

Catchments to coast: protecting forests to give coral reefs a future

Joseph Maina



- coral reef management strategy in a high CO₂ world: sediment and nutrient pollution



Pic: Simon Albert

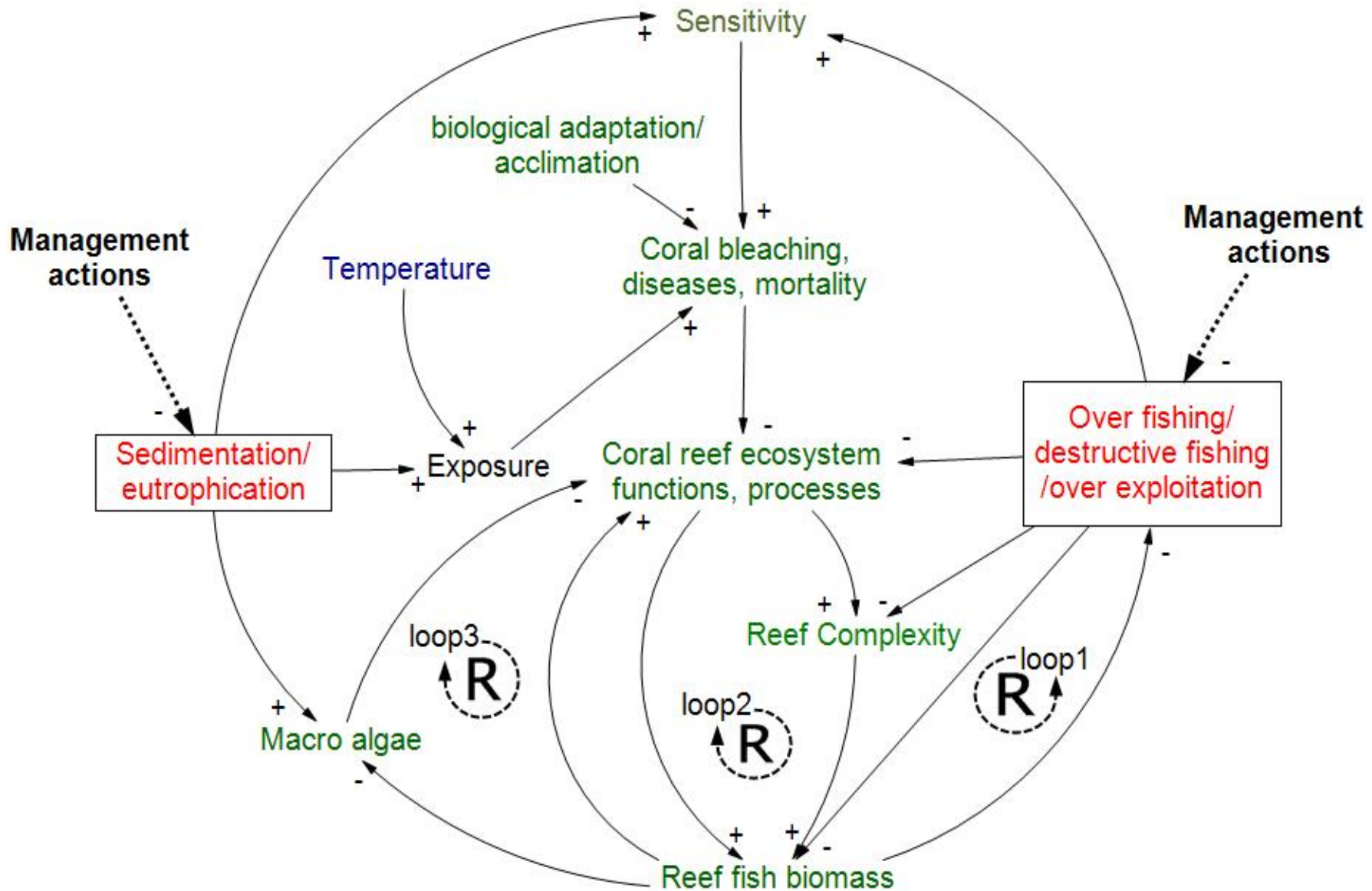


- **GBR Proposed actions include..**

‘(iv) Fund catchment and coastal management to the required level to solve pollution issues for the Greater GBR by 2025, before climate change impacts on Greater GBR ecosystems become overwhelming’



Coral reef biophysical and human coupled system



Impacts of turbidity on coral reefs

- What we know:

The bad...

ECOLOGICAL APPLICATIONS
ECOLOGICAL SOCIETY OF AMERICA

Article |  Full Access

Water quality as a regional driver of coral biodiversity and macroalgae on the Great Barrier Reef

Glenn De'ath , Katharina Fabricius

The good...

 **Global Change Biology**

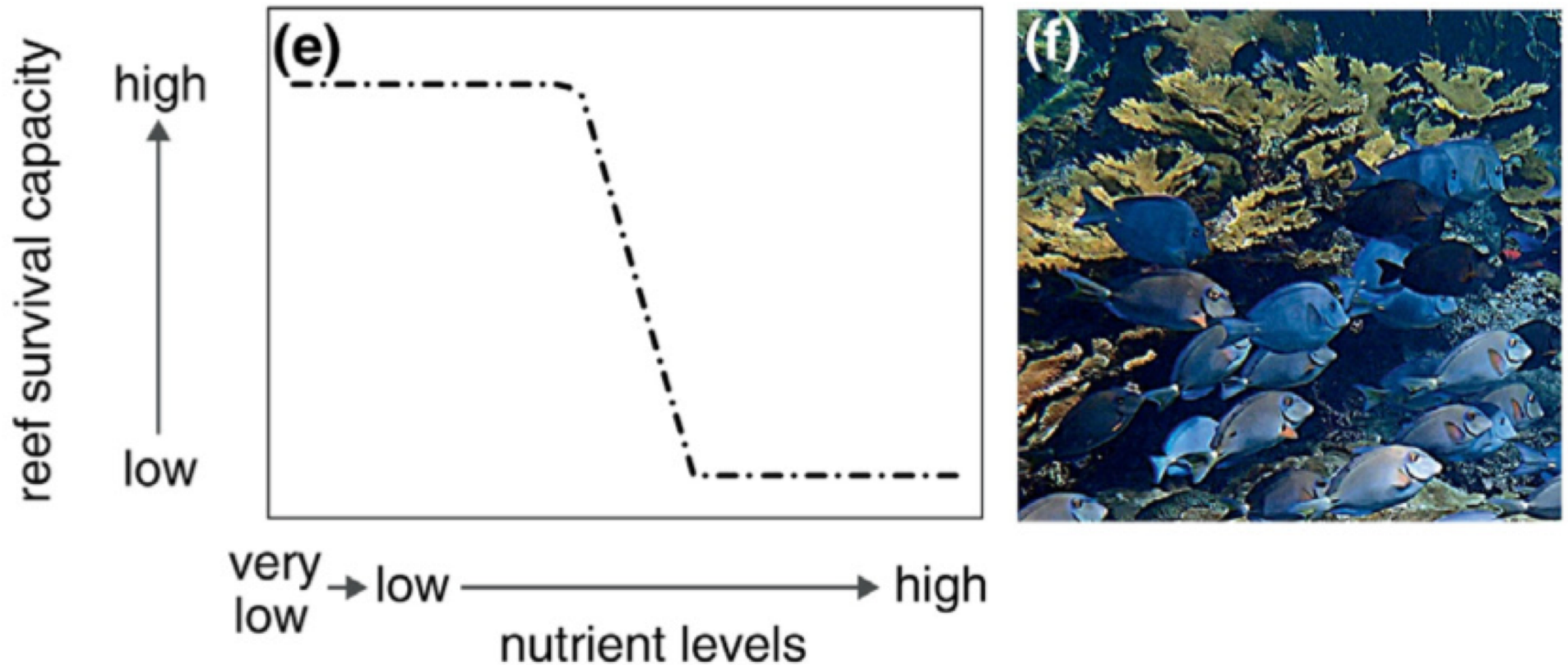
Primary Research Article

Climate-change refugia: shading reef corals by turbidity

Chris Cacciapaglia , Robert van Woesik

Impact – response conceptual framework

The combination of direct and indirect effects of nutrient enrichment affects reef survival



Current Opinion in Environmental Sustainability

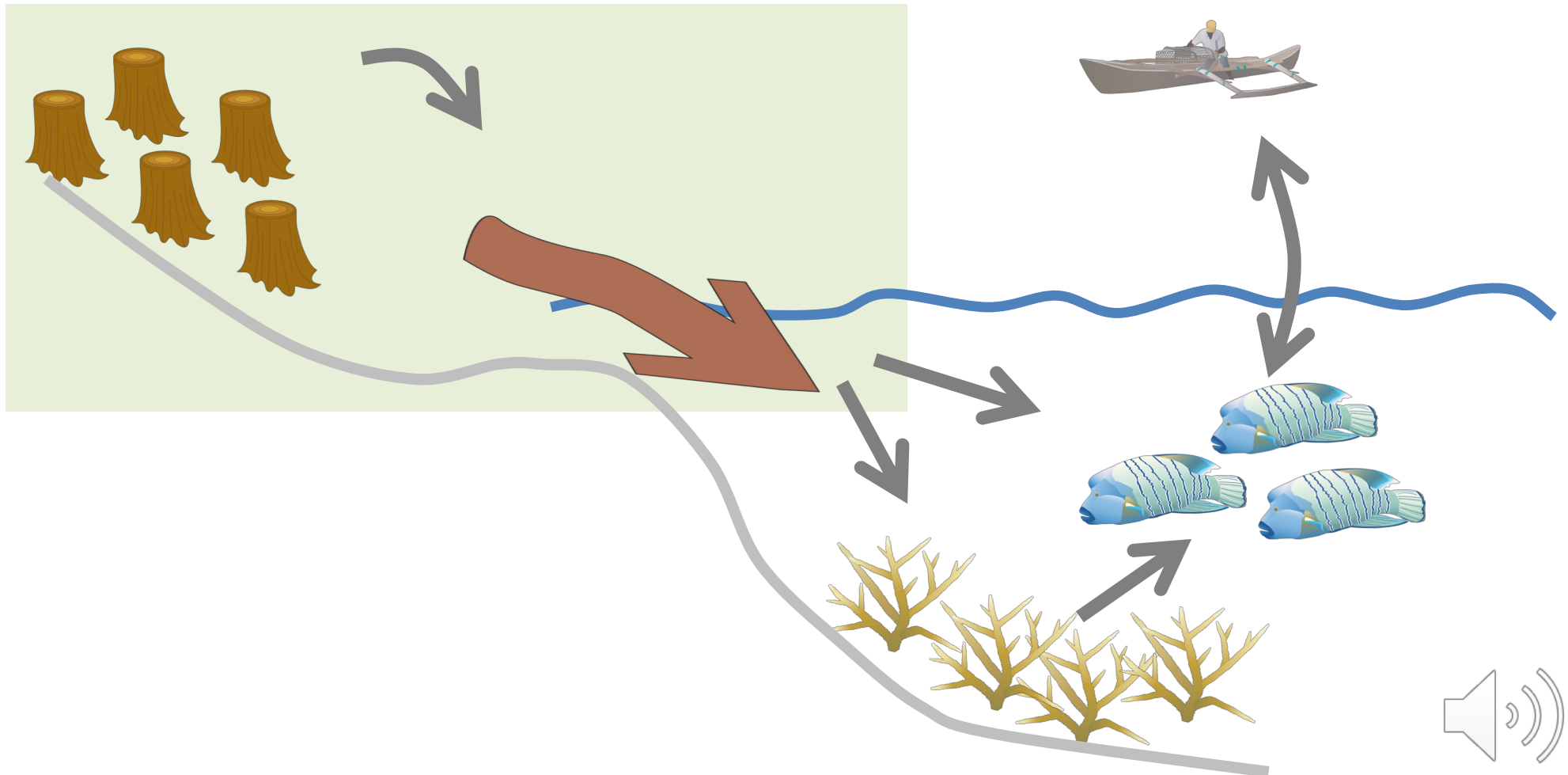
- Understanding the thresholds



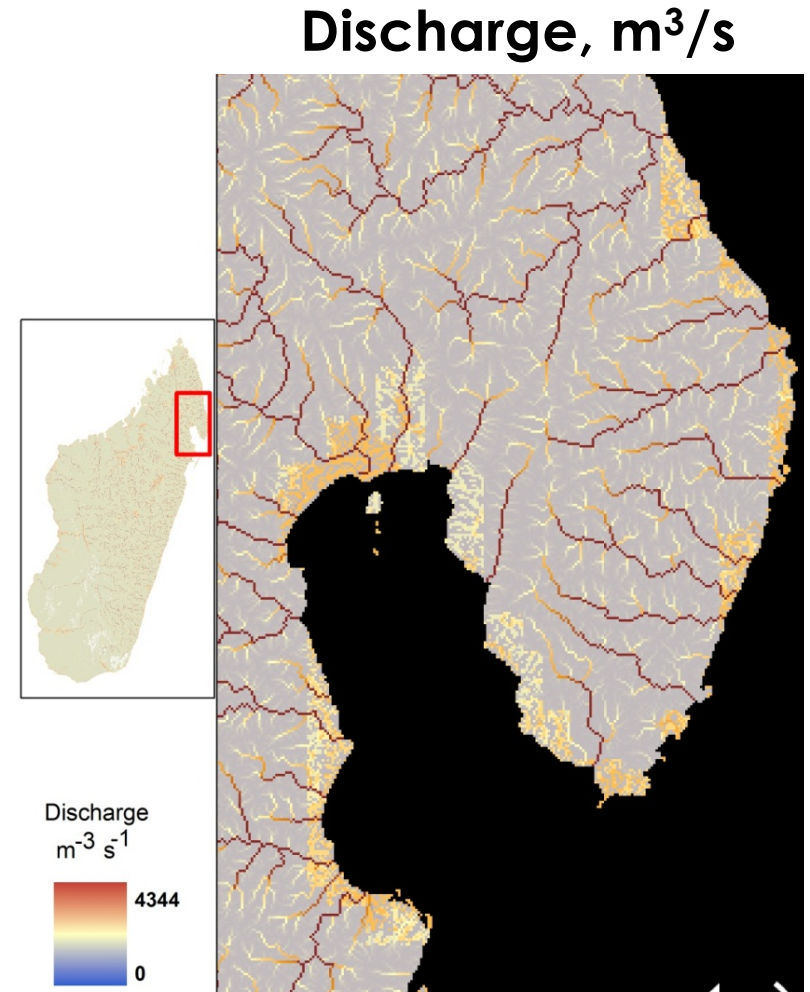
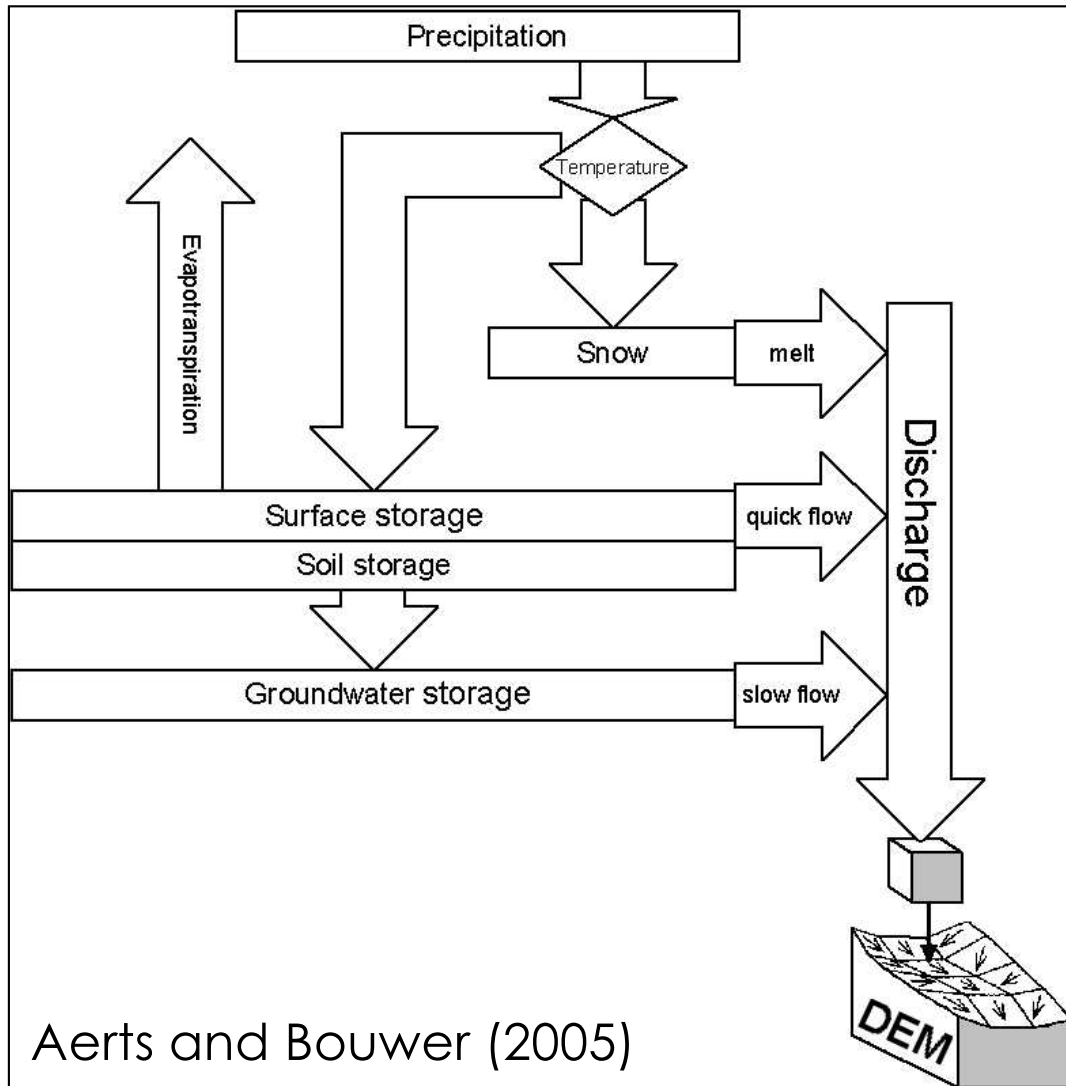
Supporting decisions on Land-sea management

- How much sediment?
- Present relative to baseline?
- Explicit sediment reduction targets - landsea planning
- Dynamics of the climate-mediated changes

(1) Part 1 of the puzzle: how land-use impacts on turbidity

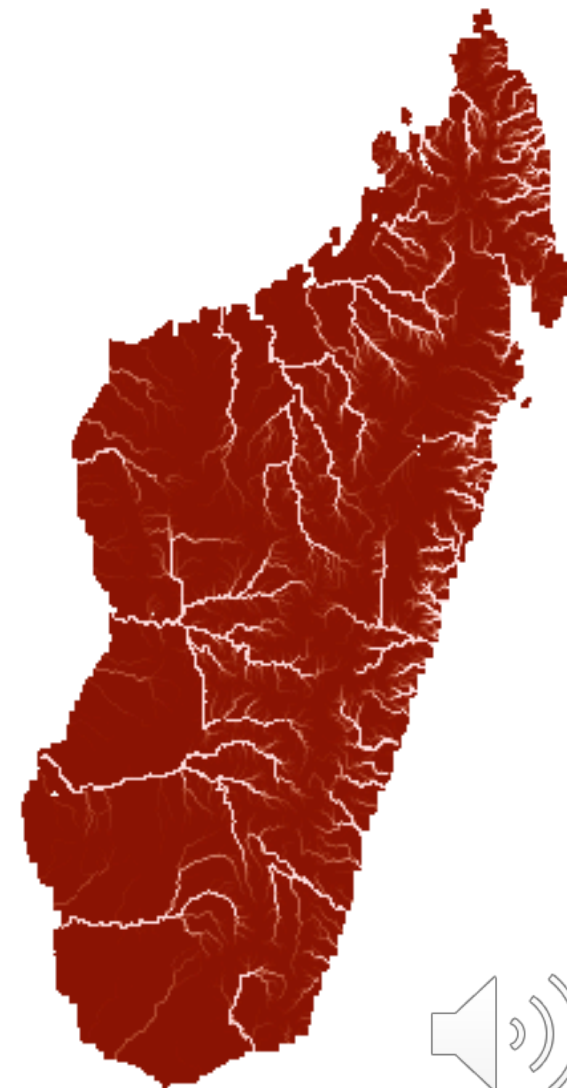
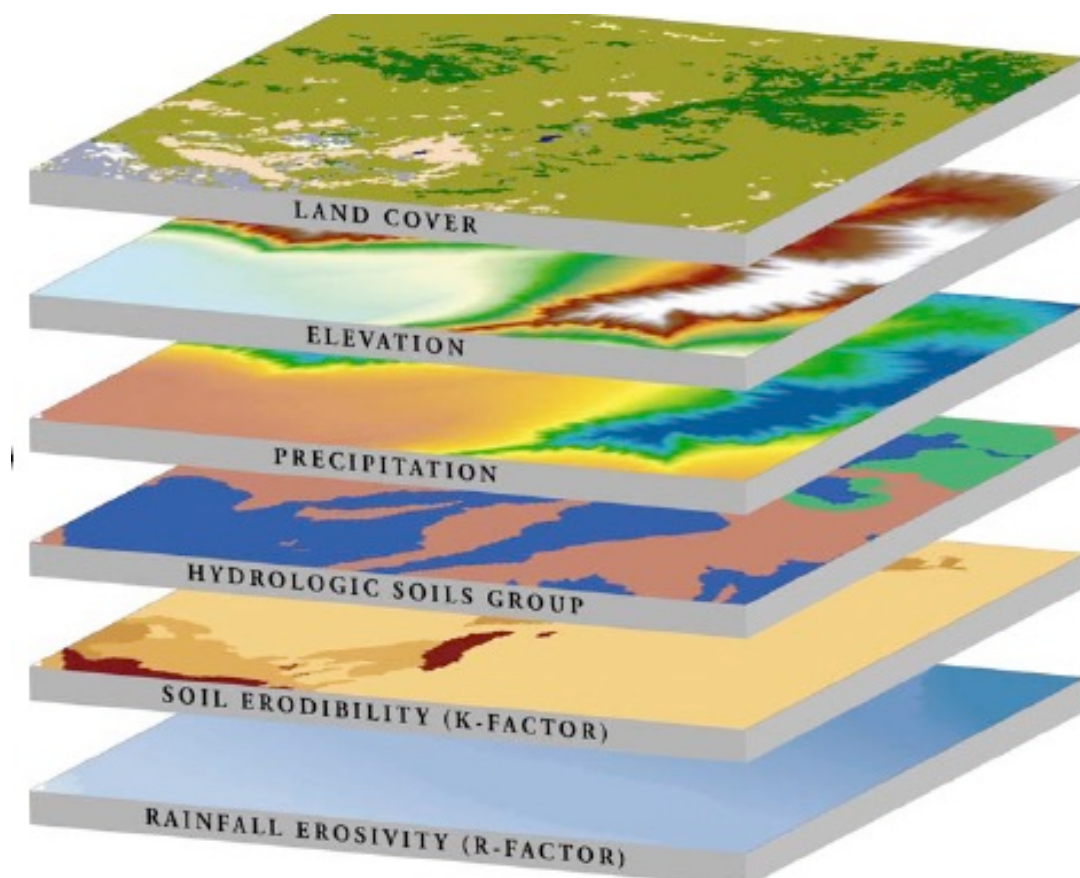


Tools: Hydrological models



Tools: Hydrological models

- N-SPECT Tool by NOAA Coastal Services Center

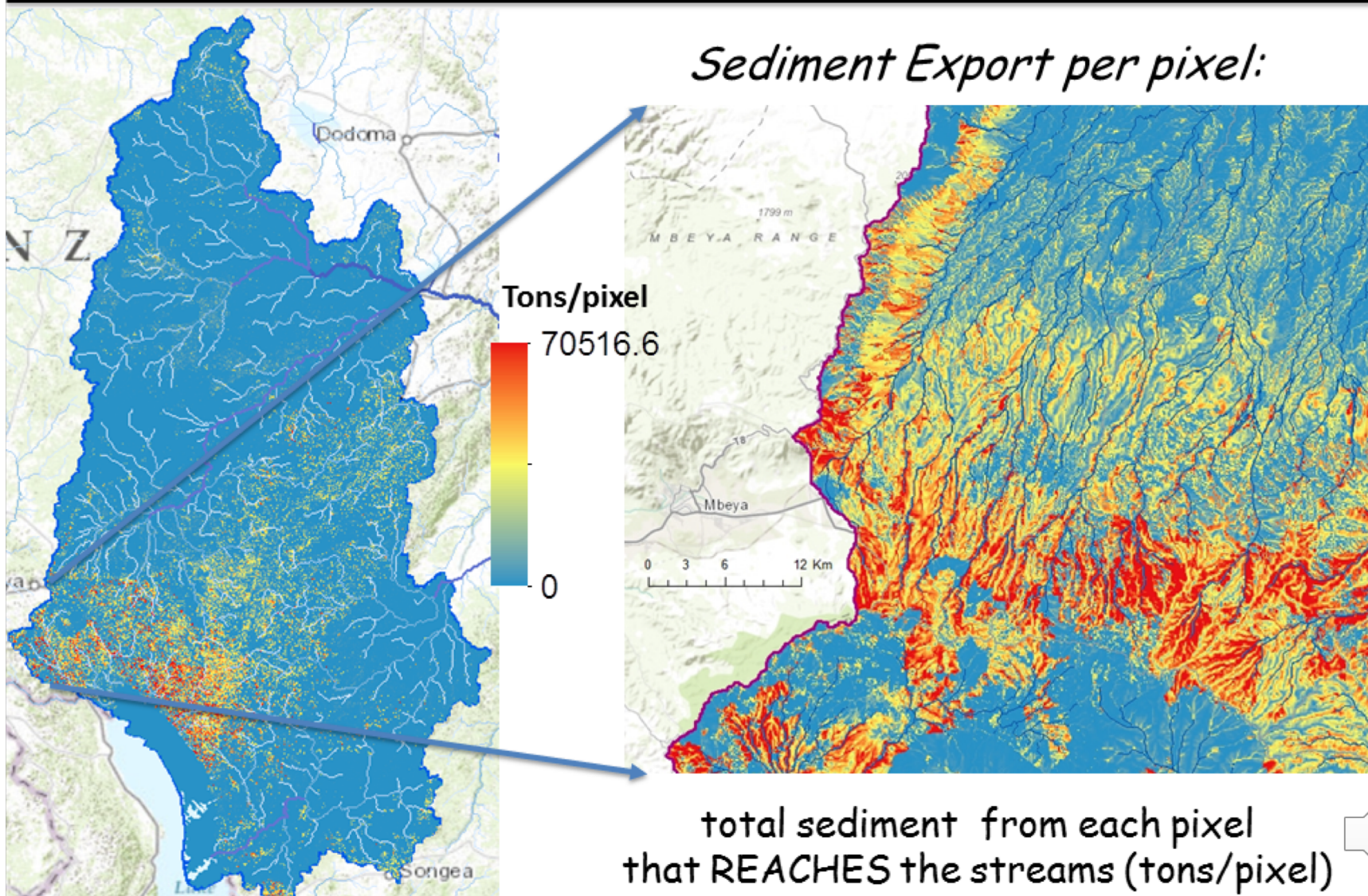


Sediment Yield/Year, mt



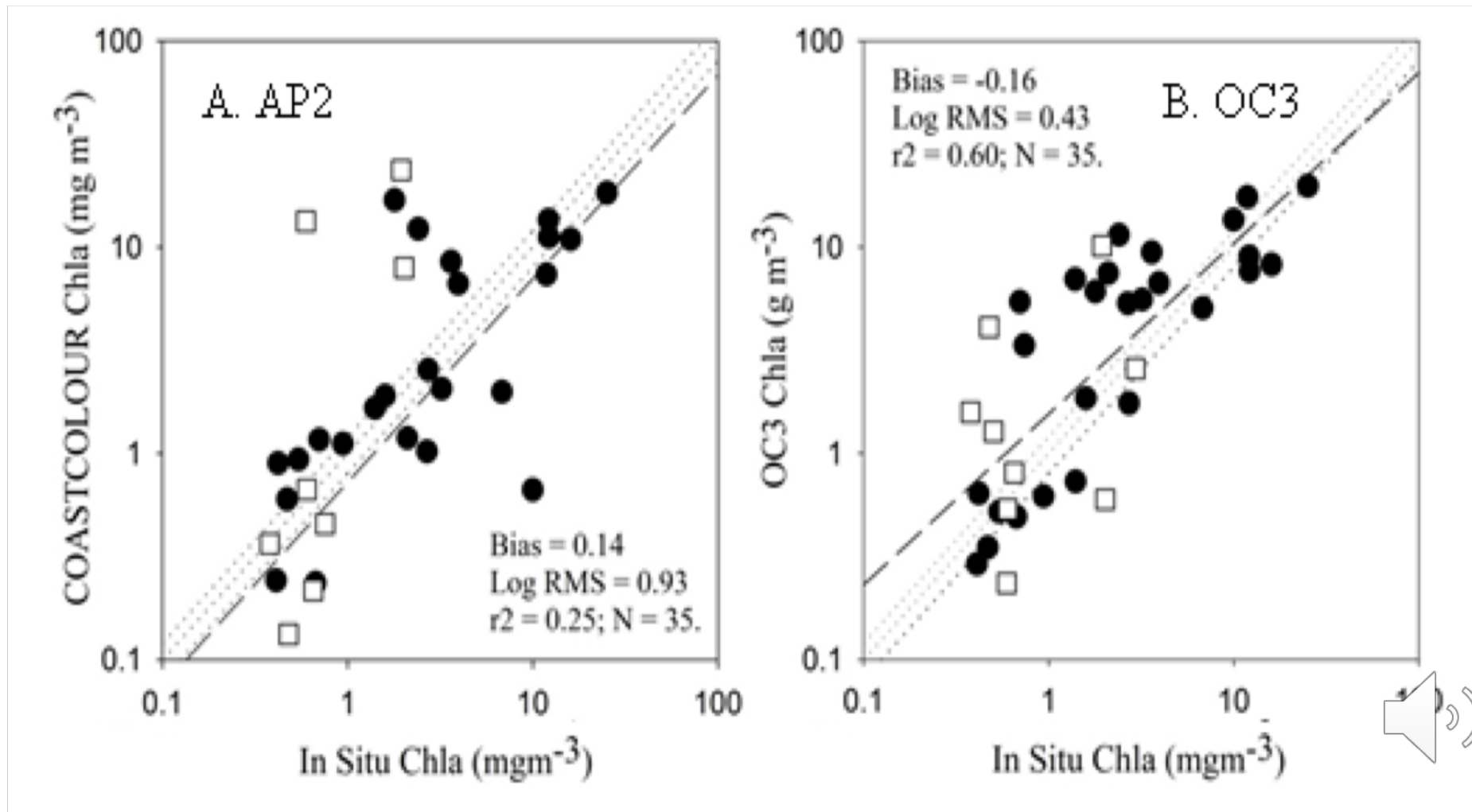
Outputs: erosion vulnerability maps

sediment reaching streams

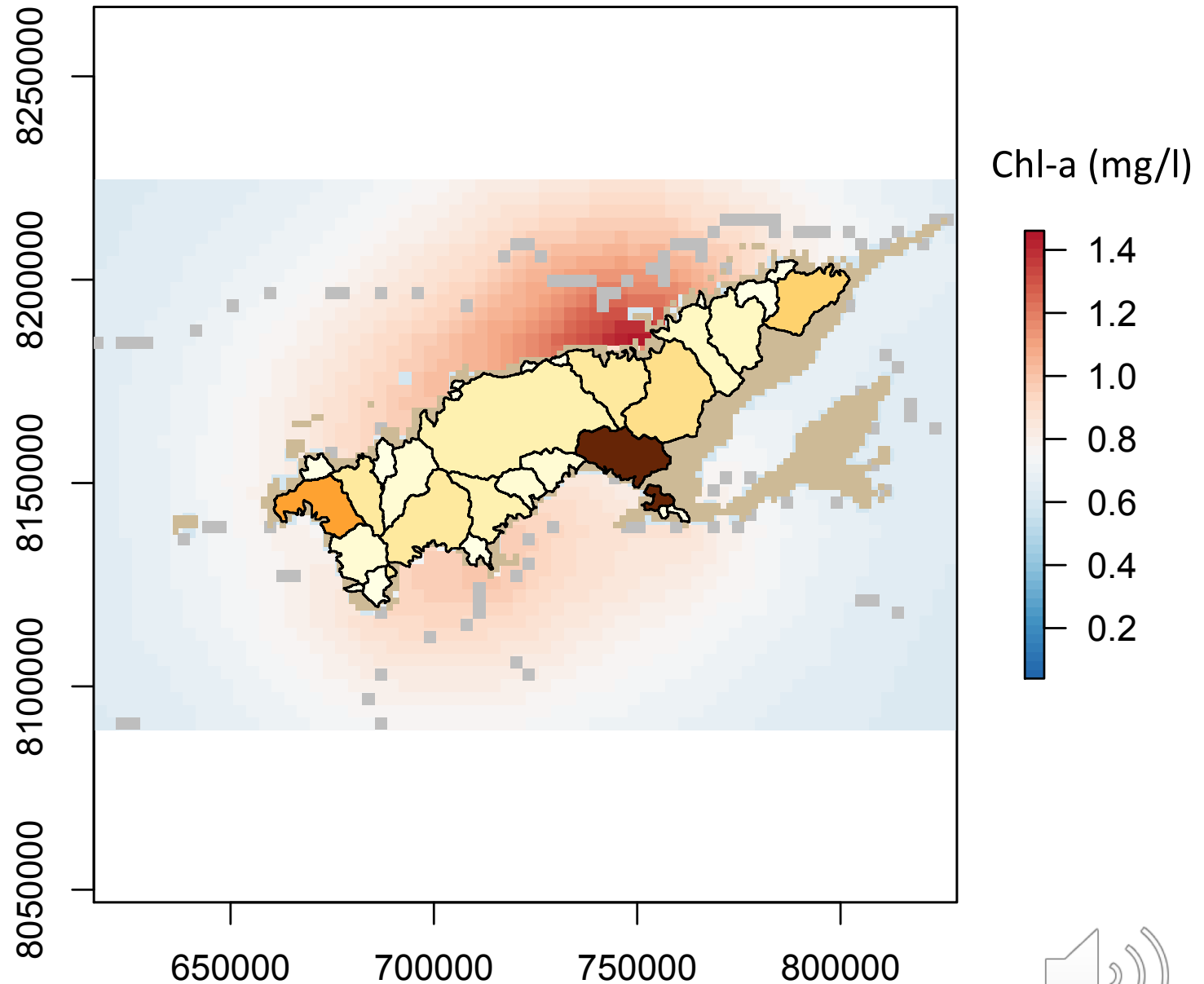


Tools: Remote Sensing

- retrieving water optical properties and concentrations from reflections spectra in coastal waters: validating satellite data for two sites in *Tulear - SW Madagascar*



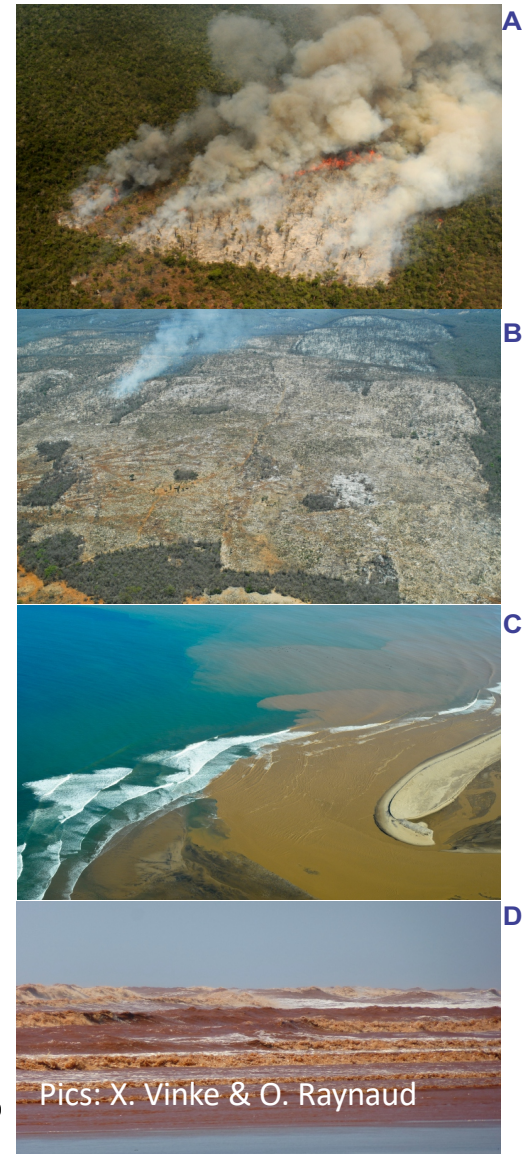
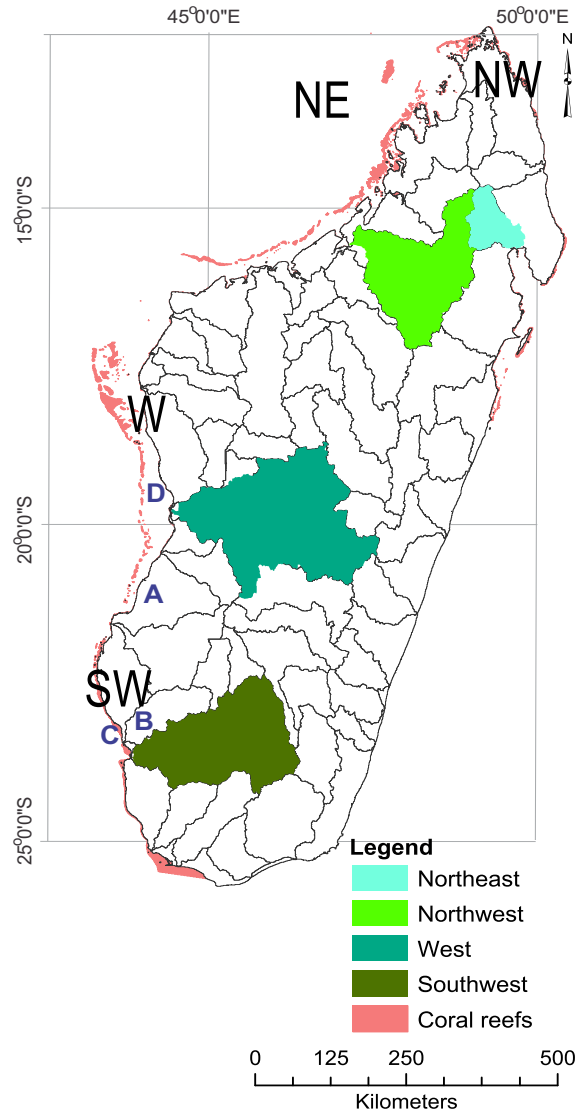
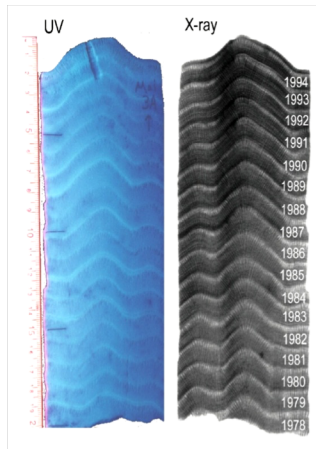
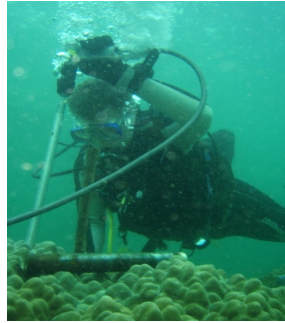
Tools: Coupling Remote Sensing & Hydrological models



www.seascapemodels.org/data/FijiWaterQuality.html



Tools: coupling hydrological models with Geochemistry/sediment cores



Approach

Land use
mapping

Predicting
land-use

Hydrologic
Modelling

Climate

Sediment
modelling

1980

1990

2000

2010

2014

2020

2025

2030

1981

-

2014

2015

-

2030

Historical
temperature
& rainfall

Projected
temperature
& rainfall

Land-use change

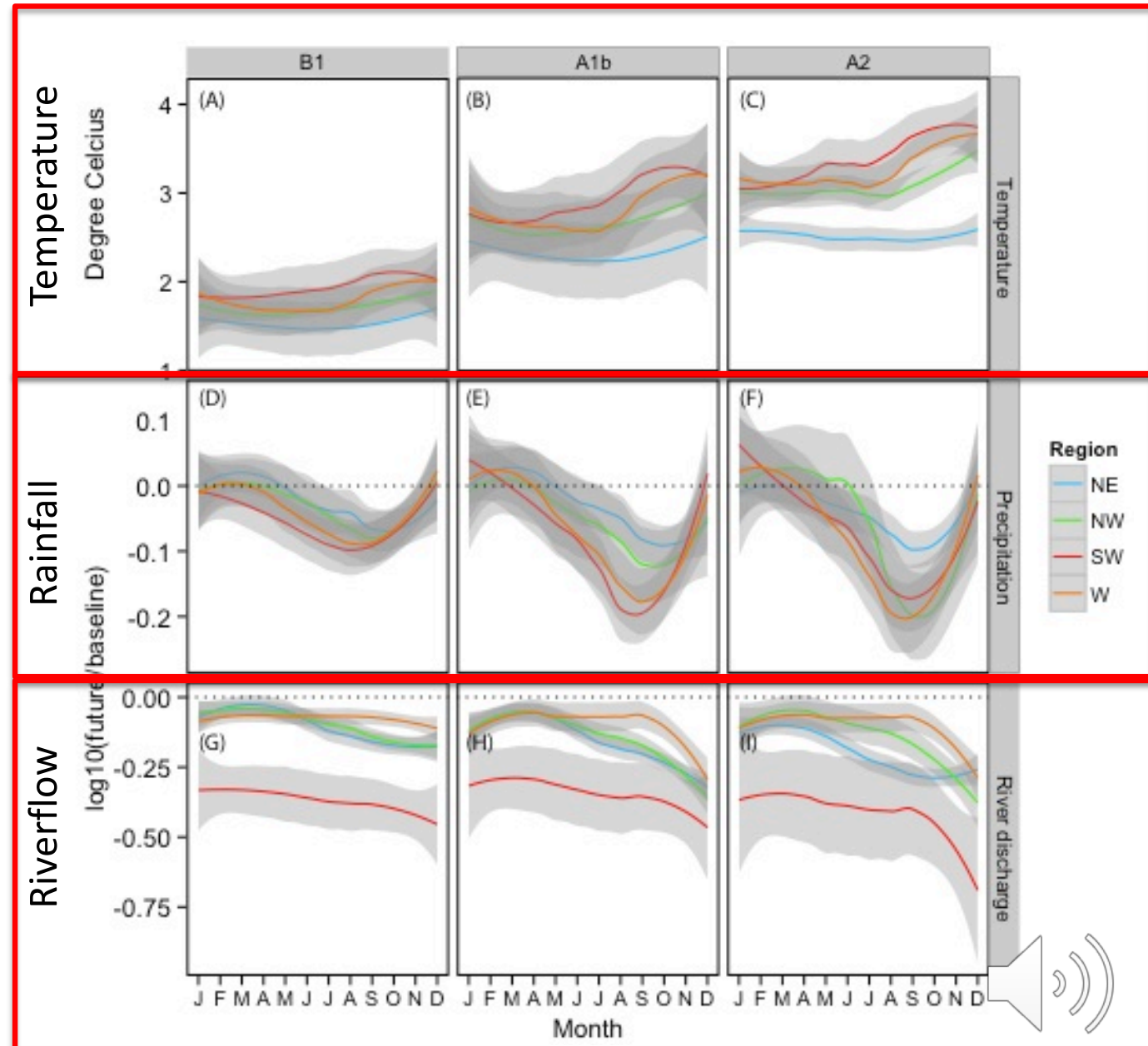
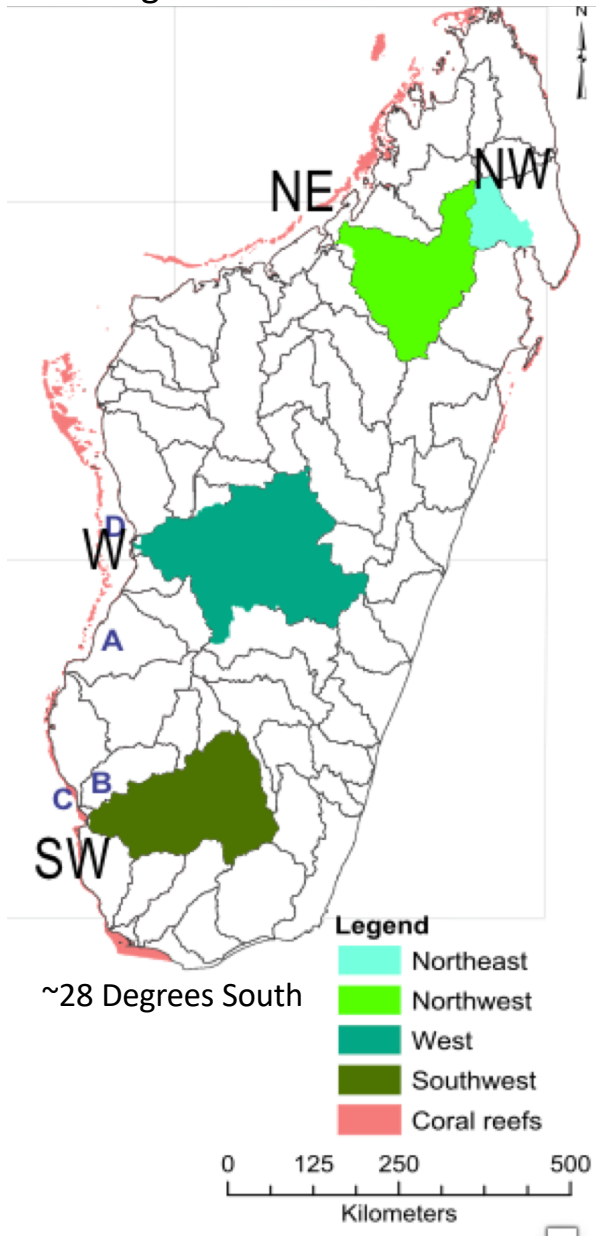
River-flow estimates

Erosion/Sediment
estimates



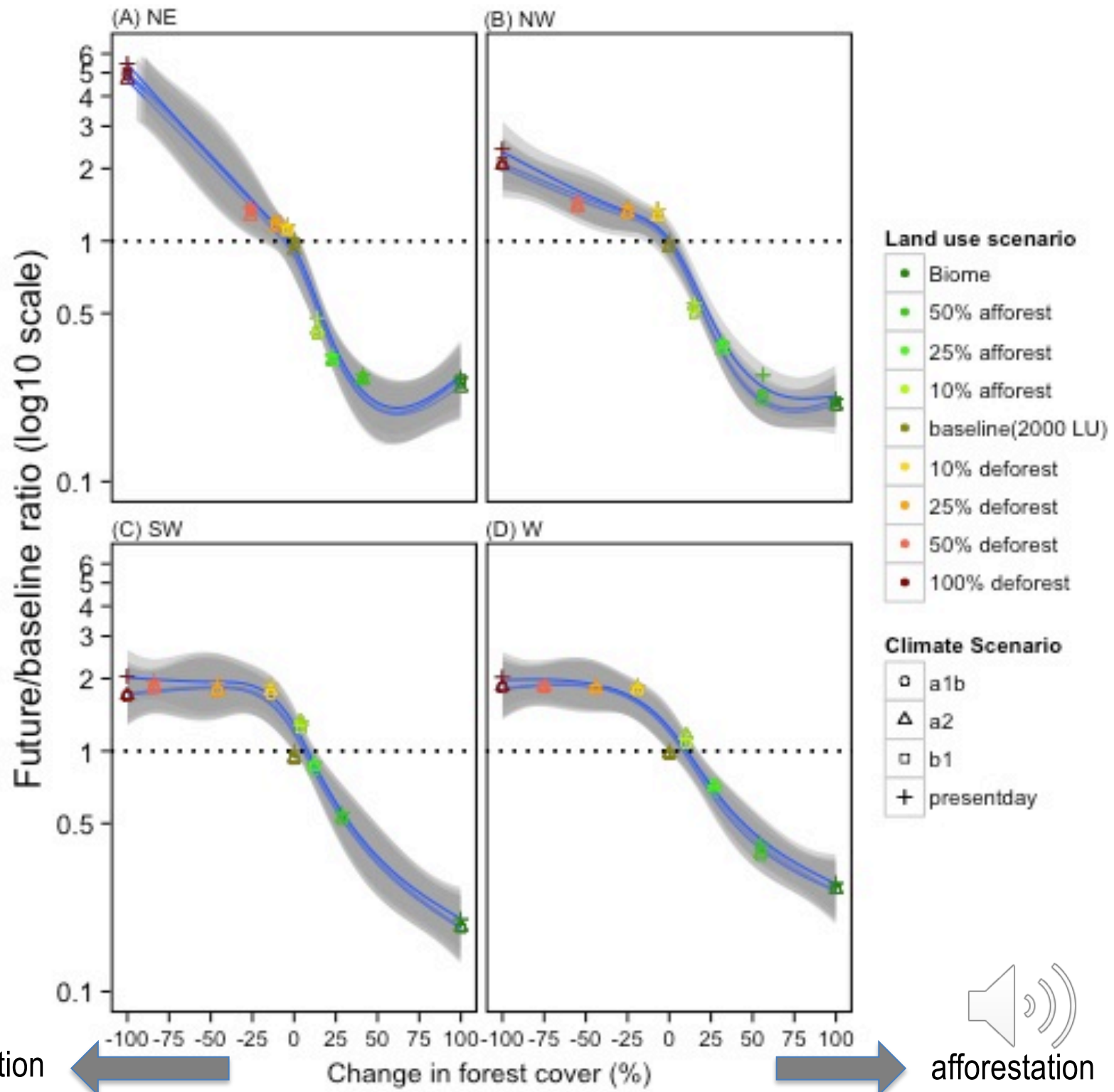
Global Environmental Change: Climate & Land use dynamics

~12 Degrees South



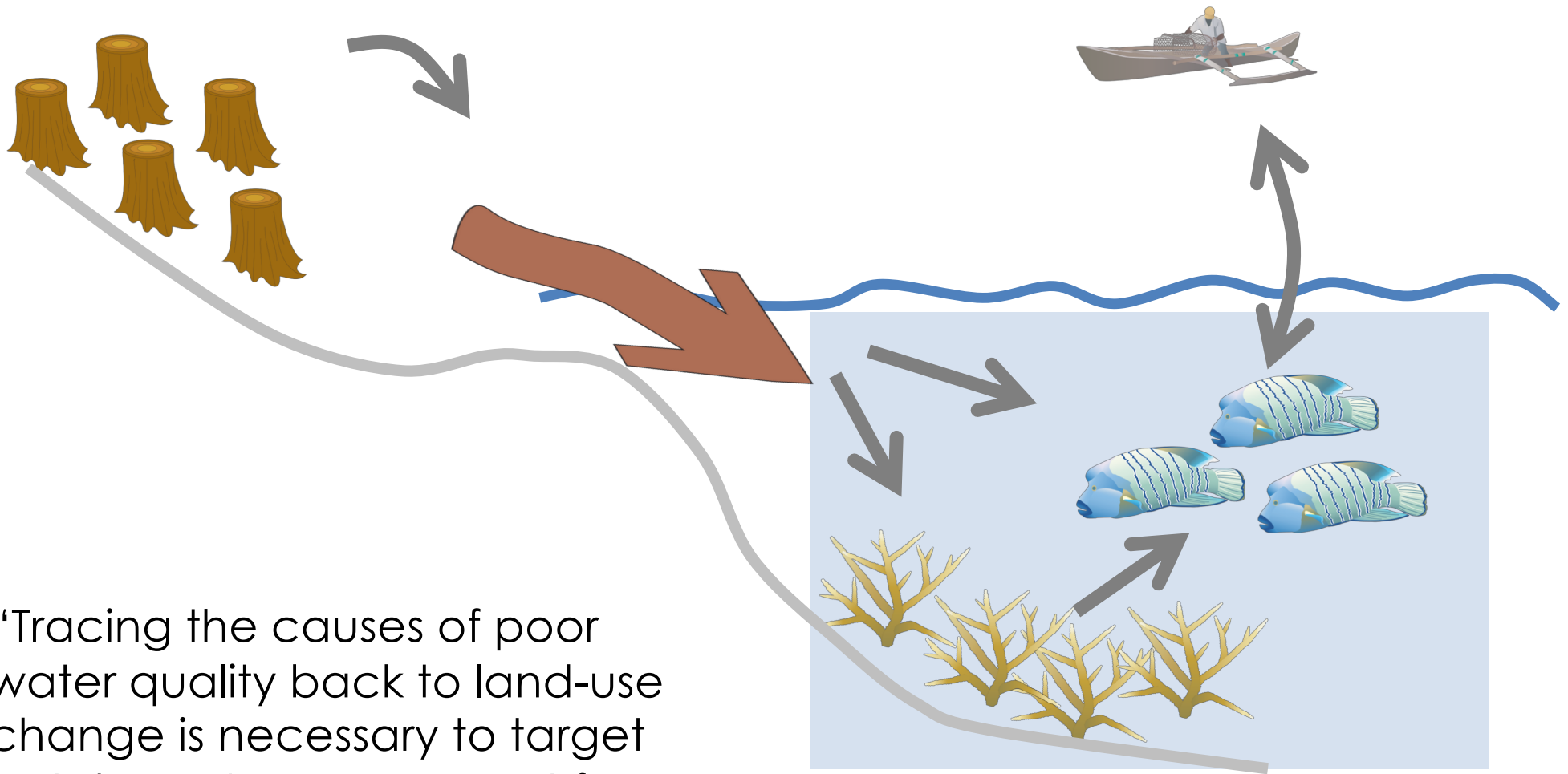
- Forest conversion increases sediment yield by up to five-fold

- Afforestation decrease sediment yield in all the four regions by 75% - 80%



afforestation

(2) Part 2 of the puzzle: Fish responses to habitat change/catchments



“Tracing the causes of poor water quality back to land-use change is necessary to target catchment management for coastal zone management”





Abundance of fish across gradients of fishing pressure and turbidity - Fiji

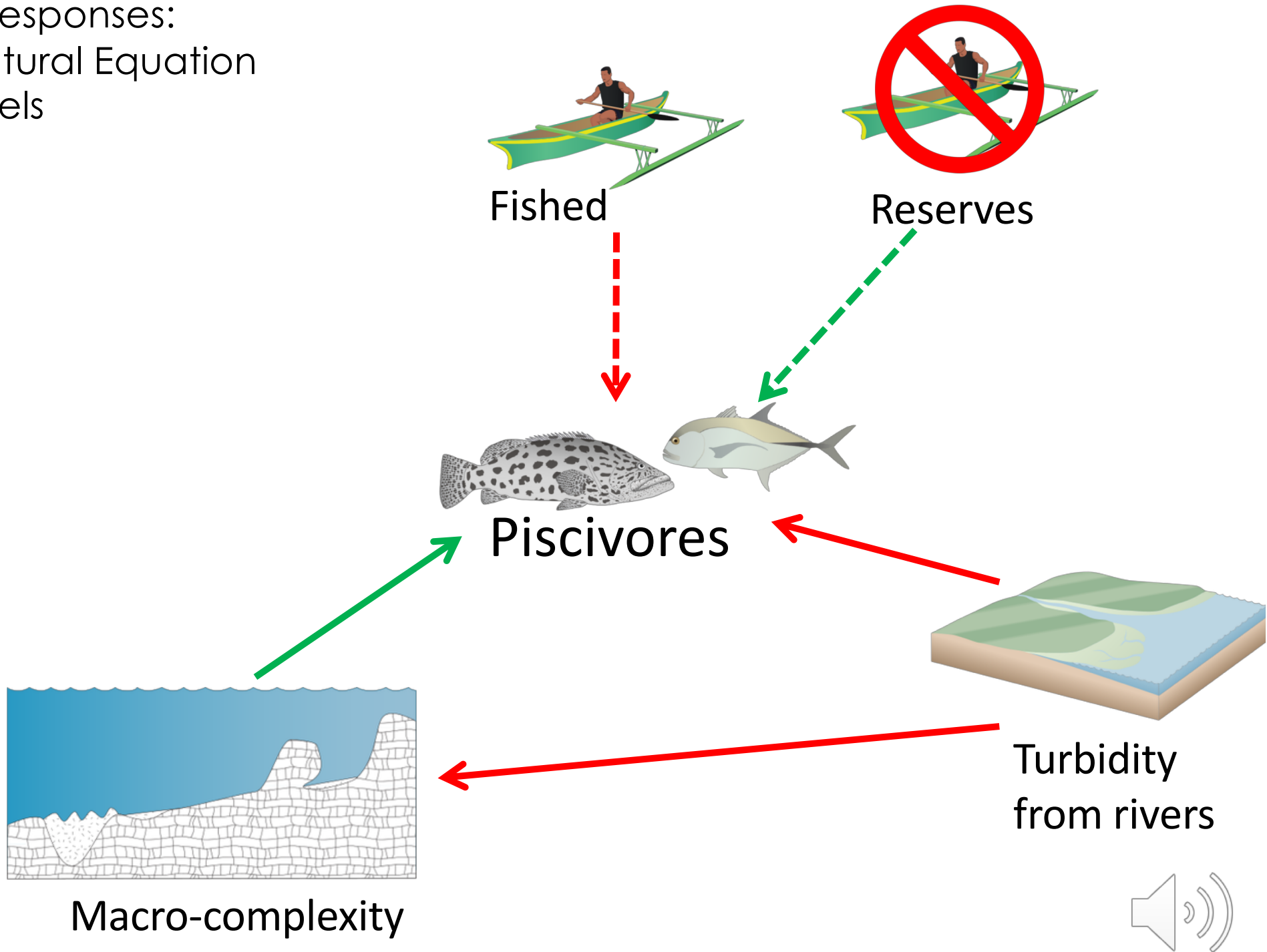


Data-sets

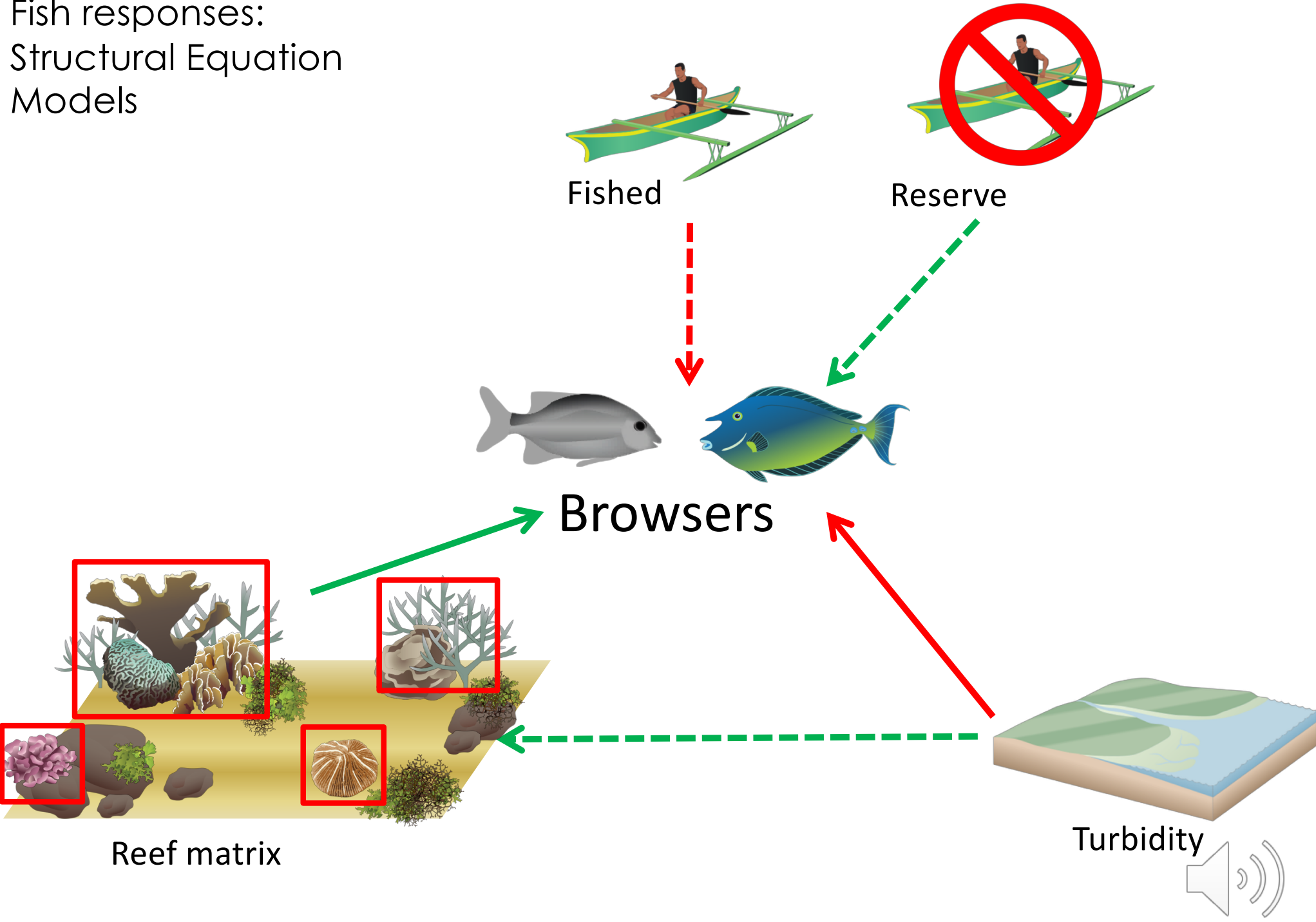
- Landcover from Sentinel-2 (S2)
 - ~14 Million pixels (10 x10 metres) for Vanua Levu
- Water quality
 - 650 000 pixels (260 x 300 metres) by 214 *MERIS* images by 6 variables = ~844 million data points
- Reef surveys (2010 – 2012)
 - 158 sites
 - >58 000 point observations of benthic cover
 - >230 000 individual fish
 - 3.6 tons of fish
 - 374 fish species



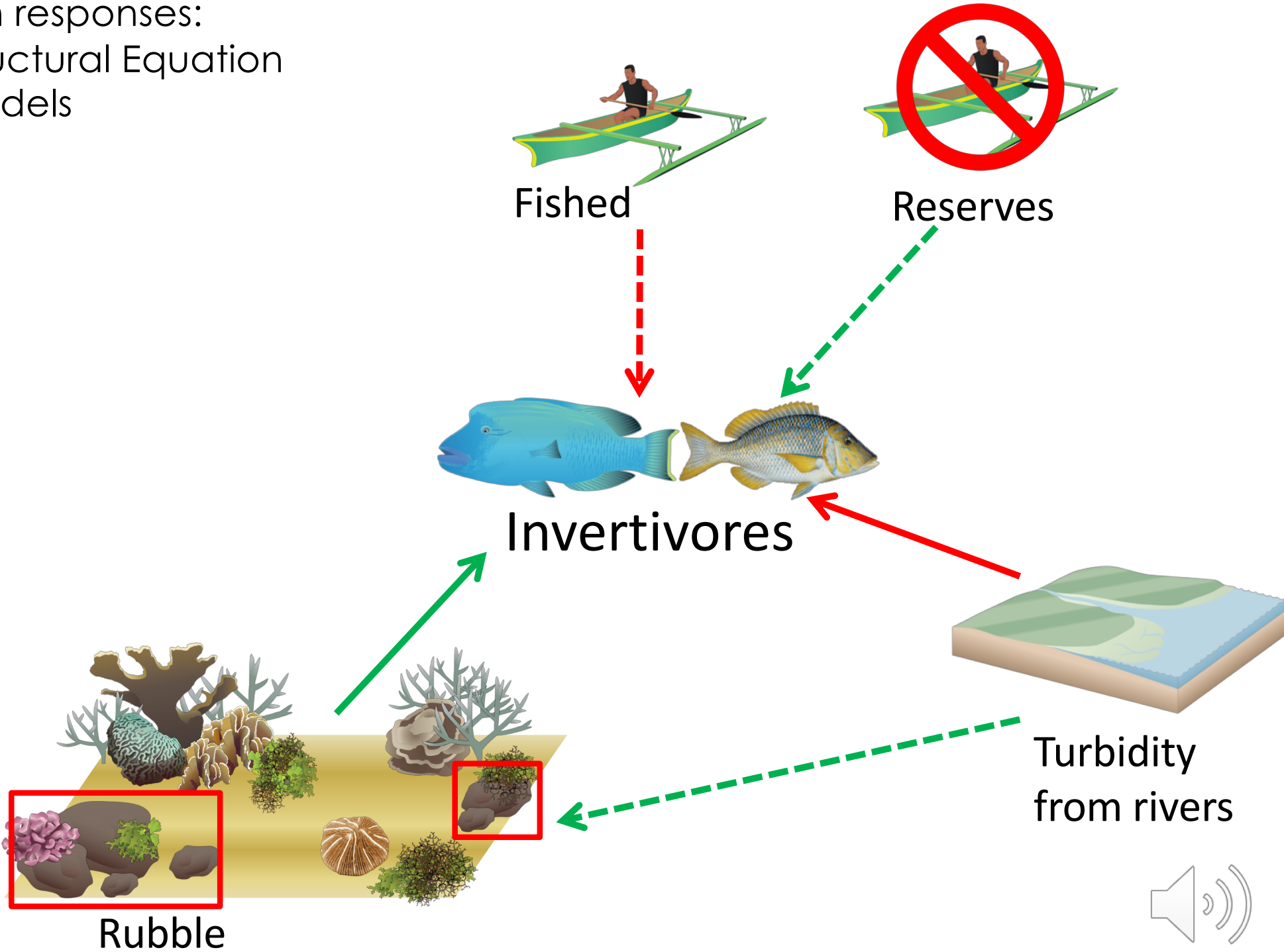
Fish responses:
Structural Equation
Models



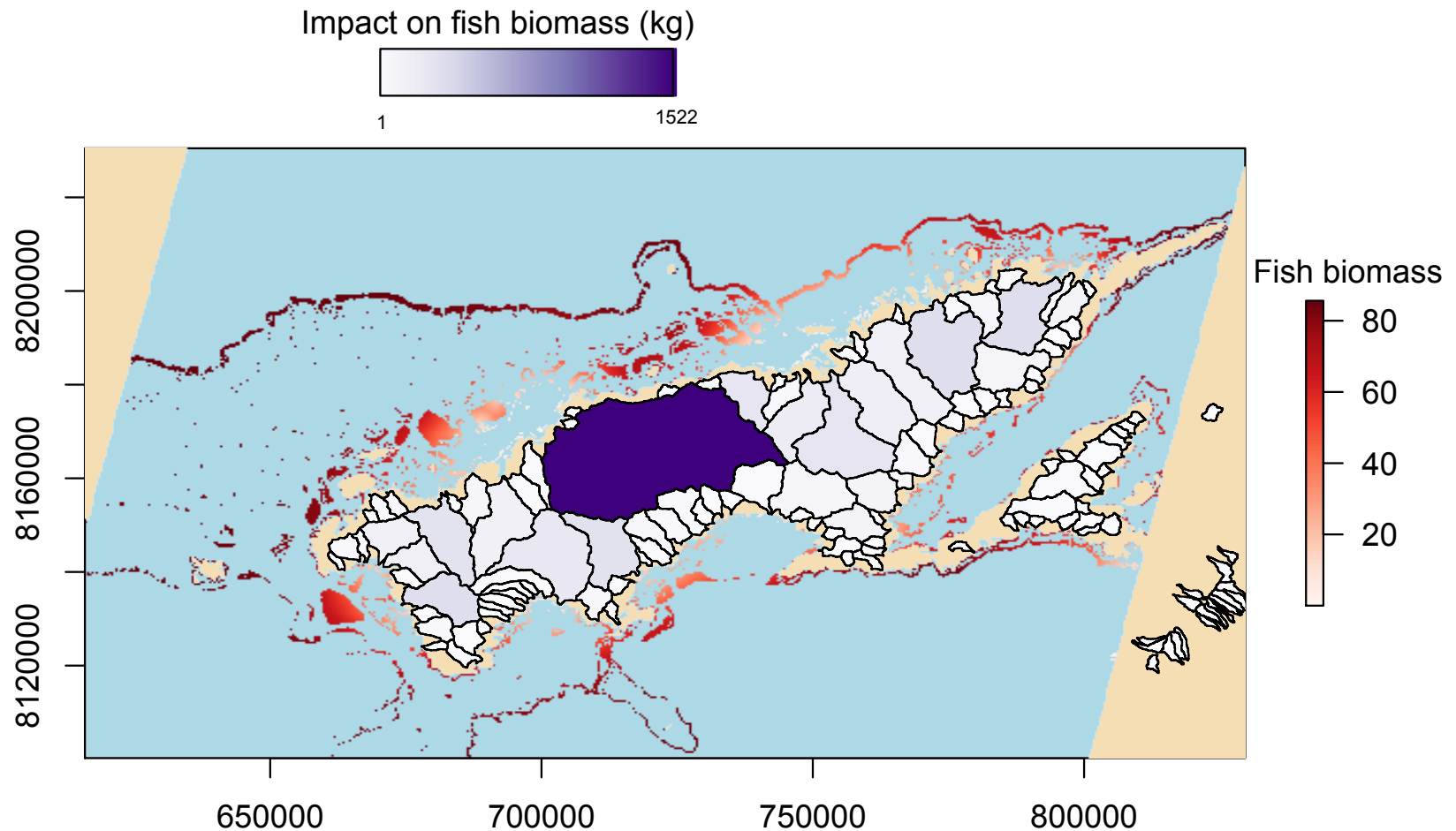
Fish responses:
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Fish responses:
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(2) Part 2 of the puzzle: Fish responses to habitat change/catchments

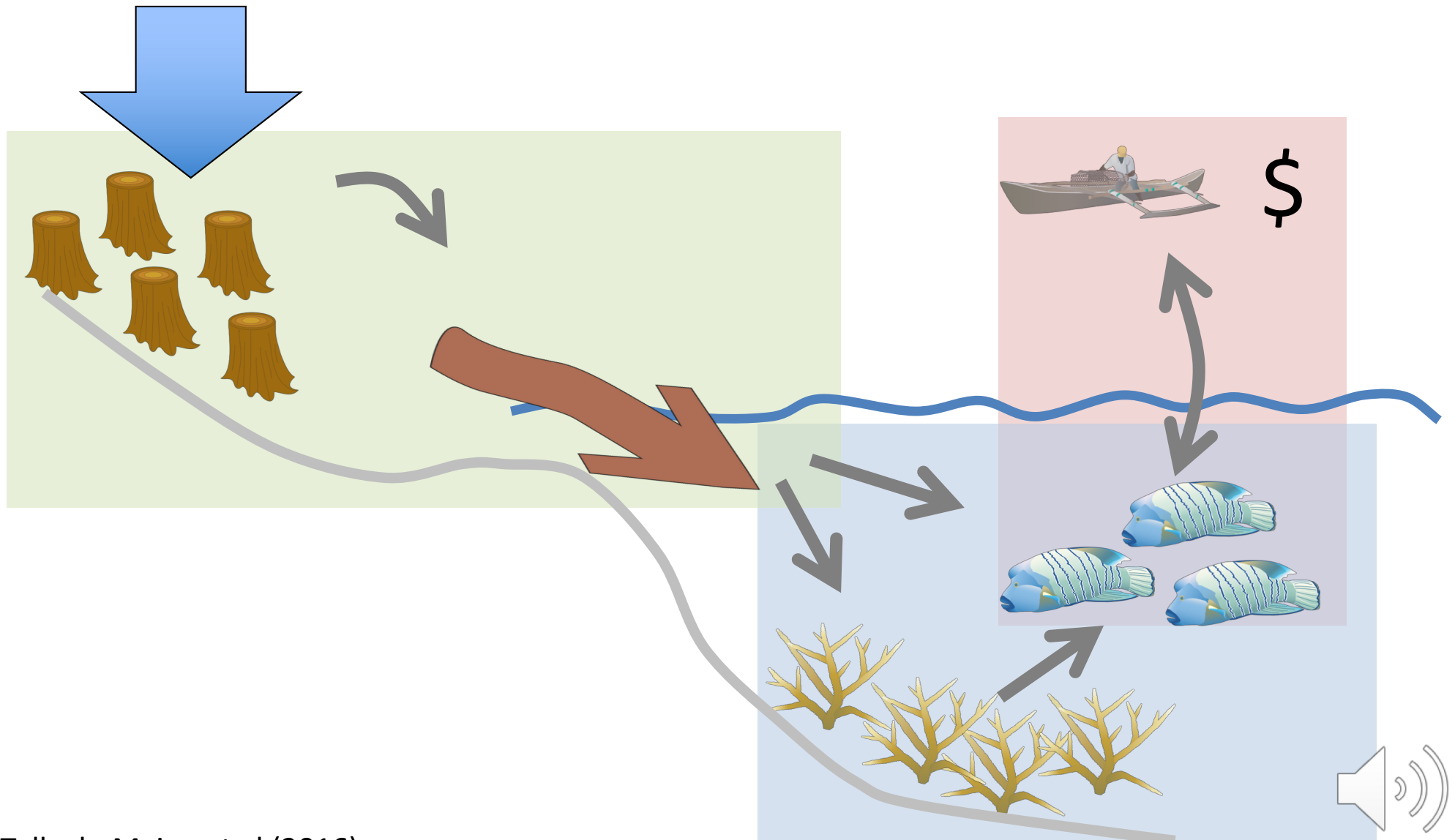


- **These findings suggest that terrestrial run-off modifies the composition of reef fish communities indirectly by affecting the benthic habitats that reef fish use**



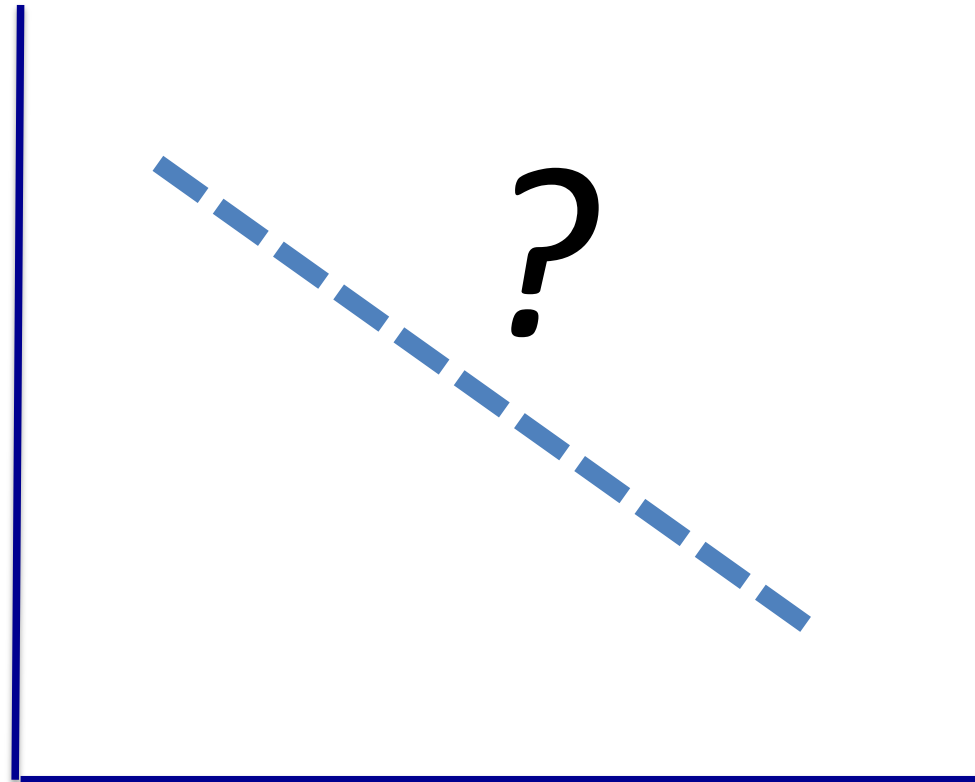
(3) Part 3 of the puzzle: linking processes to planning

Future land-uses

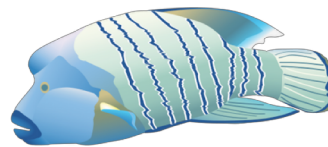


(3) Part 3 of the puzzle: Planning trade-offs

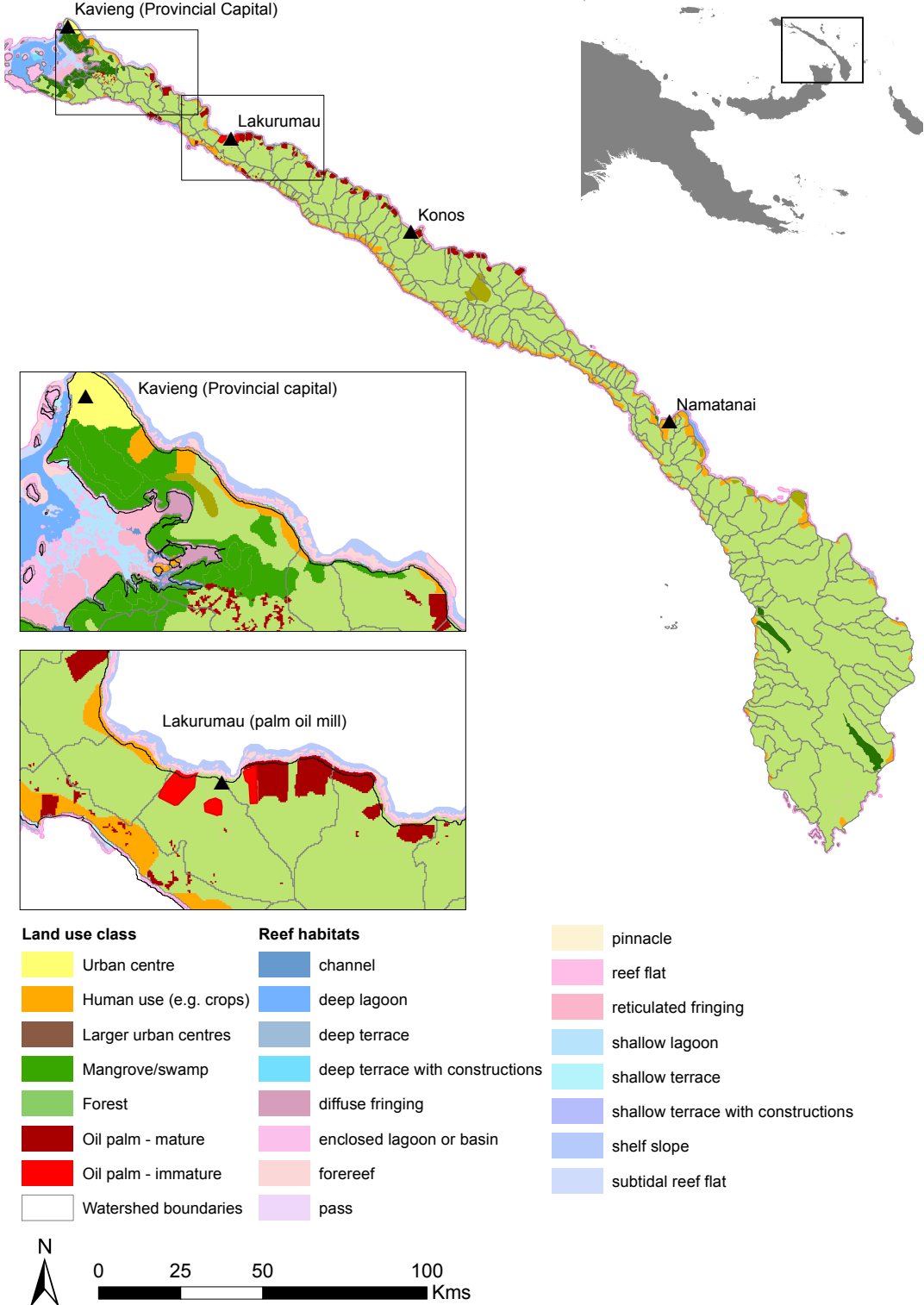
Forestry \$

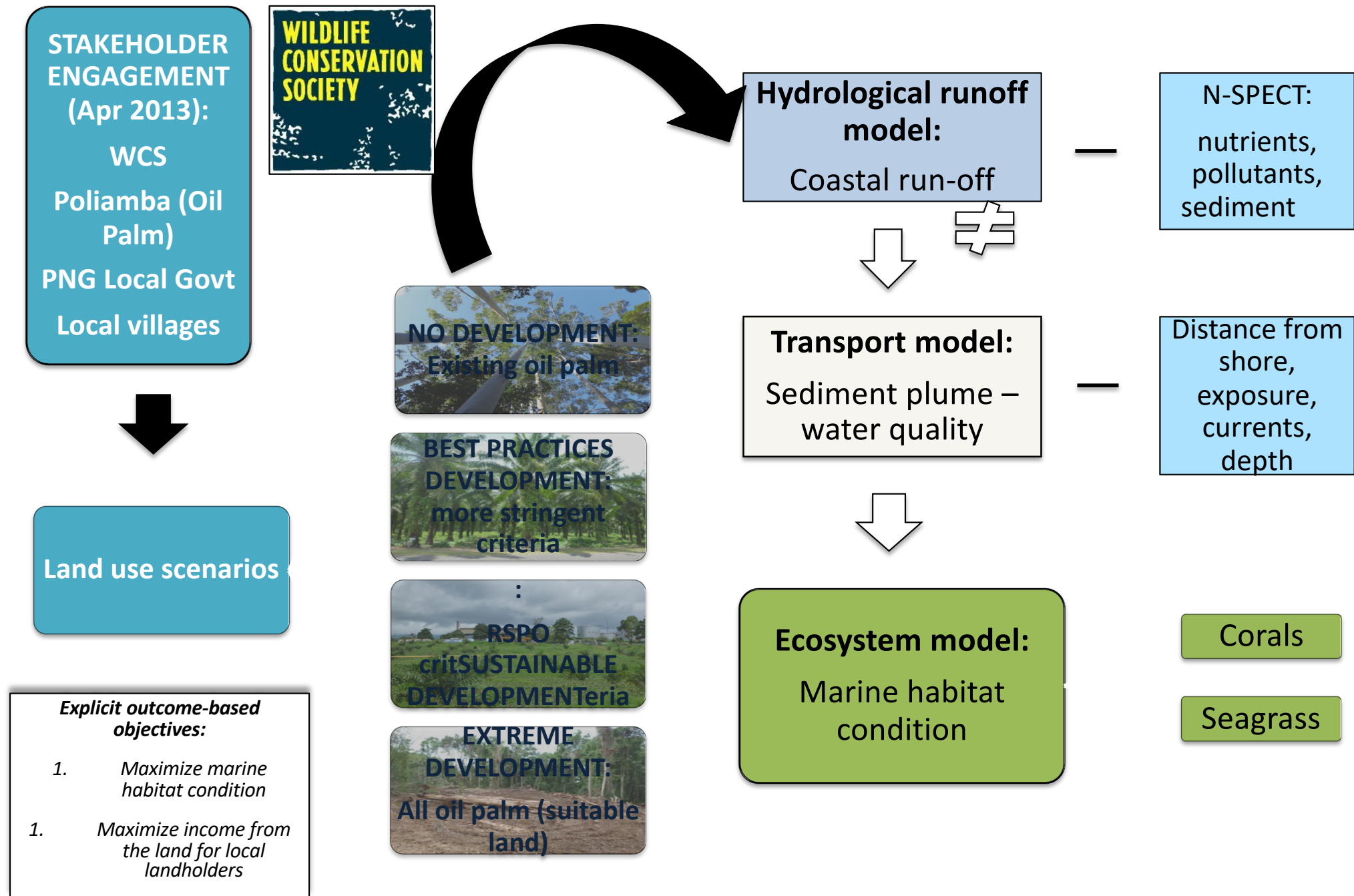


Fishery \$



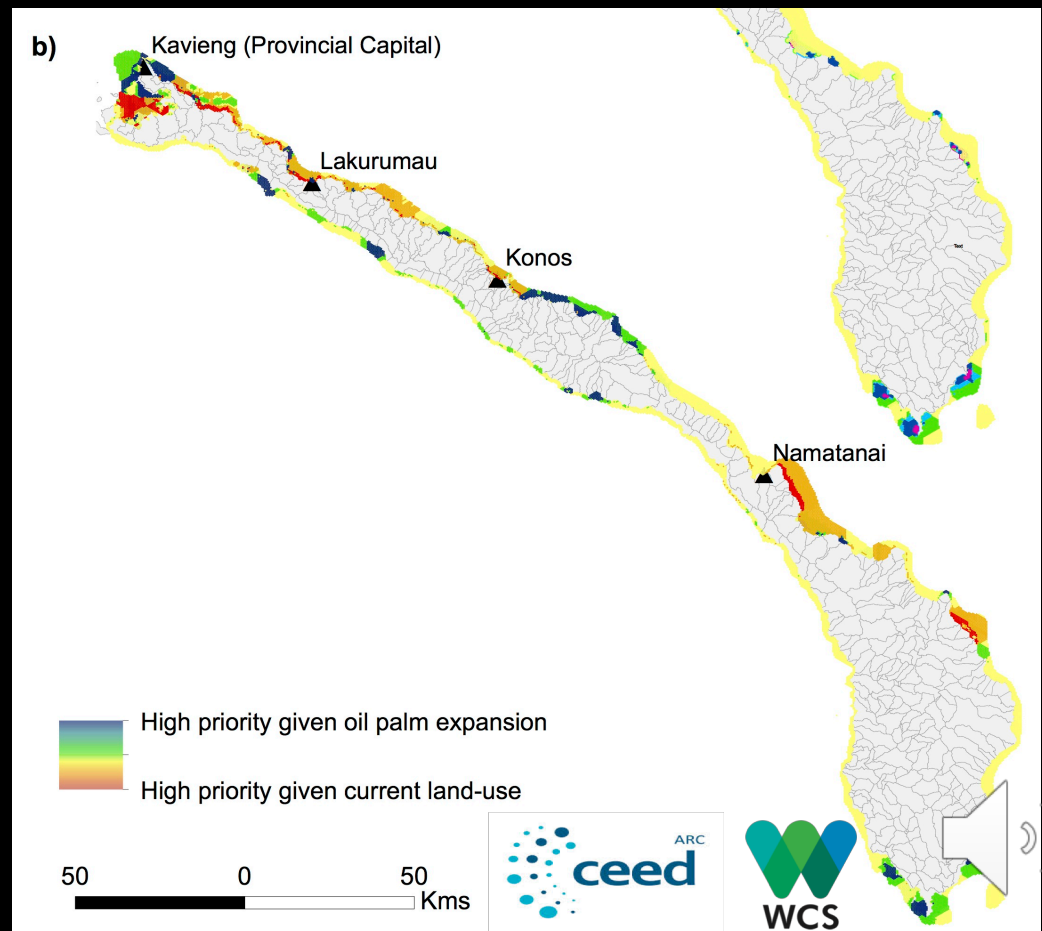
Papua-New Guinea: Coupling land/sea models to simulate impacts of oil palm development





Coupling land/sea models to simulate impacts of oil palm development

- current land-use: 50% of reef ecosystems in marine reserves will be heavily degraded
- Using best practices ensured there was minimal risk of future reef retrogression



Key points

- Need to plan for future development (it's going to happen!)
- Can't assume that things we protect now will be protected in the future
- Act now, use best available data, don't delay or it might be Too late



Appreciation

Hugh Possingham

Vivian Tulloch

Carissa Klein

Maria Berger

Stacy Jupiter

WCS staff in Fiji/PNG

Nature Conservancy staff

Blue Ventures Staff

Hans de Moel

Jens Zinke

