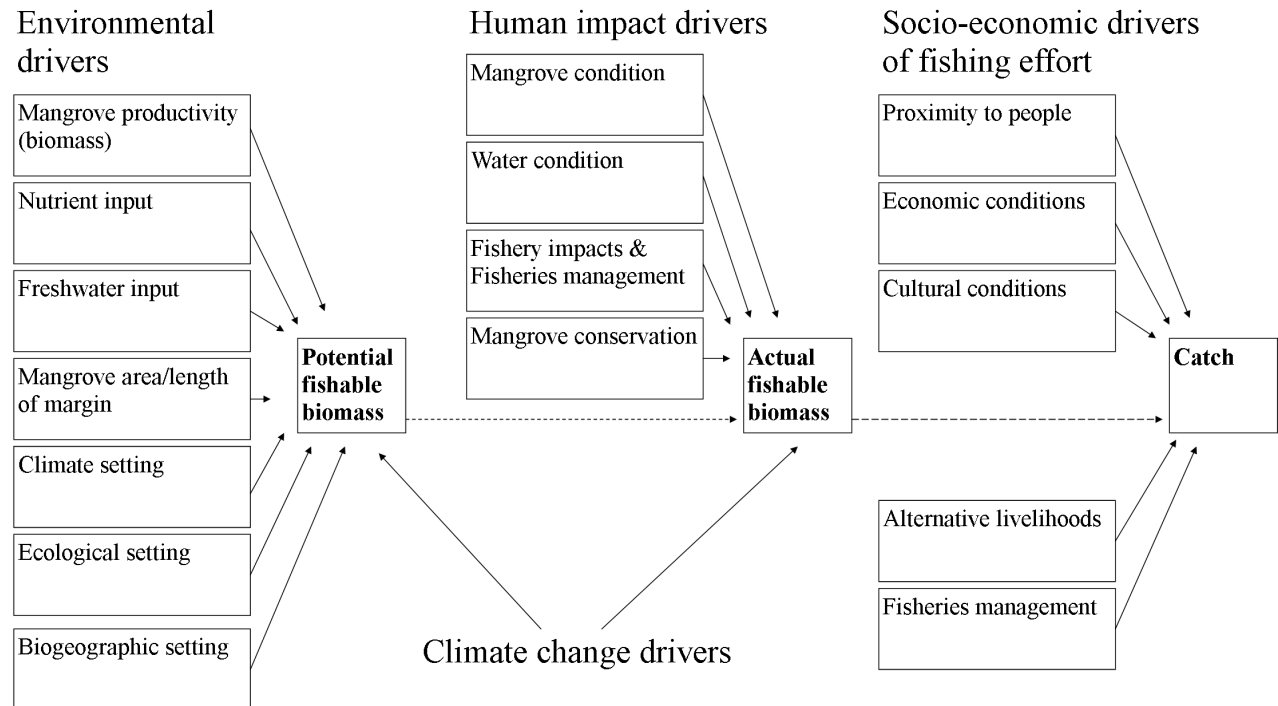
Methods – Global and regional analysis

- Use global catch data to look for simple correlations between mangrove presence/ attributes and fisheries productivity

- Also look at regional correlations e.g. EEZ's or LME's

- Model global mangrove vulnerability using DIVA Wetland Change Model
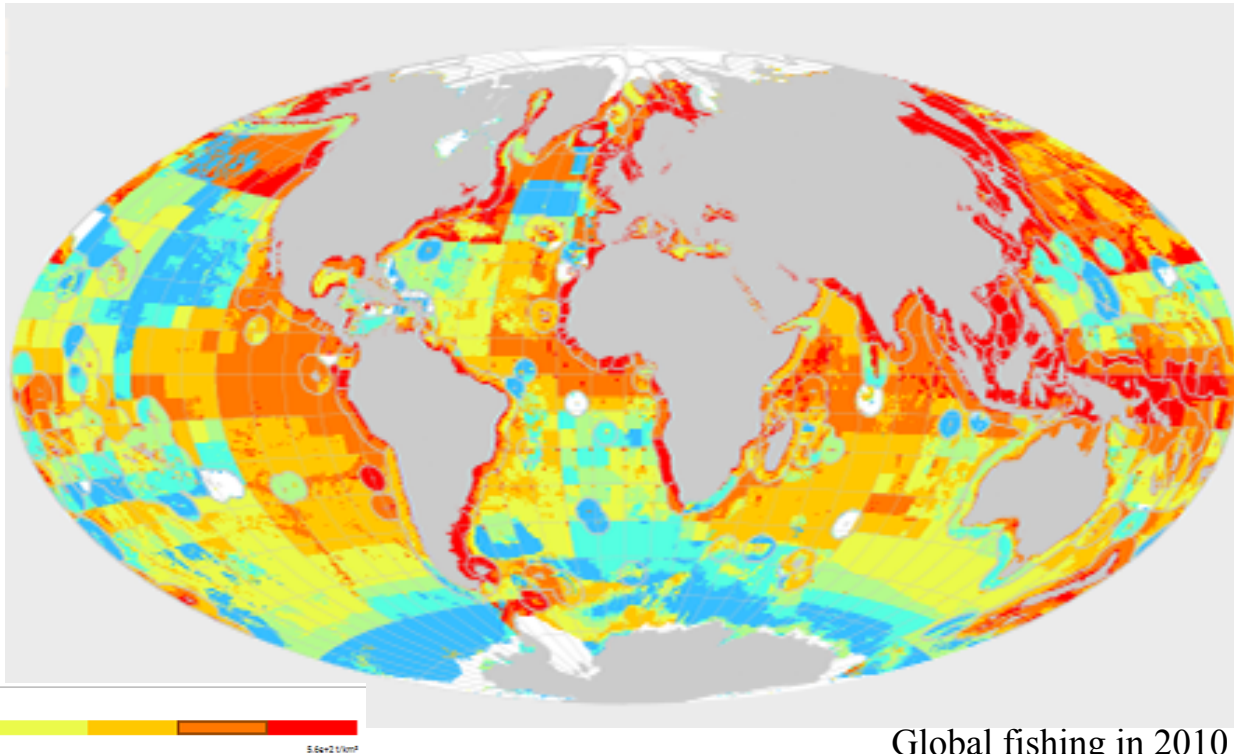
Global fishing in 2010 (Sea Around Us, 2016)

Methods – Vulnerability modelling
The DIVA Wetland Change Model

• One module of the DIVA (Dynamic Interactive Vulnerability Assessment)

• Identify the vulnerability of coastal wetlands on a broad spatial and temporal scale

• Projects under a range of scenarios for sea level rise (SLR) and changes in accommodation space from human intervention

• Quantify vulnerability of mangrove areas based on forcing by SLR, tidal range, sediment supply and accommodation space

• Global or regional (EEZ's/LME's)

• Map areas at risk

• Look into subsequent vulnerability of fisheries and communities

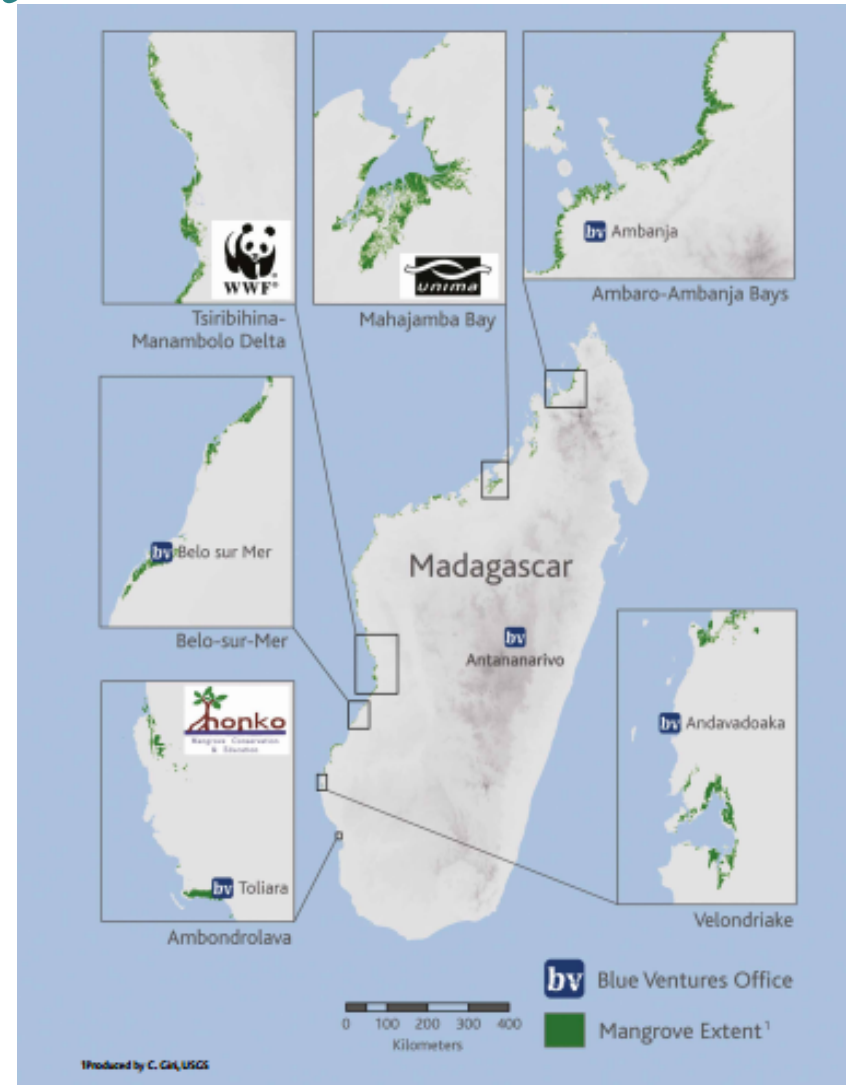(McFadden et al., 2007, Spencer et al., 2016)

Methods – Community level

Collecting information on:

- Attributes of the mangrove forest
- Artisanal fisheries catch
- Socio-economic information

Possible analysis:

- Statistical modelling
- Agent-based modelling

Mangrove forests and communities being studied by Blue Ventures in Madagascar

Thoughts on adaptation framework for a community dependent on mangroves...

Objective	Objective function	Mechanism	Outcome
Community well-being	Level of anthropogenic pressure on mangroves	Alternative livelihoods	Available products for subsistence and economy
		Adopting new markets	
	Climate change drivers of mangrove loss/ change	Management (e.g. fisheries or managed retreat)	Potentially reduced loss of mangrove area
	Level of dependence	Mangrove conservation	
	Opportunity for alternative livelihoods		

Conclusions

Proposed project outcomes

- Further knowledge on the linkages between mangroves, fisheries productivity and community livelihoods in a local and global context

- Provide quantitative validation for the paradigm of fisheries enhancement by mangroves

- Supporting argument for the protection of mangroves vs. land reclamation

- Provide projections for the future of mangrove forests in light of climate change and continued anthropogenic mangrove loss

- Inform management decisions for sustaining mangrove-fisheries and community livelihoods

Thank you