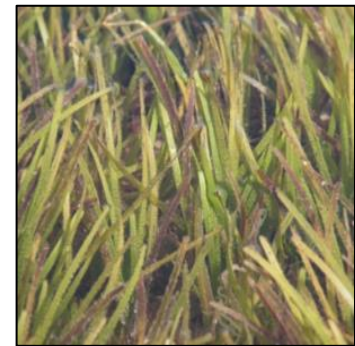
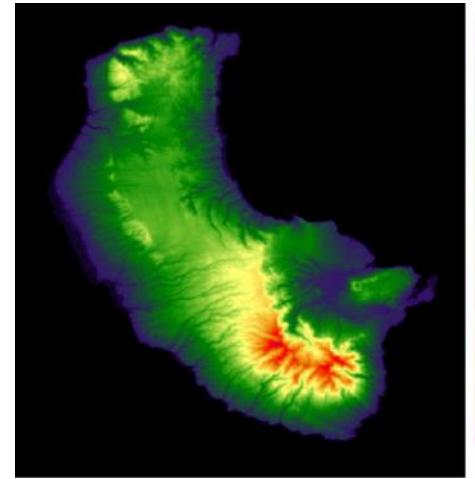


# Griffith ESRAM Team Methodology & Results-to-date



# Griffith ESRAM Team

## *Project director*

Prof Brendan Mackey

## *Project manager*

Dan Ware

## *Terrestrial ecosystems*

Dr Willow Hallgren

Prof Brendan Mackey

## *Marine ecosystems*

Prof Rod Connolly

Tyson Martin

## *Micro-economics*

Assoc Prof Chris Flemming

Dr Prof Jim Smart

## *Social Science*

Dr Johanna Naulu

## *System integration & decision support*

*Dr Oz Sahin*

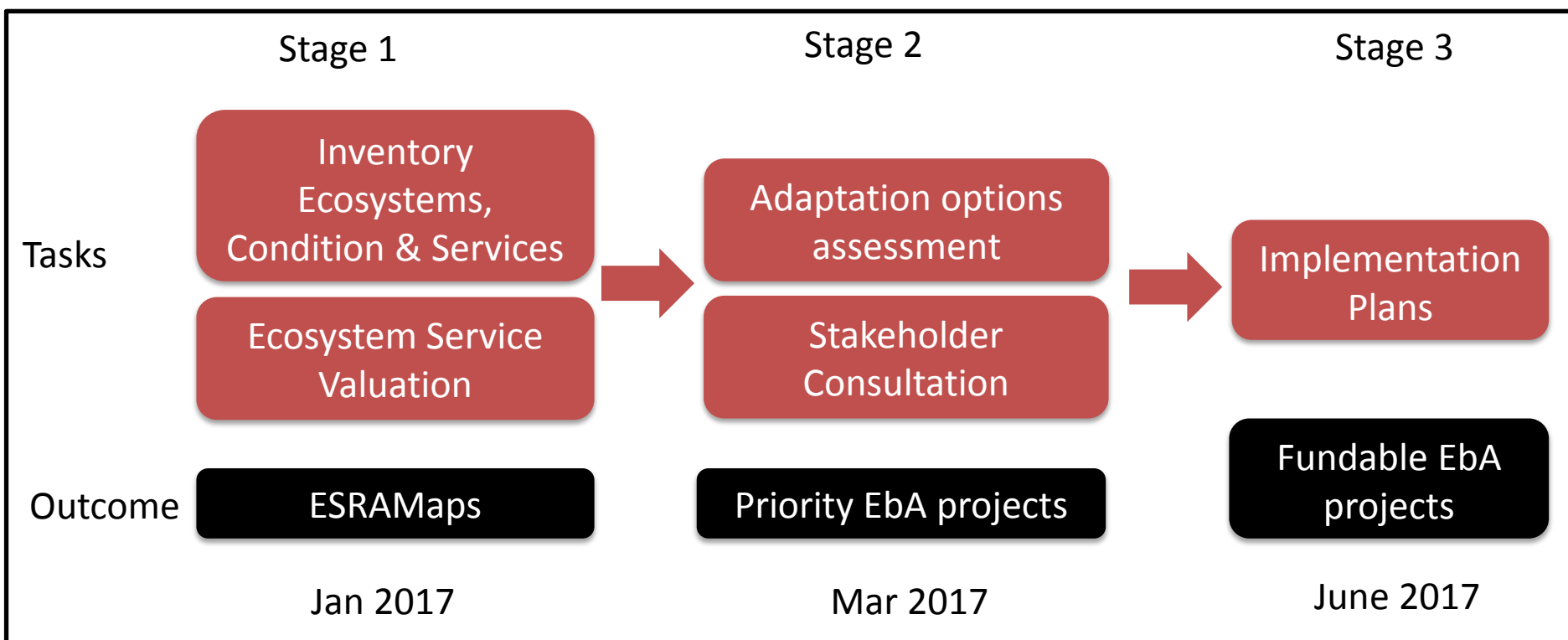
# Project Outputs & Timeline

## 1. Vanuatu national level ESRAM

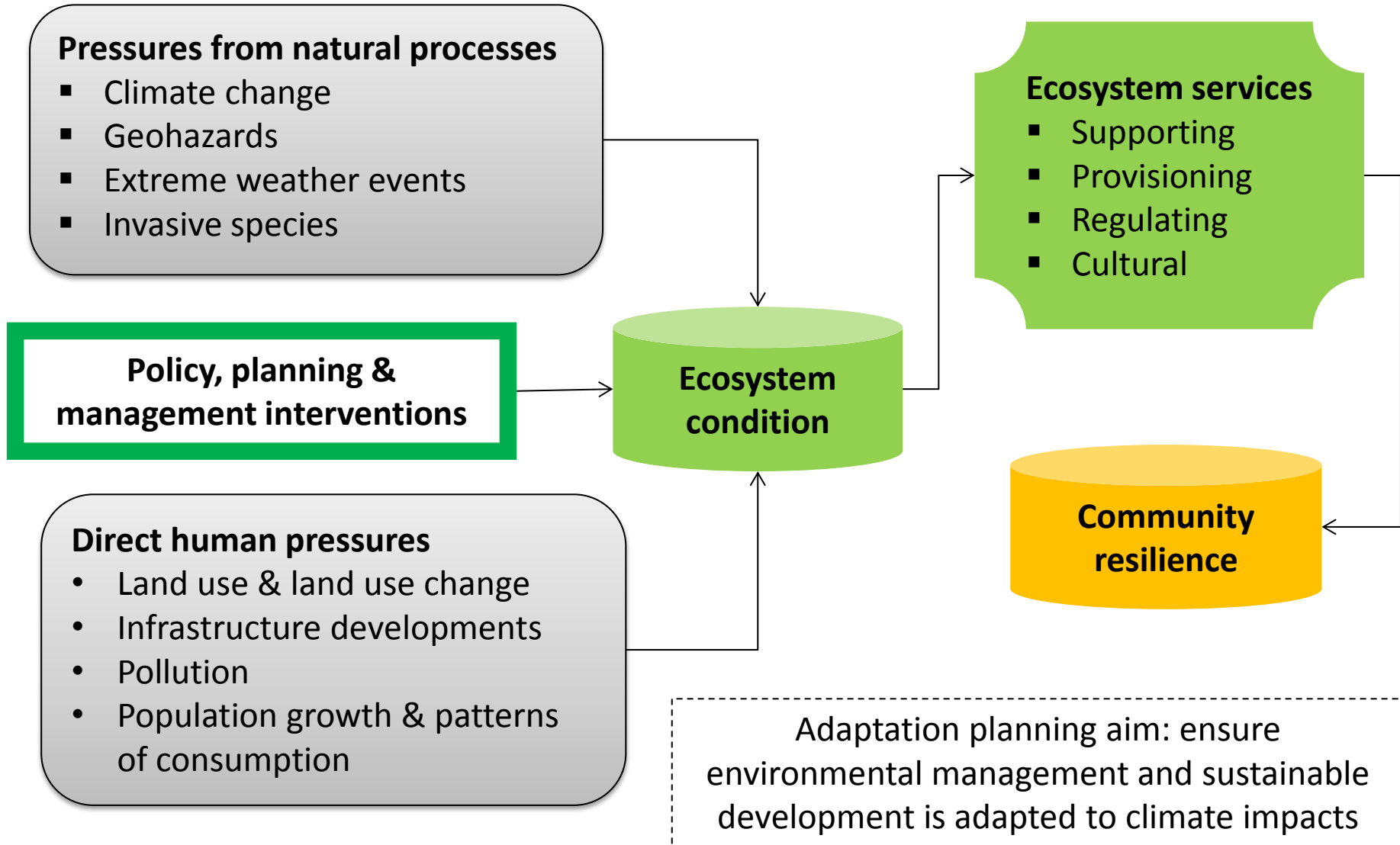
- The 'map' is GIS database and decision support systems

## 2. Tanna Island ESRAM

- ESRAMaps
- Project options assessment
- Project implementation plans



# Conceptual Framework



# Adaptation

*'The process of adjustment to actual or expected climate and its effects. In human systems, adaptation seeks to moderate or avoid harm or exploit beneficial opportunities. In some natural systems, human intervention may facilitate adjustment to expected climate and its effects.'*

**Adaptation** enables the **resilience** of a system (socio-ecological, societal, ecosystem) to be maintained or strengthened to current or future pressures (threats, stresses, shocks)

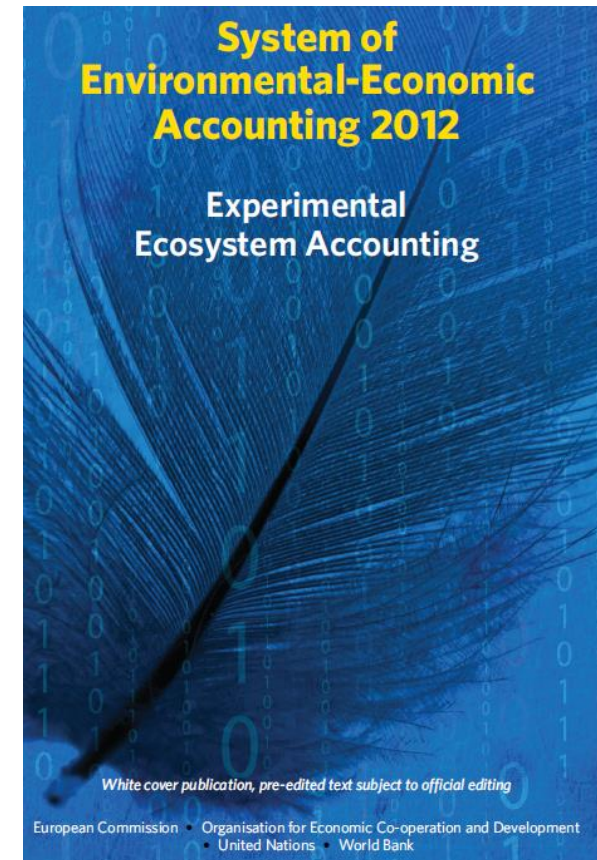
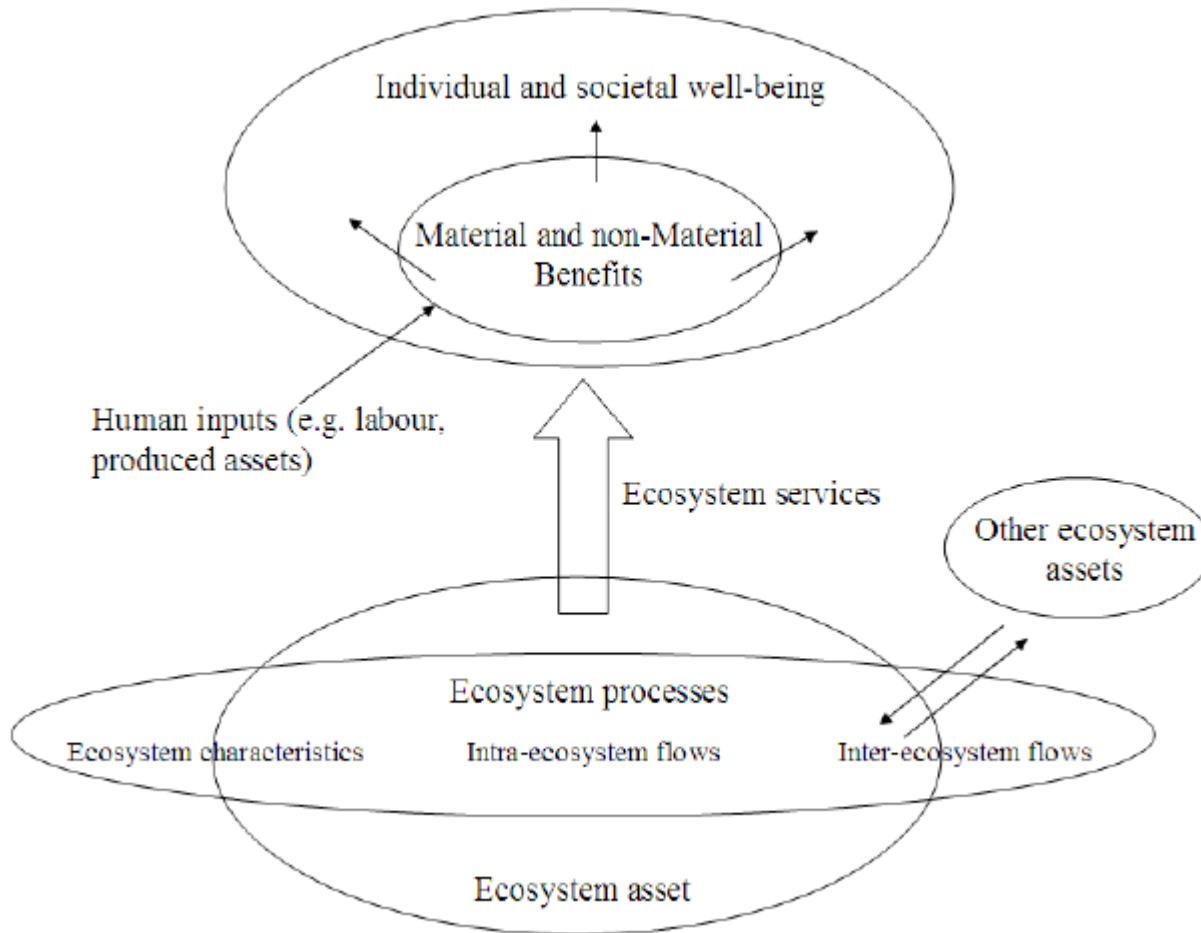
The pressures (threats, stresses, shocks) may be so great that the current system is maladapted. In which case, the system needs to have sufficient adaptive capacity to be **transformed** into a different kind of system, one that is resilient to the new circumstances.

# Adaptation planning & Decision Support

- The complex and integrated social, economic and environmental dimensions of climate change adaptation cannot be effectively managed using traditional approaches that focus only on one dimension and are unable to examine adaptation strategies in the face of alternative future scenarios, large uncertainties, and a range of stakeholder needs.
- Approaches are needed that are accessible (including for ‘non-modellers’), reliable given the best available data, integrate social, economic and environmental factors, examine the trade-offs between different goals, and can account for the future impacts of a rapidly changing climate.
- A key aim is to identify planning options that are likely to be robust and result in desirable outcomes under a range of scenarios (i.e., plausible futures) given current and future development pathways and climate change impacts, among other things.

*A first step towards adaptation to future climate change is reducing vulnerability and exposure to present climate variability (high confidence). Strategies include actions with co-benefits for other objectives.’ (Source: IPCC AR5 WGII)*

# What are ecosystem services



Ecosystem services do not result only from the harvesting or extraction of materials from ecosystems. They also result from the general functioning of the ecosystem (and to other characteristics of an ecosystem. Thus the term “services” is used here in an all-encompassing manner covering the various ways in which humans may benefit from ecosystems.

# Ecosystem Services

## Provisioning services

*Products obtained from ecosystems*

- Food
- Freshwater
- Fuelwood
- Fibre
- Biochemicals
- Genetic resources
- ...
- ...

## Regulating services

*Benefits obtained from regulation of ecosystem processes*

- Climate regulation
- Disease regulation
- Water regulation
- Water purification
- ...
- ...
- ...

## Cultural services

*Nonmaterial benefits obtained from ecosystems*

- Cultural heritage
- Spiritual & religious
- Recreation & ecotourism
- Aesthetic & Inspirational
- Educational
- Sense of place
- ...
- ...

## Supporting services

*Services necessary for the production of all other ecosystem services*

- Soil formation
- Nutrient cycling
- Primary production
  - Pollination



# Ecosystem Assets

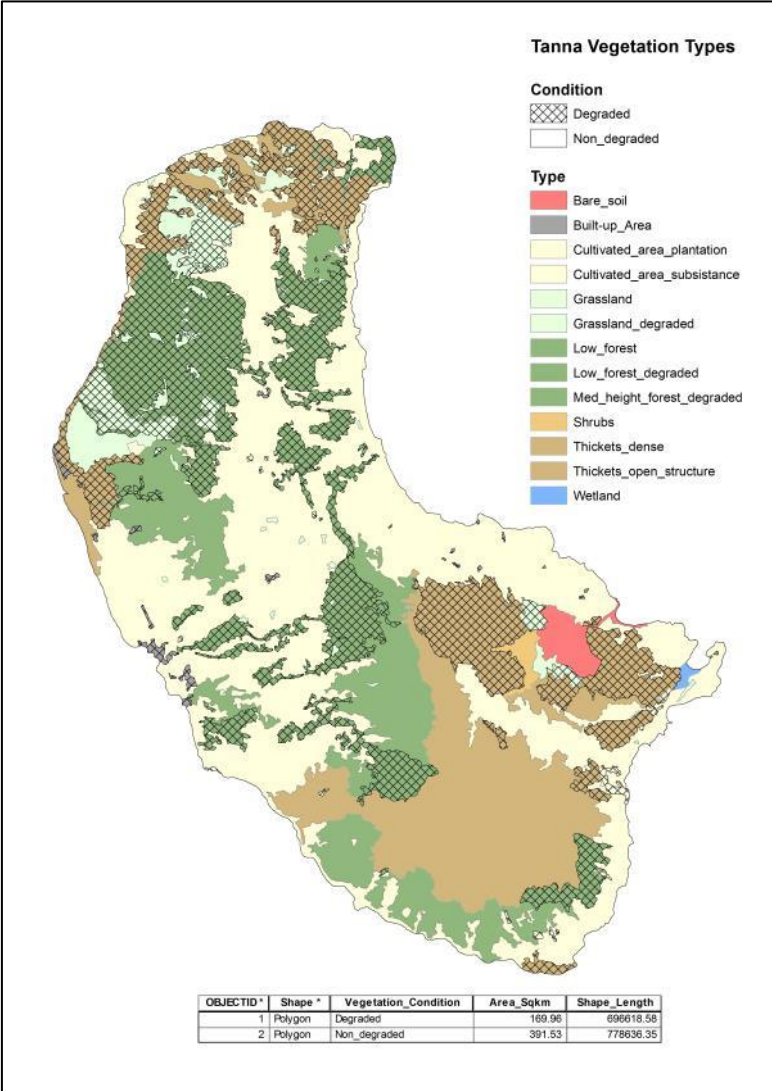
Ecosystem assets are spatial areas containing a combination of biotic and abiotic components and other characteristics that function together.

Ecosystem assets are measured in terms of:

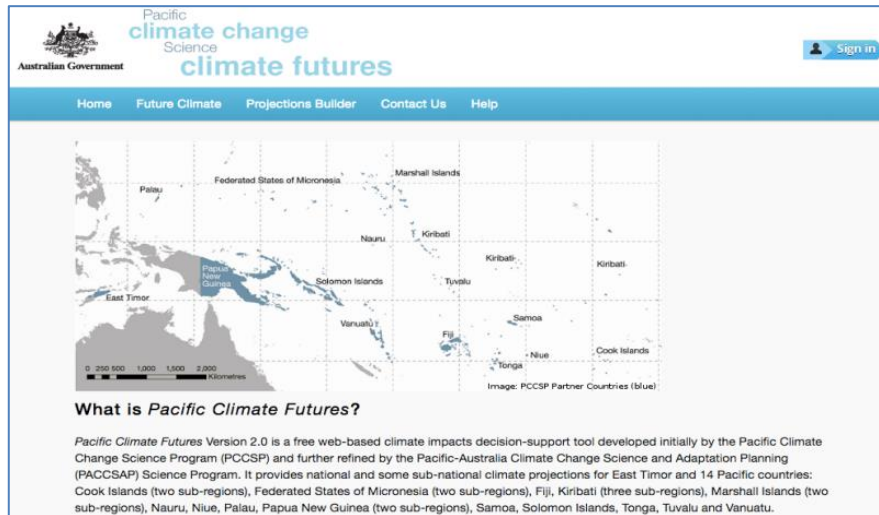
1. Ecosystem type
2. Ecosystem extent
3. Ecosystem condition and
4. Ecosystem services

# Progress on National Level ESRAM

# Vanuatu Forestry Department Vegetation Map

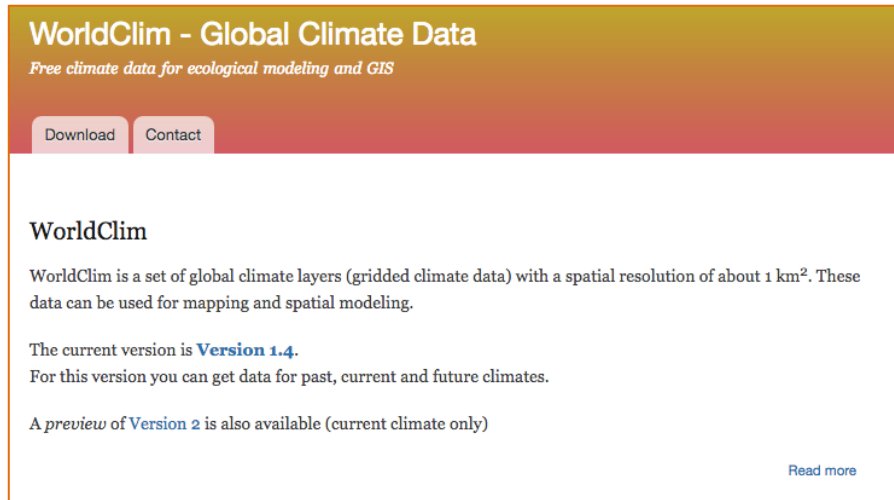


# Climate Change Impacts



The screenshot shows the Pacific Climate Futures website. At the top left is the Australian Government logo. The main header features the text "Pacific climate change Science climate futures" with a "Sign in" button. Below the header is a navigation menu with "Home", "Future Climate", "Projections Builder", "Contact Us", and "Help". The main content area displays a map of the Pacific region with various countries labeled, including Palau, Federated States of Micronesia, Marshall Islands, Nauru, Kiribati, Tuvalu, Samoa, Cook Islands, Vanuatu, Fiji, Niue, and Tonga. A scale bar at the bottom left indicates distances up to 2,000 Kilometres. Below the map, there is a section titled "What is Pacific Climate Futures?" followed by a paragraph describing the tool as a free web-based decision-support tool developed by the Pacific Climate Change Science Program (PCCSP) and refined by the Pacific-Australia Climate Change Science and Adaptation Planning (PACCSAP) Science Program. It provides national and sub-national climate projections for East Timor and 14 Pacific countries: Cook Islands (two sub-regions), Federated States of Micronesia (two sub-regions), Fiji, Kiribati (three sub-regions), Marshall Islands (two sub-regions), Nauru, Niue, Palau, Papua New Guinea (two sub-regions), Samoa, Solomon Islands, Tonga, Tuvalu and Vanuatu.

Which climate change model output should we use?



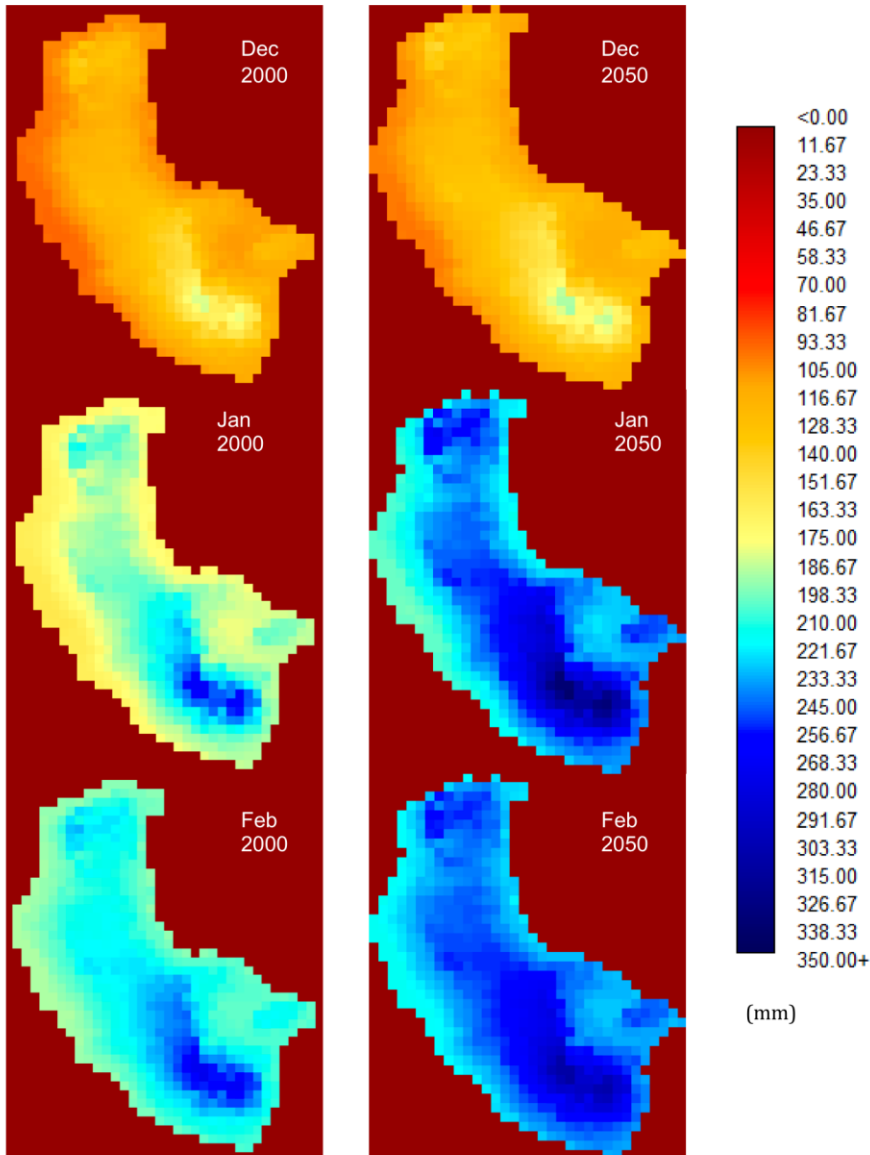
The screenshot shows the WorldClim website. The header is orange and contains the text "WorldClim - Global Climate Data" and "Free climate data for ecological modeling and GIS". Below the header are "Download" and "Contact" buttons. The main content area is white and features the "WorldClim" logo. The text describes WorldClim as a set of global climate layers (gridded climate data) with a spatial resolution of about 1 km<sup>2</sup>. It states that the current version is **Version 1.4** and that for this version, users can get data for past, current, and future climates. A *preview of Version 2* is also available (current climate only). A "Read more" link is located at the bottom right of the content area.

GIS data mapping current and future (2050 & 2070) climate

- mean monthly rainfall, min/max temperature
- Probability distribution function for extreme events

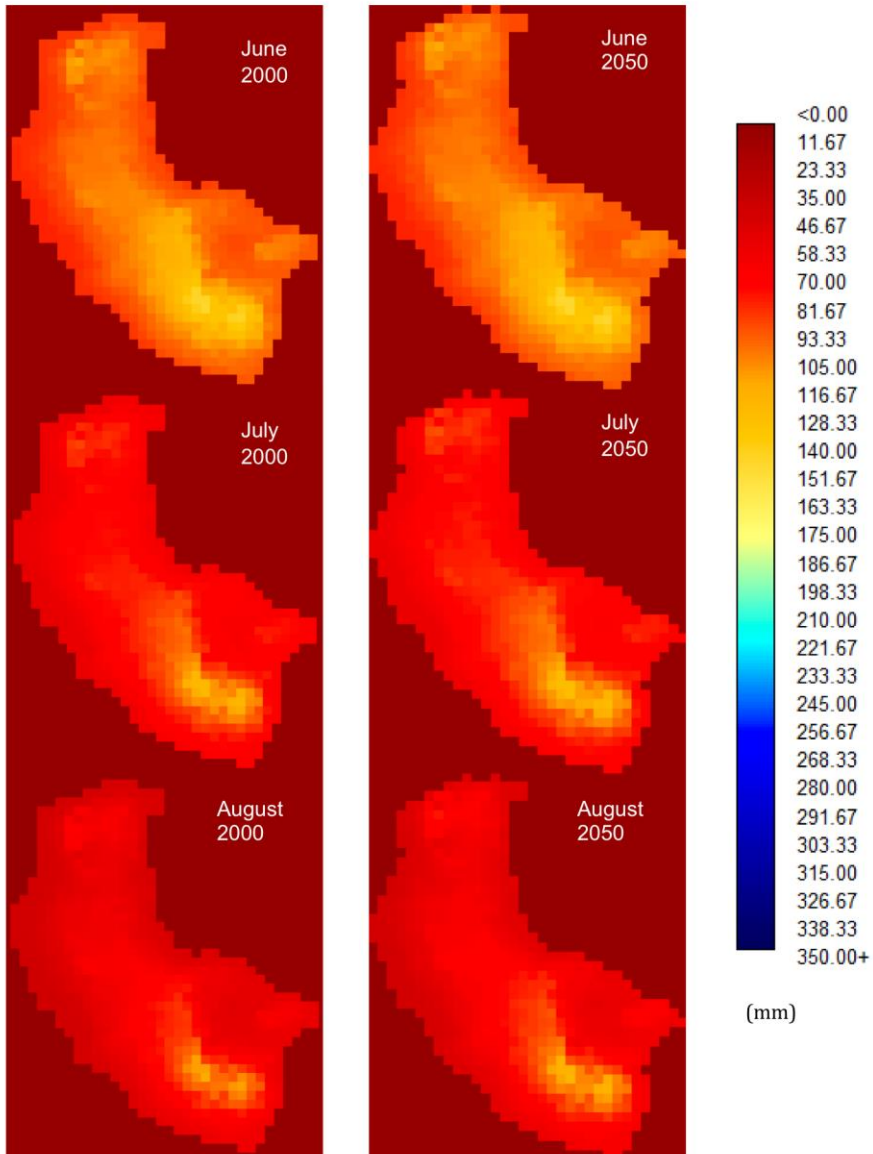
Climate change analysis  
for Tanna Island  
2000-2050

Summer Rainfall (December-January-February)  
for 2000 and 2050



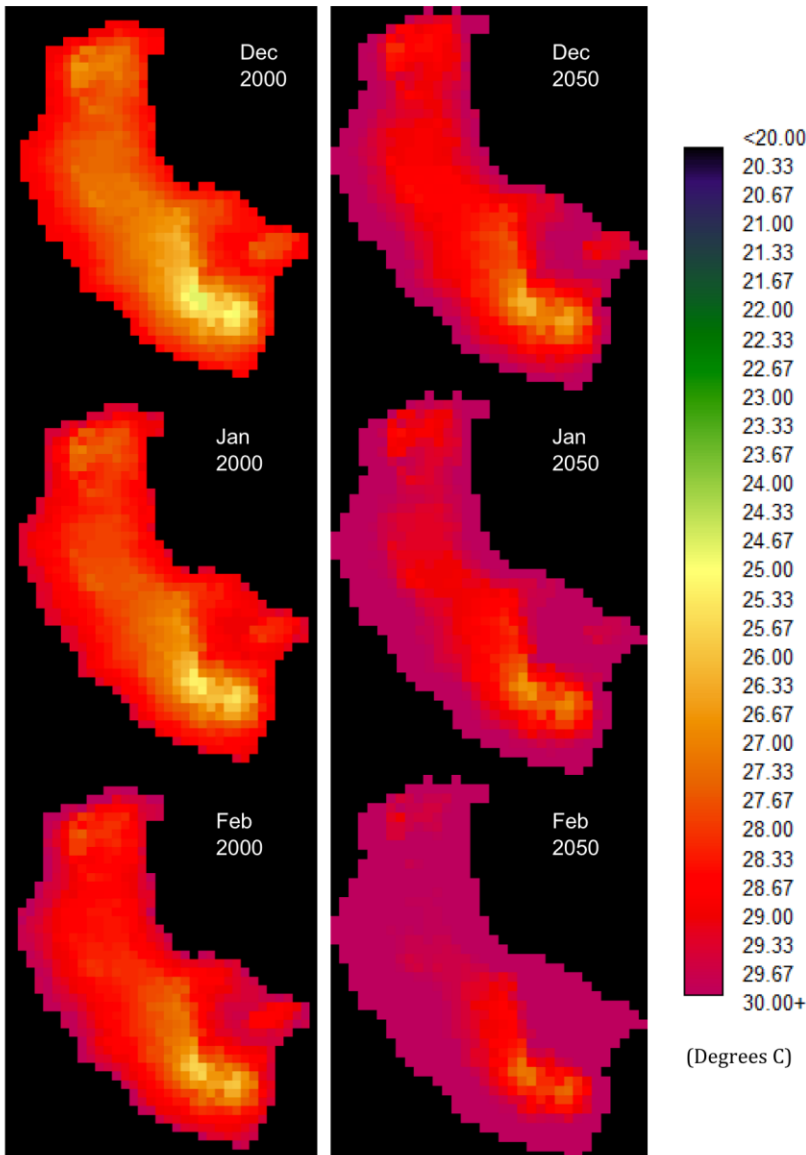
- Summer rainfall increases from December to February
- Highest rainfall in southern mountainous region
- Driest area on the west coast
- Major changes seen in Summer rainfall
- Slight increase in December
- Large increases in January and February
- January rainfall increases most

## Winter Rainfall (June-July-August) for 2000 and 2050



- Almost no change seen in Winter rainfall

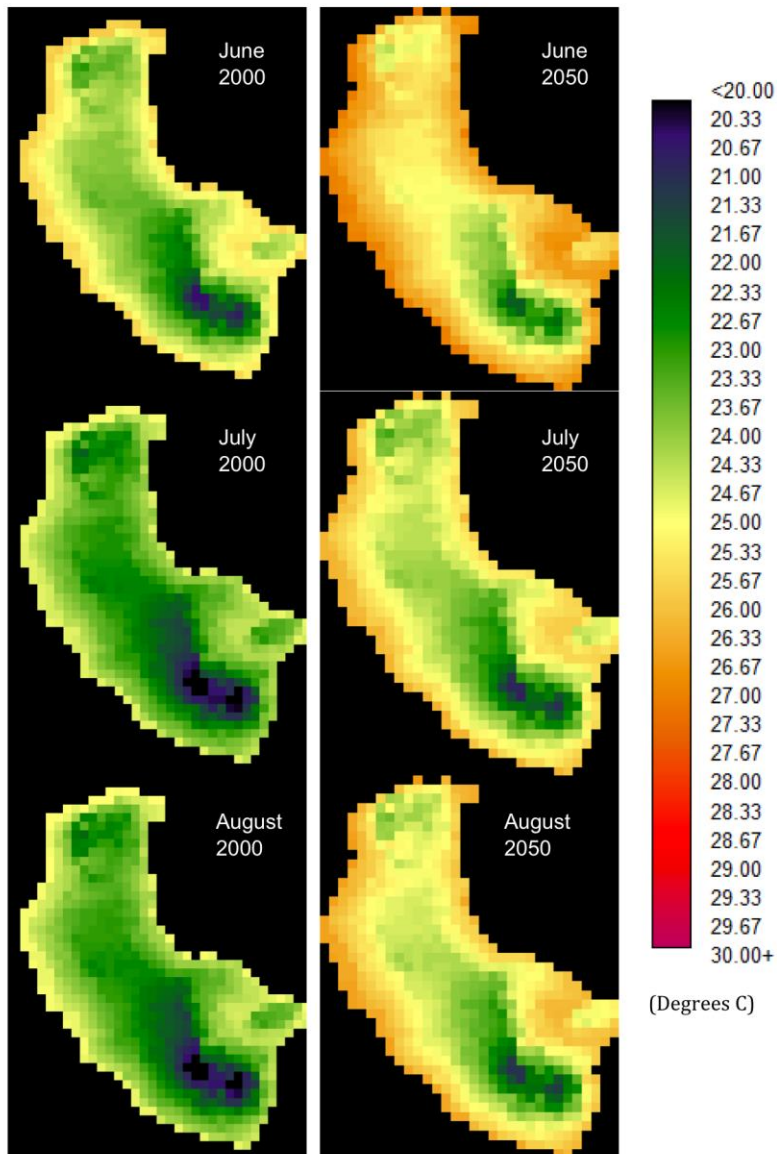
## Summer Maximum Temps (December-January-February) for 2000 and 2050



- Maximum temperatures increase throughout the summer months
- Highest temperatures around the coastal areas, cooler temperatures with increasing elevation
- Moderate changes seen in Summer maximum temperatures
- Higher maximum temperatures are predicted for December, January and February



## Winter Maximum Temperatures (June-July-August) for 2000 and 2050



- Temperatures cool as the season progresses from June to August
- As for summer, coolest temperatures are at highest elevations; the coastal areas and lowlands are several degrees warmer
- Major changes seen in Winter maximum temperatures
- June is particularly warmer in 2050
- Difference in temperatures between the coast and mountains increases in 2050

A country-scale estimate of the  
monetary value of ecosystem  
service flows

# Approach

---

Our approach is to use data derived from de Groot, et al. (2012) to estimate a monetary value for seven relevant ecosystem types, for each ecosystem service flow, for each of the eight most populated islands in Vanuatu (Ambae, Ambrym, Efate, Epi, Espiritu Santo, Malakula, Pentecost and Tanna).

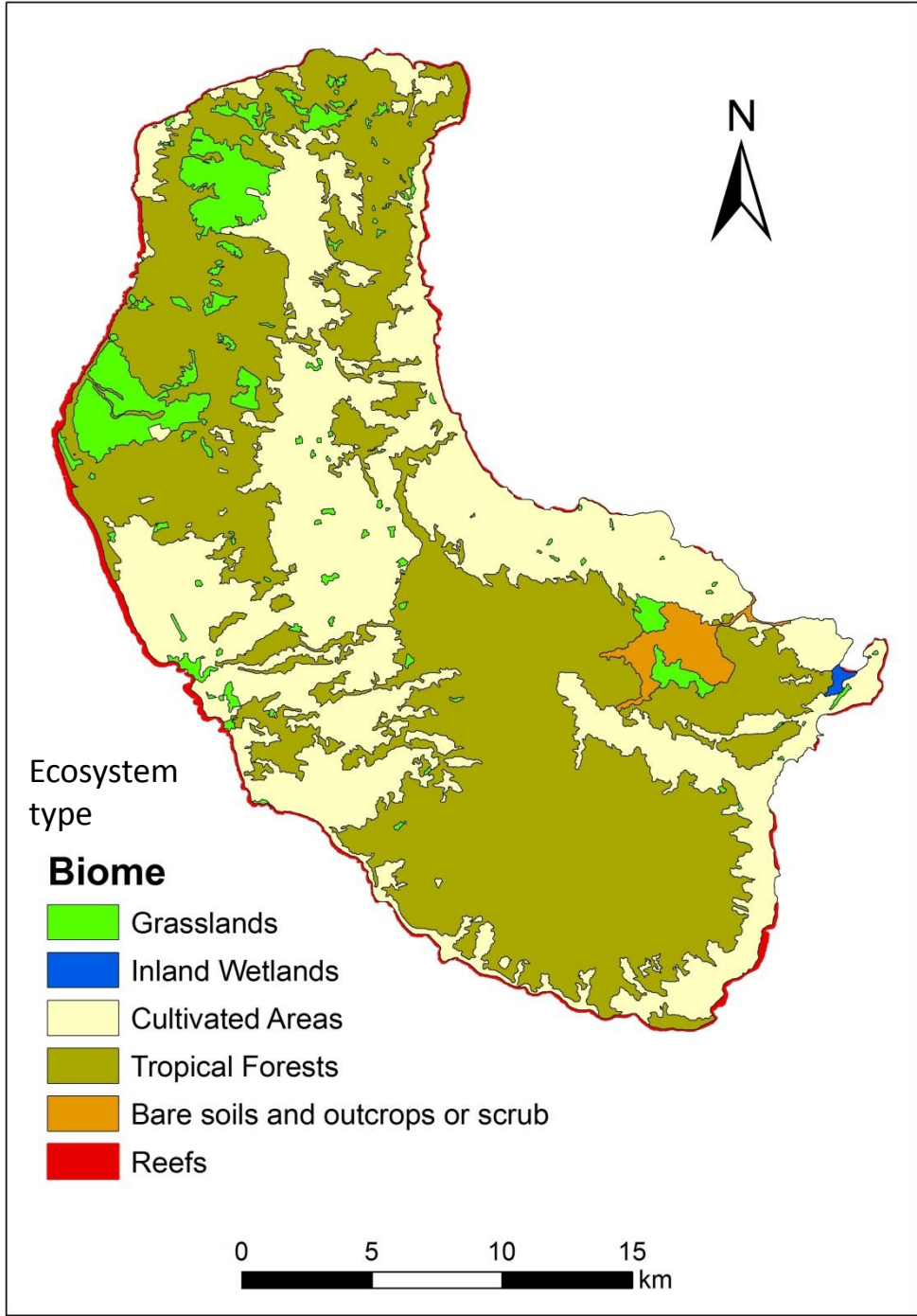
Together these islands account for approximately 85% of the population of Vanuatu. These monetary values will then be summed to yield an approximate country-wide estimate.

De Groot, R., Brander, L., Van Der Ploeg, S., Costanza, R., Bernard, F., Braat, L., ... & Hussain, S. (2012). Global estimates of the value of ecosystems and their services in monetary units. *Ecosystem services*, 1(1), 50-61.

# Monetary values – Provisioning services

---

<b>Service (USD/ha/year)</b>	<b>Coral reefs</b>	<b>Coastal systems</b>	<b>Coastal wetlands</b>	<b>Inland wetlands</b>	<b>Fresh water</b>	<b>Tropical forests</b>	<b>Grassland</b>
Food	\$201	\$138	\$342	\$52	\$1,573	\$25	\$1,359
Water	N/A	N/A	\$54	\$127	\$3,096	\$42	N/A
Raw materials	\$36,672	\$1	\$105	\$35	N/A	\$47	\$5
Genetic resources	\$37,675	N/A	N/A	N/A	N/A	N/A	N/A
Medicinal resources	N/A	N/A	\$344	\$112	N/A	\$1,715	\$1
Ornamental resources	\$895	N/A	N/A	\$130	N/A	N/A	N/A



# Monetary value of ecosystem types (Tanna Island)

---

	<b>Coral reefs</b>	<b>Coastal systems</b>	<b>Coastal wetlands</b>	<b>Inland wetlands</b>	<b>Fresh water</b>	<b>Tropical forests</b>	<b>Grassland</b>
Extent (ha)	N/A	N/A	N/A	58	N/A	30,053	2,924
Value (USD Million/ha/year)	\$256,649	\$29,670	\$8,204	\$8,441	\$7,071	\$3,202	\$1,473
<b>Value (USD Million/year)</b>	<b>N/A</b>	<b>N/A</b>	<b>N/A</b>	<b>\$0.5</b>	<b>N/A</b>	<b>\$96.2</b>	<b>\$4.3</b>

# Progress on Tanna Island ESRAM










National vegetation map will be updated for Tanna Island using:

- RapidEye Satellite Image of Tanna Island (5m resolution)
- ‘Segmentation’ classification plus field data plus existing land cover mapping
- For mapping terrestrial and marine ecosystem



# Terrestrial Ecosystem Condition Assessment

	0	I	II	III	IV	V	VI
<b>Vegetation class</b>	Bare	Intact & largely unmodified	Modified	Transformed (Highly modified)	Replaced-adventive (invasives)	Replaced – managed (cultivated)	Removed
<b>Current regenerative capacity</b>						V.1 Healthy V.2 Degraded	
<b>Vegetation structure</b>							
<b>Vegetation composition</b>							

Reporting vegetation condition using modified the Vegetation Assets, States and Transitions (VAST) framework

Source: Thackway R. and Lesslie R. (2006) Ecological Management & Restoration 7 S1, S53-S62



# Coastal Ecosystems

## Condition Assessment

# Marine Ecosystem Condition Assessment

*Coral reefs*



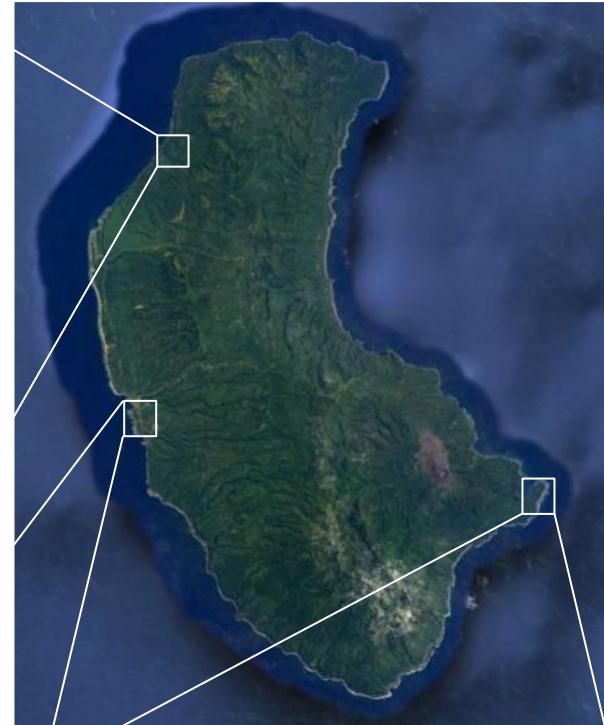
*Seagrass meadows*



*Mangrove forests*

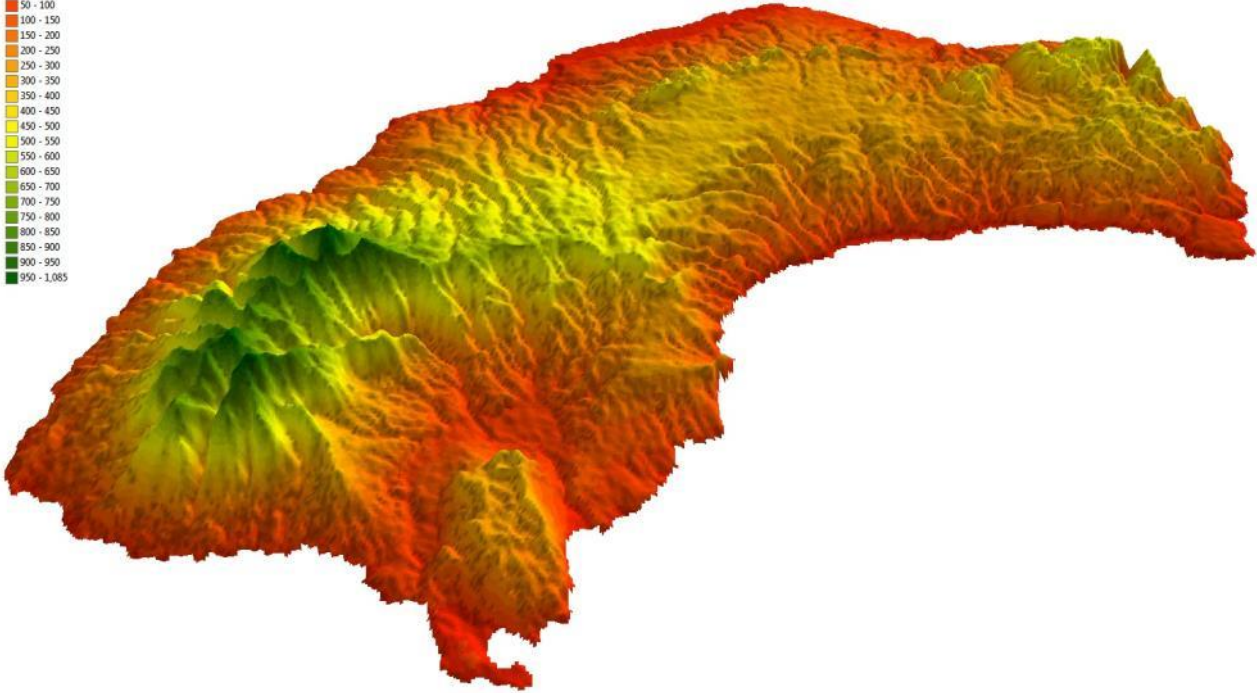
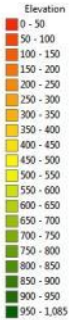
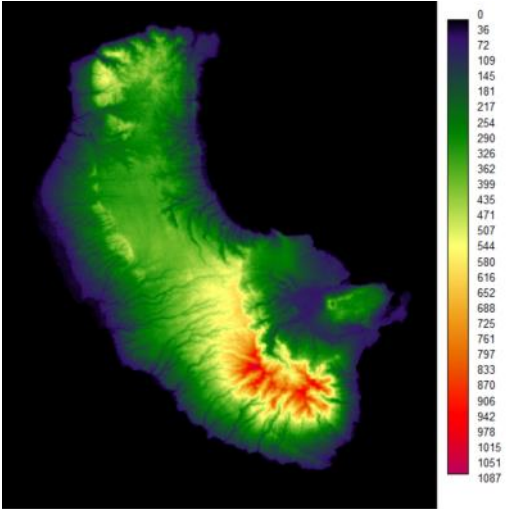


Detailed fish and coral surveys: Health, extent, species

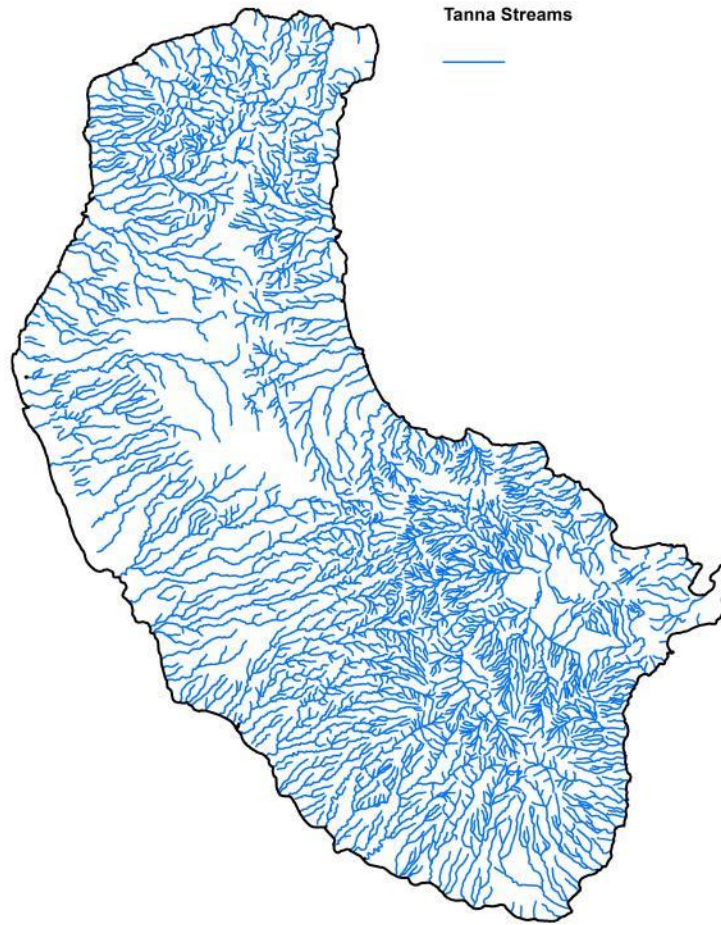


# GIS-based Approach to ESRAM

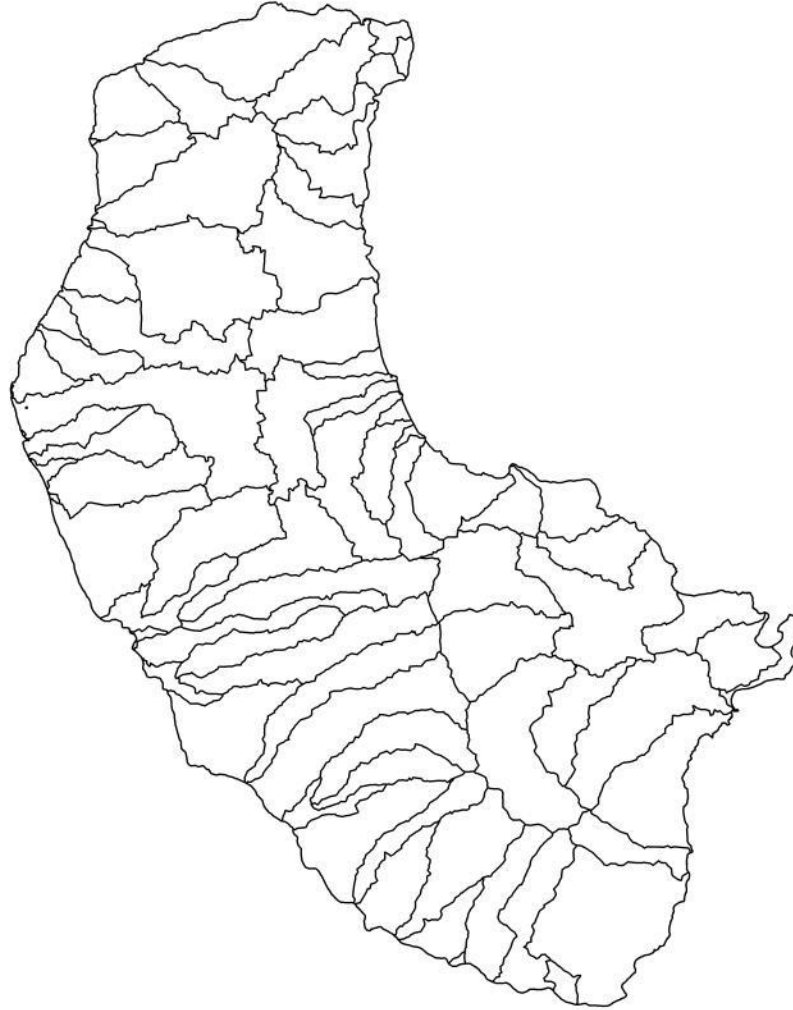
# ASTER Digital Elevation Model (DEM) of Tanna Island (30m resolution)



# Stream Network



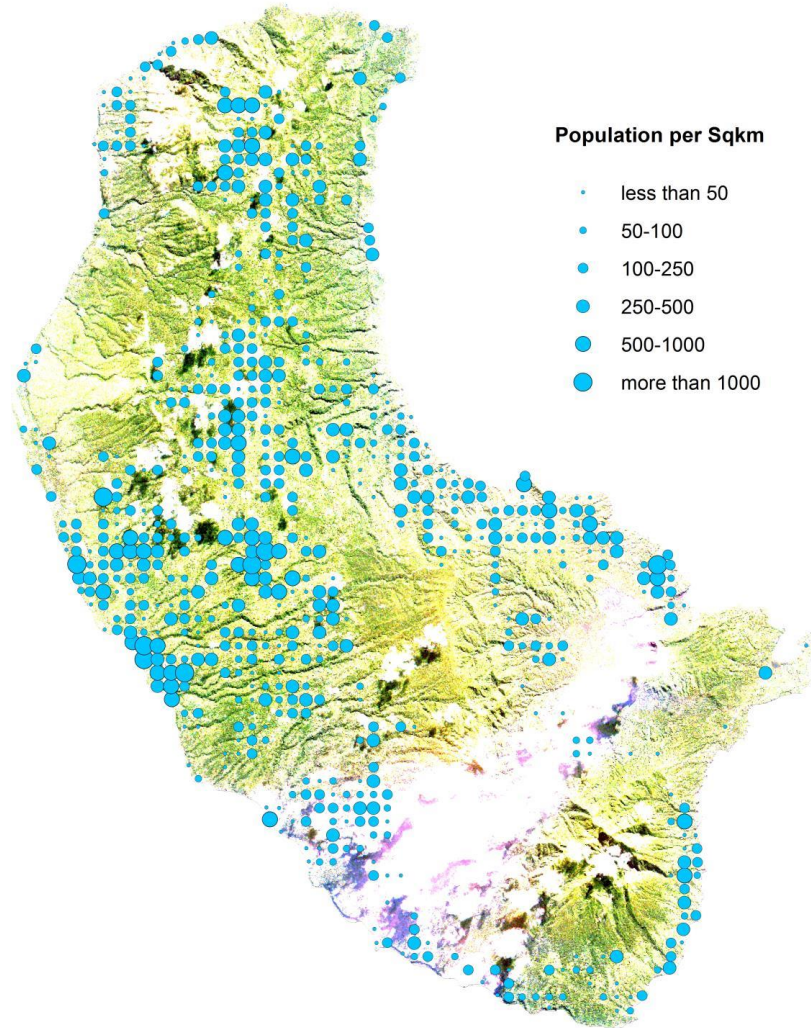
□ Tanna Catchments



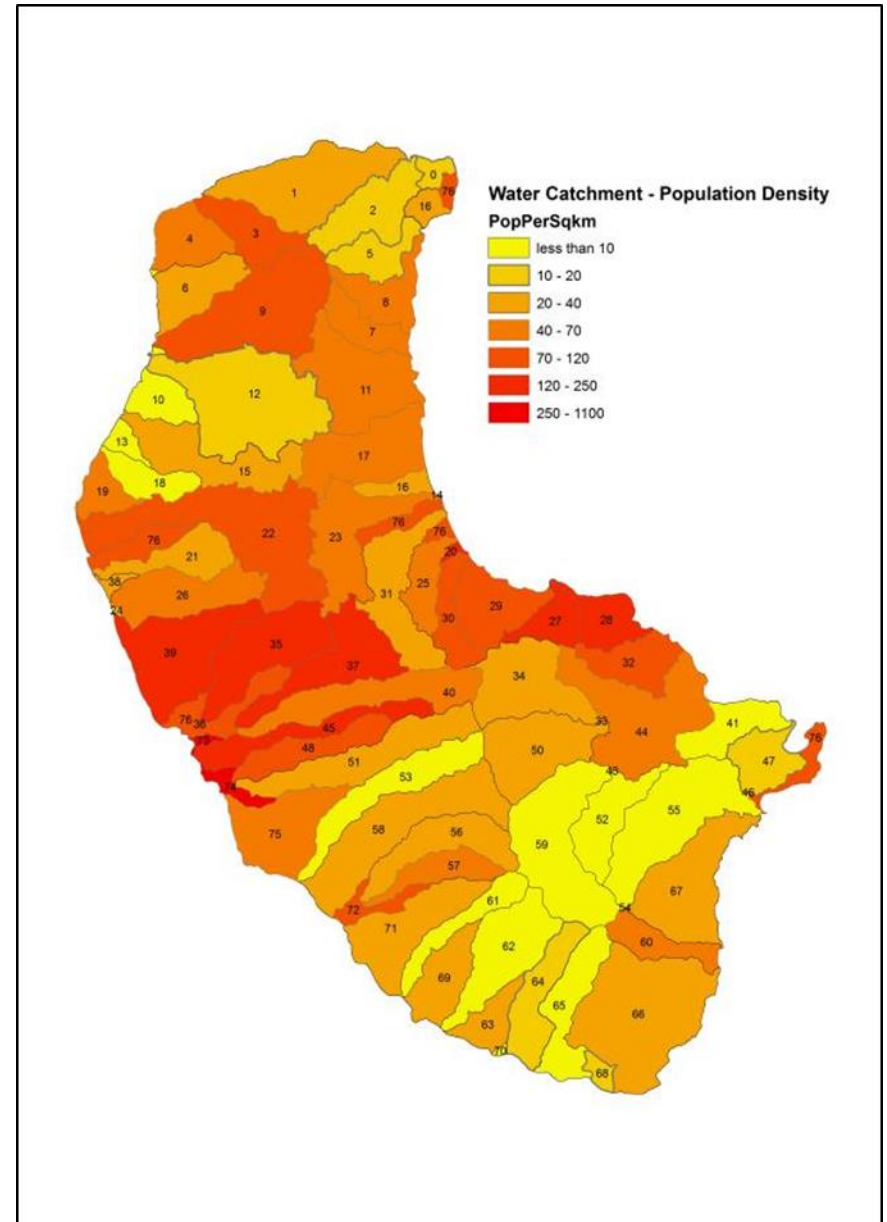
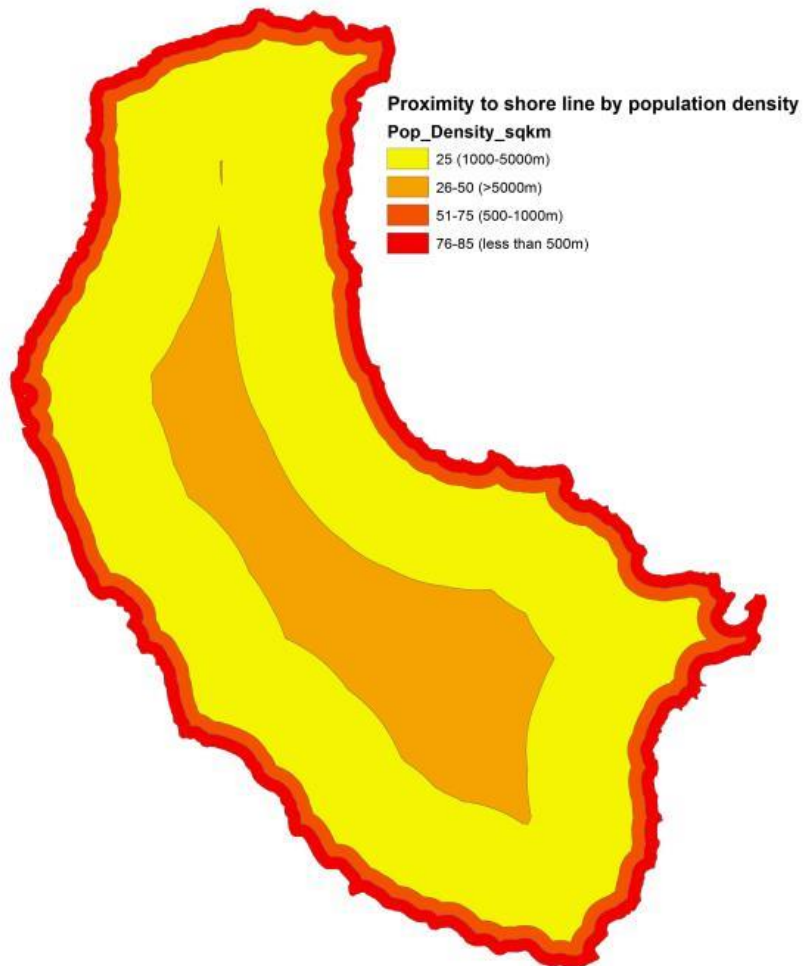


# Population from 2009 national census

rainfall satellite imagery



# Analyses enabled by a GIS-based Approach



# Tanna island

## Social Science component



# Tanna island

- 44 000 people, 7 different languages
- Most famous for strong 'kastom'
- Home for the Yasur volcano



# ESRAM Social Science Methodology

Engaging with the communities in the ESRAM process:

- Meeting with tribes in case study/project locations: meeting first with chiefs to discuss the projects, and conducting community discussions with both women's and men's groups
- Local fieldwork assistants as interpreters (from Tannese to Bislama/English)
- Meetings and workshops also with provincial government, NGOs, and tourism operators
- Subsequent semi-structured interviews for more detailed information where feasible

# ESRAM Social Science Methodology

Engaging with the communities in the ESRAM process:

- Scoping out main development and livelihood issues with the communities → creating context-specific understanding of the challenges and opportunities
- Development of Community-based Monitoring and Evaluation (M&E) processes and indicators
- Identifying relevant Traditional Knowledge practices (kastom) to be included in each project activity
- Integrating gender equality in project roles and management practices

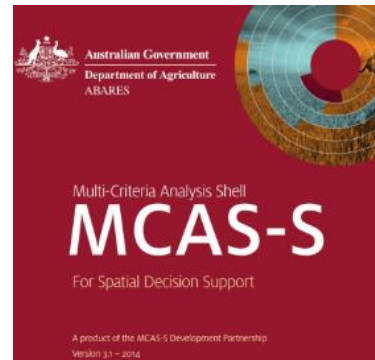
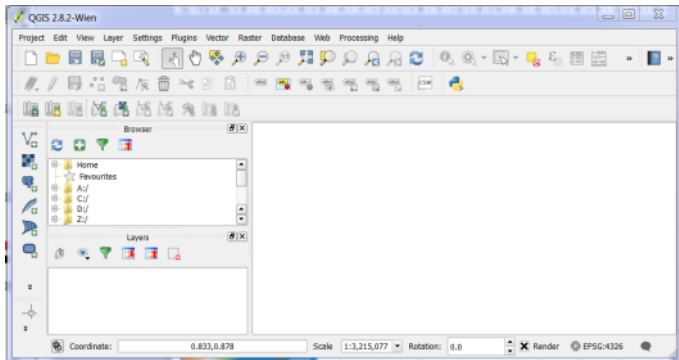
# Governance & Stakeholder consultations



## Who

- Tanna Customary land owner communities – men, woman
- Tanna Area Councils
- Tanna Council of Chiefs
- Tafea Provincial Government officers
- Vanuatu Government
- Other IGOs and NGOs
- Businesses

# Planning & Decision Support Tools

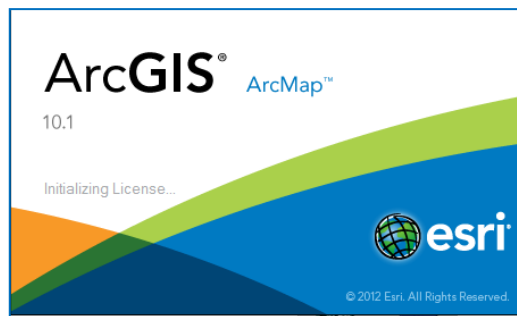


High level DST for stakeholders to explore scenarios, options and trade-offs



Mid-level modelling & visualisation tool

- Ecosystem service evaluations
- Catchment processes
- Land cover and land use change
- Future climate impacts



Advanced GIS for mapping and spatial analysis



# Potential Project Pressures & Solutions

1<sup>st</sup> Stakeholder Workshop, Lenakel, Tanna Island, November 2016 where participants discussed: (1) ecosystem benefits, (2) pressures and (3) solutions

## Key issues:

- Declining subsistence food security
- Declining water supply and quality
- Degradation of forest and coral reef ecosystems
- Environmental and social impacts of rapid tourism development and associated infrastructure
- Rising levels of waste, including plastics & pollution
- Social impacts of modernisation and challenges to kastom governance

## Possible Solutions:

- Community Conservation Areas
- Sustainable subsistence food production systems
- Sustainable Development Planning
- ...