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Torres Strait Futures: Regional Stakeholders' Future Scenarios and Livelihood Adaptation Strategies



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Rochester, W., Johnson, J. and Doupe, J.



Australian Government

Department of Sustainability, Environment,
Water, Population and Communities



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Project 11.1 Building Resilient Communities for Torres Strait Futures

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Acronyms

AFMA	Australian Fisheries Management Authority
CCAM	Conformal Cubic Atmospheric Model
CSIRO	.....	Commonwealth Scientific and Industrial Research Organisation
DOGIT	.....	Deed of Grant in Trust
DSEWPac	.....	Department of Sustainability, Environment, Water, Population and Community
DFAT	.....	Department of Foreign Affairs and Trade
EGS	.....	Ecosystem goods and services
IBIS	.....	Islanders' Board of Industry and Service
IPCC	.....	International Panel on Climate Change
NAQS	.....	Northern Australia Quarantine Strategy
NERP	.....	National Environmental Research Program
NGO	.....	Non-government Organisation
PBC	.....	Prescribed Body Corporate
PNG	.....	Papua New Guinea
RRRC	.....	Reef and Rainforest Research Centre Limited
TOs	.....	Traditional Owners
TSRA	.....	Torres Strait Regional Authority
TS	.....	Torres Strait
TSIRC	Torres Strait Island Regional Council
TSPZ	Torres Strait Protected Zone
WP	Western Province

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Vic McGrath	TSRA Land and Sea Management Unit
John Rainbird	TSRA Land and Sea Management Unit
Miya Isherwood	TSRA Land and Sea Management Unit
Annabel Jones	Australian Fisheries Management Authority
Shane Fava	Australian Fisheries Management Authority
John McDougall	DSEWPaC International Section
Simon Moore	DFAT Torres Strait Treaty Liason Officer
John O'Halloran	Queensland Department of Local Government
Sheriden Morris	RRRC
Dr. Peter Doherty	Australian Institute of Marine Science and NERP Tropical Ecosystems Hub

Dr. Russell Wise (CSIRO Ecosystem Sciences) assisted with the Western Province population projections. Dieter Tracey (Greenant Photo-design) provided system diagrams interpreted from workshop participants' scenario planning drawings.

Executive summary

The Torres Strait is a region of rich natural and cultural values, with tight linkages between its environmental assets and the livelihoods of local communities. The Torres Strait Treaty explicitly aims to protect these communities' livelihoods, and improve them through sustainable economic development. As Australia's northern border with Papua New Guinea (PNG), however, the region is under increasing pressure from PNG population growth, extractive development and exploitation of shared Torres Strait resources. Global drivers such as peak oil, fluctuating economic conditions and climate change will also have complex positive and negative impacts on livelihoods. Because of the rapid and increasing rate of change and uncertainty, it is important to make predictions of potential changes and plan proactively rather than respond reactively. This requires the design of 'no regrets' strategies which bring benefits even in the absence of change, and which are flexible and therefore less likely to be 'mal-adaptive'.

Through participatory scenario planning with Torres Strait communities and regional stakeholders, informed by integrated ecosystem services, climate and resilience modeling, this project aims to explore potential future scenarios for the region, identify 'no regrets' strategies to protect livelihoods and achieve sustainable economic development. In July 2010-December 2014 the project aims to:

1. Provide information to communities and regional stakeholders to advise strategic decision-making, including the Torres Strait Treaty
2. Identify 'no regrets' adaptation strategies
3. Increase the capacity for communities and stakeholders to avoid mal-adaptive strategies
4. Support the development of TSRA community-based adaptation planning

This report summarises the first scenario planning workshop held at the regional level with 22 federal, state and local government stakeholders, plus representatives of private enterprise, NGOs and research organisations. The joint CSIRO, JCU and RRRC project team provided downscaled climate projections, population modeling and other scientific information, which was integrated with stakeholders' knowledge. The workshop was held on 22-23 October 2012 at the Shangri-la Hotel, Cairns.

The workshop was structured into six sessions, and each addressed a specific question. The results of each session were:

Session 1: What are the drivers of change for Torres Strait communities and their livelihoods? Working groups listed 66 current or imminent drivers of change. These were grouped into themes, and participants voted on the two most important themes. Politics and economics (e.g. cost of living, government support for infrastructure, employment opportunities) and institutional and social drivers (e.g. population growth and emigration, health, education) were selected.

Session 2: What are the desired and possible futures for Torres Strait communities? Participants agreed the following desired vision for Torres Strait livelihoods in 2100:

"Torres Strait Islanders will enjoy a good standard of living in culturally vibrant communities with a strong sense of identity and core values. Torres Strait Islanders will have healthy communities with good access to education and livelihood opportunities, low crime rates, strong traditional culture and knowledge, sustainable natural resources, self-determination and ways of addressing the rising cost of living. Torres Strait Islanders will be able to cultivate the core values which underpin their sense of place and culture: respect, kinship, kindness, sharing and loyalty."

A matrix of four possible future scenarios was created from better or worse extremes of political and economic drivers, and institutional and social drivers. Participants created narratives and drew pictures for each scenario. These ranged from the 'Best Case' *Hope Island* (strong Torres Strait culture, stable population, political support and funding, controlled PNG population growth, less

extreme climate change and sea level rise, green Asian economic growth), to intermediate *Doug's World* and *Torres Strait Territory*, to the 'Business as Usual' *Northern Exposure* scenario (emigration, loss of language, less political support and funding, extreme climate change and sea level rise, uncontrolled PNG development and immigration, rapid and carbon intensive Asian economic growth). Key thresholds identified for this scenario, when irreversible system changes may occur, were the removal of the moratorium on mining in the Torres Strait by 2018; increased immigration from PNG and Indonesia by 2022 followed by emigration of Torres Strait Islanders; seagrass and coral die-off caused by pollution and run-off from PNG by 2032, and militarisation of the Torres Strait by 2032 to manage these problems.

Session 3: What impact will the Business as Usual scenario have on human well-being? An ecosystem goods and services (EGS) model was developed for the Torres Strait. This projected the impacts of drivers of change on EGS and human well-being in 2030 under the 'Business as Usual' *Northern Exposure* scenario. The northern islands close to the PNG coast (Boigu, Saibai, Dauan) were the most negatively impacted. The primary impacts in all islands were caused by increased exploitation from human population growth. The greatest climate change impacts were from ocean acidification and sea level rise, but these were off-set by some positive effects from increased temperatures boosting marine productivity.

Session 4: What is the adaptive capacity of Torres Strait communities today? Using the livelihoods capitals framework (natural, social, human, physical, financial, political) participants developed 56 indicators of adaptive capacity and enabling factors for Torres Strait communities. Key terms used were 'ability', 'change', 'community', 'employment', 'government', 'healthy', 'integrated', 'knowledge', 'marine', 'planning', 'sea' and 'traditional'. Participants identified strengths and weaknesses for each island in terms of these indicators.

Session 5: Which are the most vulnerable communities and livelihoods in the Torres Strait? Combining the EGS and human well-being impacts for 2030 with the adaptive capacity assessments enabled participants to discuss the relative vulnerability of islands. Three islands were chosen for the design of adaptation strategies: Saibai, Masig and Dauan.

Session 6: What are the priority adaptation strategies required to improve livelihoods in the Torres Strait? Based on the human well-being impacts and adaptive capacity for each island, participants designed adaptation strategies for livelihoods to steer them away from the Business as Usual *Northern Exposure* scenario and towards the Torres Strait vision. All strategies were targeted at specific local EGS impacts and/or adaptive capacity issues which were the sources of vulnerability, and ranked as follows:

Saibai:

1. Adaptive sea walls that can rise with sea level
2. Climate-adaptive housing and services design
3. Border Protection Hub to provide employment and manage cross-border issues
4. Develop renewable energy
5. Develop a strong political voice through the Torres Strait Treaty to improve monitoring of pollutant discharge from PNG rivers
6. Establish home gardens for food security
7. Subsidise imported food supplies to reduce harvesting pressure on local EGS

Masig:

1. Marine resource conservation
2. Promote tourism and sponge aquaculture
3. Climate-change proof terrestrial EGS against sea level rise

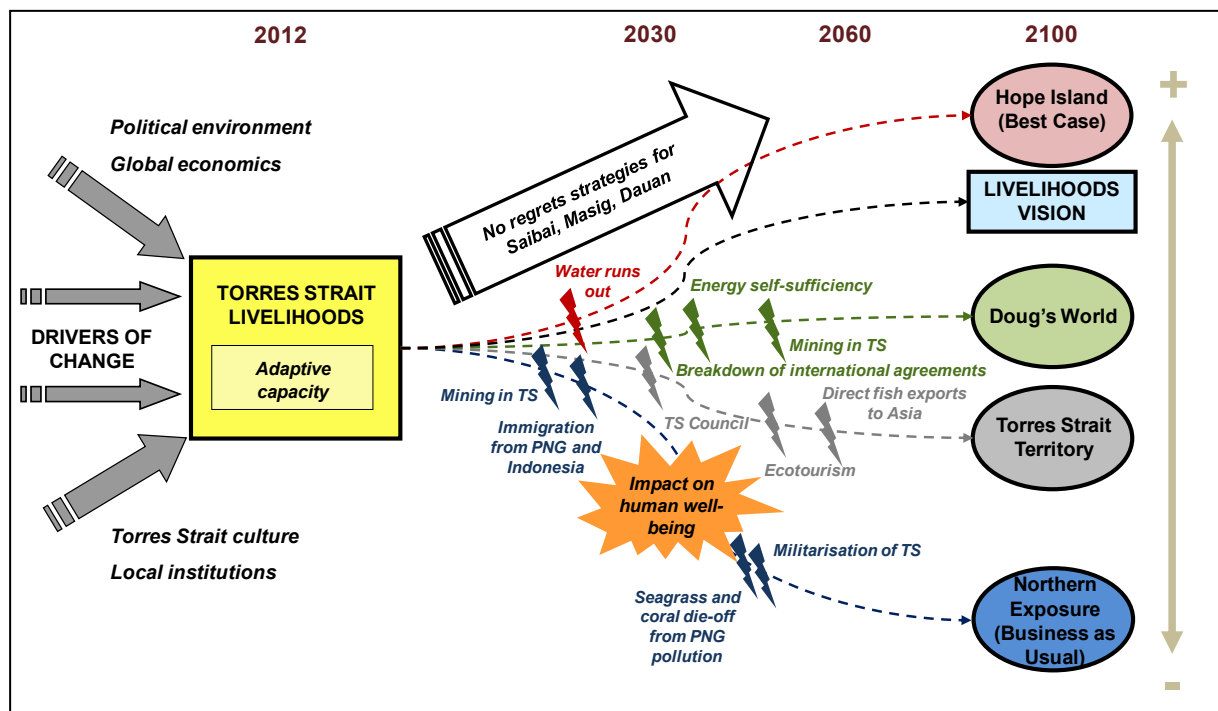
Dauan:

1. Develop alternative sources of protein (e.g. permaculture) for PNG coastal communities to reduce pressure on coastal finfish
2. Community-based management of all marine EGS
3. Improved water management to preserve freshwater supplies
4. Community-based habitat protection (e.g. Indigenous Protected Areas) for climate-sensitive species (turtles, reef fish, dugong, barramundi)

Strategies were cross-checked with the other potential future scenarios (i.e. *Hope Island*, *Doug's World*, *Torres Strait Territory*) to determine whether they would be mal-adaptive if these scenarios eventuated. For Saibai and Masig sea level rise-related strategies could be mal-adaptive if climate change is not as severe as projected. For Saibai, the development of a Border Protection Hub could also be mal-adaptive if cross-border pressures do not escalate. All other strategies would be 'no regrets' and beneficial for livelihoods under any future change.

Workshop evaluation: A questionnaire survey carried out before and after the workshop examined how participants' perceptions had changed. To the question "are Torres Strait communities resilient to future change?", 46% disagreed before and this fell to 34% after. To the statement "the Torres Strait's climate adaptation policies are enabling the region to be ready to cope with climate change", 14% agreed before the workshop, but none agreed after the workshop. Similarly, 9% disagreed before, increasing to 42% after.

Case studies and next steps: The selection of communities as case studies for the community scenario planning workshops will be undertaken in consultation with the TSRA Board and TSIRC Councillors in March 2013. If communities agree to participate, these exercises will be undertaken in June-August 2013. If the communities of Saibai, Masig and Dauan wish to participate, their perceptions and those of the stakeholders presented here will subsequently be combined through integration and policy evaluation workshops.



Summary of the workshop process and results for all sessions. Lightning symbols represent thresholds identified for each scenario.

1. Introduction

The Torres Strait (Fig. 1) is a region of rich natural and cultural values, with tight linkages between its environmental assets, ecosystem services and the livelihoods of communities. The Torres Strait Treaty explicitly aims to protect these communities' livelihoods, and improve them through sustainable economic development. As Australia's northern border with Papua New Guinea (PNG), however, the region is under increasing pressure from PNG population growth, extractive development and exploitation and pollution of shared Torres Strait resources. Global drivers such as peak oil, shipping traffic and climate change will also have complex impacts on environmental assets. This uncertain future will present challenges for maintaining resilient Torres Strait communities, but may also provide opportunities for sustainable economic development (e.g. tourism, aquaculture, sustainable fisheries).

Because of the rapid and increasing rate of change and uncertainty, it is important to make predictions of potential changes and plan proactively rather than respond reactively. This requires the design of 'no regrets' strategies which bring benefits even in the absence of change, and which are flexible and therefore less likely to be 'mal-adaptive'.

Through participatory scenario planning and resilience analysis with Torres Strait communities and stakeholders, informed by integrated ecosystem service and climate modeling, this project aims to explore potential future scenarios for the region, identify 'no regrets' strategies to protect livelihoods and achieve sustainable economic development. This will respond in part to the 2010 Senate Foreign Affairs, Defence and Trade Committee Inquiry, which recommended an analysis of the vulnerability of the Torres Strait to climate change and other future pressures. The project outputs will support the delivery of ongoing TSRA, DSEWPac and DFAT initiatives promoting climate adaptation, alternative livelihoods, food security and economic development in the region, including:

- The TSRA's community adaptation plans under the Torres Strait Climate Change Strategy;
- The Torres Strait Treaty's Joint Advisory Committee and Environmental Management Committee's objectives of achieving food security and alternative livelihoods in the Western Province, PNG;
- The Torres Strait and Northern Peninsula Regional Plan;
- The TSRA's Sustainable Land Use Plans;
- The Integrated Service Delivery Framework

In July 2010-December 2014 the project's outcomes and impacts will be to:

1. Provide information to communities and regional stakeholders to advise strategic decision-making, including the Torres Strait Treaty
2. Identify 'no regrets' adaptation strategies
3. Increase the capacity for communities and stakeholders to avoid mal-adaptive strategies
4. Support the development of TSRA community-based adaptation planning

The project addresses five research questions:

1. What are possible future changes in the Torres Strait?
2. How will they affect communities and their livelihoods?
3. Which communities are most likely to be impacted by changes?
4. What is their capacity to adapt?
5. What are the priority 'no regrets' strategies that will enhance communities' resilience and capacity to adapt?

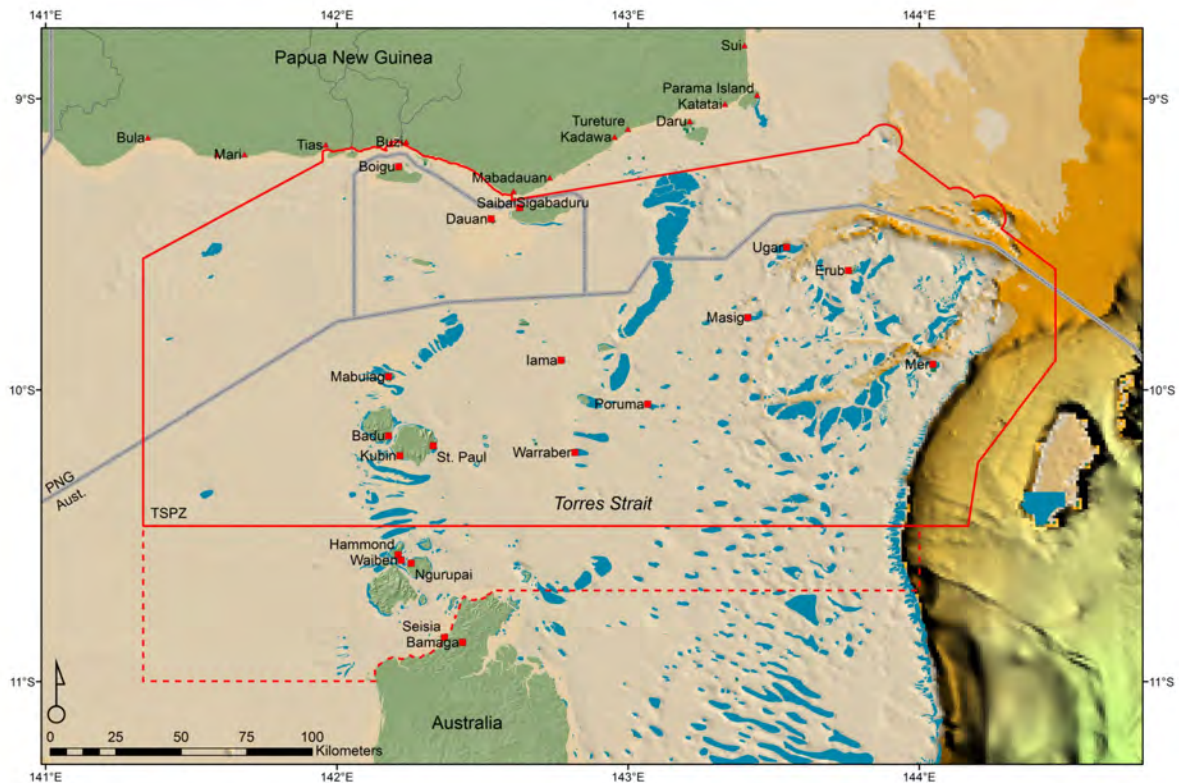


Figure 1. The Torres Strait region, showing reefs, international boundaries, the Torres Strait Protected Zone (TSPZ) and Australian and PNG communities. The 14 Australian communities within the TSPZ are the focus of this study.

2. Methodology

Integrating the challenges of global change with broader livelihoods and social development goals in remote areas of developed countries is a novel area of research and practice. This project contributes to this field by applying and integrating a suite of systems science concepts and methods, both climate and development-orientated, to the nexus between adaptation, development and natural resource policy and management.

There are many stakeholders from different sectors involved in the planning and improvement of livelihoods, including communities themselves. They may have similar aims, but different roles and perceptions of how to achieve sustainable development. To be more effective, these stakeholders' efforts need to be coordinated, and their knowledge combined to tackle development challenges. By exploring and visualising potential future development trajectories, scenario planning can challenge values and assumptions, bridge stakeholders' world views, generate innovation and create an anticipatory 'adaptation window' (Gidley *et al.* 2009; Ravera *et al.* 2011). The method is also effective for integrating scientific information with traditional or local knowledge (Enfors *et al.* 2008), which is both an opportunity and challenge in the Torres Strait (Butler *et al.* 2012a).

This project applies participatory scenario planning with government and community stakeholders to enable them to express their different perceptions of livelihoods, the system dynamics determining their characteristics and their possible development trajectories. Workshops held at the regional and community level identify adaptation strategies which stakeholders believe will reduce any perceived negative impacts of drivers of change on human well-being, reducing livelihoods' vulnerability and building communities' adaptive capacity for

future change (Fig. 2). Subsequent workshops integrate the adaptation strategies identified by all stakeholders, allowing comparison between their perspectives, and an assessment of whether the strategies have been introduced by policies and programs. If not, the barriers to their implementation are identified. This social learning process creates 'adaptive co-management', whereby new knowledge, partnerships and adaptive capacity are generated amongst all stakeholders to improve livelihoods.

In July 2011-December 2014 the project is carrying out a series of activities, linked by outputs (Fig. 3). This report describes a scenario planning process which investigated government and Torres Strait regional stakeholders' perceptions of communities' challenges and opportunities, and adaptation strategies required to improve their livelihoods. The study focuses on the 14 communities within the TSPZ (Fig. 1). Outputs of the workshop were 'no regrets' adaptation strategies for three case study islands, plus information on thresholds and alternative future livelihood systems which are informing a resilience assessment of the Torres Strait.

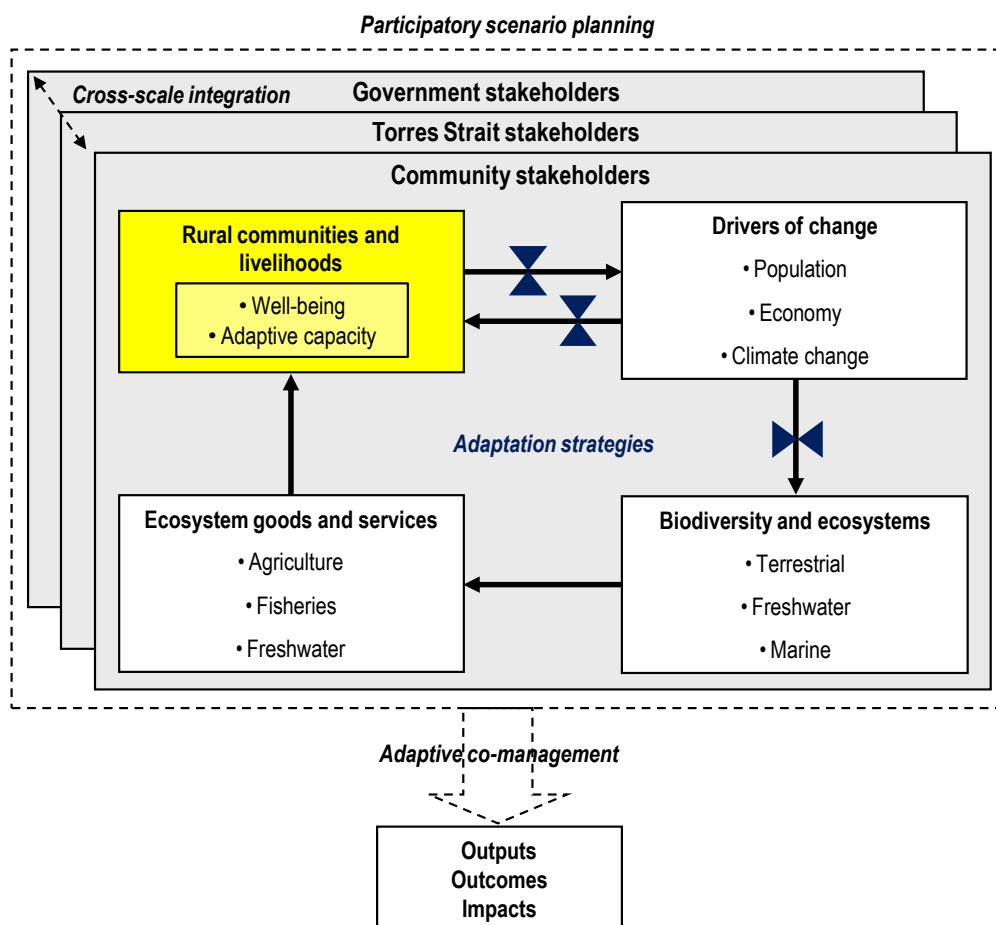


Figure 2. Conceptual diagram of the the system dynamics influencing communities and their livelihoods, stakeholder levels and adaptation strategies. The research process of participatory scenario planning, cross-stakeholder integration and adaptive co-management are indicated by dashed lines

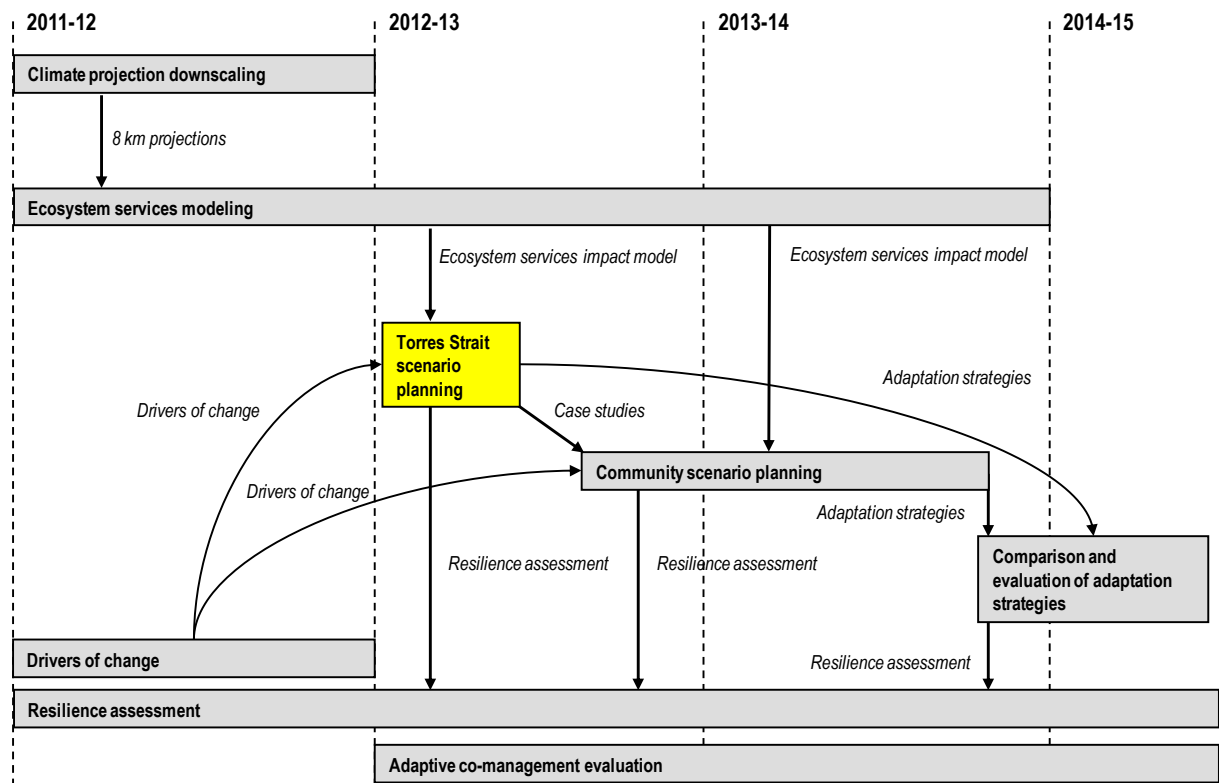


Figure 3. Timelines for project activities and outputs (in italics) linking activities in July 2011-December 2014. The activity reported here (Torres Strait scenario planning) is highlighted.

3. Torres Strait scenario planning

3.1 Stakeholder analysis

A key step in preparing for the workshop was to undertake a stakeholder analysis (following Mitchell et al. 1997) of formal organisations with responsibilities for climate change, economic development and natural resource management in the Torres Strait. In September 2012 the Steering Committee identified 36 relevant bodies, including Australian, Queensland and Torres Strait government, private companies, NGOs and research organizations (Table 1). Using the following indicators each organisation was scored on a scale of 0-5 by the Steering Committee:

1. Power of the stakeholder to govern and make decisions;
2. Legitimacy of the stakeholder as viewed by other stakeholders;
3. Urgency that the stakeholder claims immediate involvement.

Key representatives from each were then identified and invited to the workshop. Of 70 invitations, 22 attended, including three members of the Steering Committee (Table 2). The absence of TSRA representatives was due to the 2012 TSRA Board election process, which prevented outgoing members and many executives from attending. Including the CSIRO, JCU and RRRC project team, 28 people attended.



Workshop participants, CSIRO and RRRC team members

Table 1. Organisations identified and their total stakeholder analysis score, listed in descending order

No.	Stakeholder organisation	Total score
1	Torres Strait Regional Authority (Land and Sea Management Unit, Economic Development and Fisheries)	15
2	Torres Strait Island Regional Council	14
3	Commonwealth DSEWPaC (International Section, Caring for Country Rangers Program)	13
4	Commonwealth Department of Foreign Affairs and Trade (Torres Strait Treaty Liaison Office)	12
5	Australian Maritime Safety Authority	12
6	Queensland Department of Premier and Cabinet	12
7	Commonwealth Department of Health and Ageing	12
8	Torres Strait Treaty Traditional Inhabitant Representatives	12
9	Australian Fisheries Management Authority (Torres Strait Fisheries)	11
10	Cairns CMF Church	11
11	Queensland Health	10
12	Australian High Commission	9
13	State Emergency Service and Emergency Management Queensland (Department of Community Safety)	9
14	Pearl Island Seafoods Ltd.	9
15	Tagai College	9
16	Reef and Rainforest Research Centre	8
17	AusAID	8
18	Fisheries Queensland	8
19	Regional Development Australia (FNQ Torres Strait)	8
20	IBIS (Islanders Board of Industry and Service) Supermarkets	8
21	Australian Quarantine and Inspection Service (Department of Agriculture, Fisheries and Forestry)	7
22	Ergon Energy	7
23	Sea Turtle Foundation	7
24	Australian Customs and Border Protection Service	7
25	Queensland Department of Local Government	7
26	Queensland Department of Aboriginal and Torres Strait Islander and Multicultural Affairs	6
27	Commonwealth Department of Immigration and Citizenship	6
28	Kailag Enterprises	6
29	Queensland Department of State Development, Infrastructure and Planning	6
30	Queensland Remote Indigenous Land and Infrastructure Program Office Aboriginal and Torres Strait Islander Services	6
31	James Cook University Faculty of Medicine, Health and Molecular Sciences	5
32	James Cook University, School of Earth and Environmental Sciences	4
33	Australian Centre for Tropical Fisheries Research	4
34	Arafura Consulting	4
35	Centre for Appropriate Technology	4
36	Thursday Island Hospital	4

Table 2. Workshop participants, their organisations and total stakeholder analysis score

Total score	Participant (position)	Stakeholder organisation
15	Damian Miley (Manager, Land and Sea Management Unit)	Torres Strait Regional Authority
13	John McDougall (International Section)	Commonwealth DSEWPaC
13	Fiona Bartlett (Threatened Species)	Commonwealth DSEWPaC
12	Simon Moore (Treaty Liaison Officer)	Commonwealth Department of Foreign Affairs and Trade
12	Adrian Davidson	Australian Maritime Safety Authority
12	Councillor Fraser Nai (Masig)	Torres Strait Treaty Traditional Inhabitant Representatives
11	Shane Fava (Manager, TS Fisheries)	Australian Fisheries Management Authority
11	John Marrington (Fisheries Protection)	Australian Fisheries Management Authority
9	Peter Rinaudo (Area Director North Queensland)	State Emergency Service and Emergency Management Queensland
8	Sheriden Morris (Director)	Reef and Rainforest Research Centre
8	Dr. Julie Carmody	Reef and Rainforest Research Centre
8	Dr. Karen Vella	Griffith University and Regional Development Australia (FNQ Torres Strait)
8	Dr. Ruth Potts	Griffith University and Regional Development Australia (FNQ Torres Strait)
8	Ian Copeland (CEO)	IBIS Supermarkets
7	Murray Korff (Program Director, Northern Australia Quarantine Strategy Border Compliance Division)	Australian Quarantine and Inspection Service
7	Dr. Ian Bell (Senior Conservation Officer, Threatened Species Unit, Queensland Department of Environment and Heritage Protection)	Sea Turtle Foundation
7	Belinda Gill (Principal Advisor, Far North Region)	Queensland Department of Local Government
6	Philippa Bauer	Kailag Enterprises
6	Julie Colman (Principal Planner, Far North Queensland Regional Services)	Queensland Department of State Development, Infrastructure and Planning
6	Robert Zigterman (Program Manager Town Planning)	Queensland Remote Indigenous Land and Infrastructure Program Office Aboriginal and Torres Strait Islander Services
4	Alifereti Tawake	James Cook University School of Earth and Environmental Sciences
4	Dr. Garrick Hitchcock	Arafura Consulting

3.2 Workshop process

The workshop was held over two days on 22nd and 23rd October 2012 at the Shangri-la Hotel, Cairns. The dates and location were chosen to intersect with the annual Torres Strait Treaty cycle meetings, which were held on 24th – 26th October. This enabled the participation of stakeholders who might otherwise have not been able to attend, and presentation of the results to the Joint Advisory Committee. Workshop facilitation was led by James Butler (CSIRO), supported by the project team, Jo Johnson and Juliana Doupe (RRRC). Posters summarising presentations were displayed around the meeting room throughout the workshop.

The objectives of the workshop were to:

1. Explore possible future change in the Torres Strait
2. Identify the most vulnerable communities and livelihoods in the Torres Strait
3. Identify priority adaptation strategies for communities

At the start of the workshop participants were asked to give their verbal consent for the project team to apply and publish the materials and results of the workshop. All participants agreed. Key terms and concepts were presented and explained with the participants to ensure a common understanding (Table 3).

Table 3. Terms and definitions used in the workshop

Term	Definition	Reference
Livelihoods	The capabilities, assets (including both material and social resources) and activities required for a means of living	Chambers and Conway 1992
Human well-being	The basic needs of people to live a healthy life: income, food security, health, social cohesion, freedom of choice	Millennium Ecosystem Assessment 2005
Driver of change	Any natural or human-induced factor that directly or indirectly causes a change in the system of interest, including institutional and governance issues that mediate livelihood outcomes	Millennium Ecosystem Assessment 2005; DfID 2004
Ecosystem goods and services	Those goods and services which are provided by ecosystems and actually and directly valued and consumed by people	Wallace 2007; Fisher <i>et al.</i> 2007; Kent and Dorward 2012
Resilience	The capacity of a system to experience shocks while retaining essentially the same function, structure, feedbacks and therefore identity	Walker <i>et al.</i> 2005
Threshold	A tipping point where sudden and possibly irreversible change occurs in a system	Walker <i>et al.</i> 2005
Adaptive capacity	The potential for actors to make changes that increase resilience, reducing the chance of the system losing its ability to provide its desirable function, or transforming the system altogether	Chapin <i>et al.</i> 2006
Vulnerability	The degree that a system will be impacted by change, mediated by adaptive capacity	IPCC 2007
Adaptation strategies	Adjustment in ecological, social or economic systems in response to actual or expected change and their effects or impacts	Smit and Wandel 2006
'No regrets' strategies	Adaptation strategies which yield benefits under any future conditions of change	Hallegatte 2009
Mal-adaptation	Adaptation strategies which result in the system becoming more vulnerable to change	Hallegatte 2009

The workshop process was explained to the participants using Fig. 4. Six steps are taken:

1. The drivers of change for livelihoods today and in the near future are identified.
2. The desired future vision for livelihoods in 2100 is agreed in terms of human well-being. Then, based on plausible variations in the drivers of change, four future scenarios are created and compared to the desired vision. Thresholds in drivers are identified where sudden and possible irreversible change occurs.
3. The impacts on human well-being and livelihoods are modelled for 2030 for the 'Business as Usual' scenario. 2030 is investigated because impacts of drivers are more predictable in the short-term than in the long-term, and any human responses are less likely to have taken great effect.
4. The adaptive capacity of communities to cope with the 'Business as Usual' scenario is assessed.
5. Community vulnerabilities are assessed by combining the projected impacts with communities' current adaptive capacity: the most vulnerable are those with the highest impacts and the lowest adaptive capacity.
6. Based on their specific vulnerabilities, appropriate adaptation strategies are designed to build community resilience. These are compared against the scenarios identified in Step 2 to check whether they would be compatible or 'mal-adaptive' for any other futures that could eventuate. In this way 'no regrets' strategies are agreed which could steer livelihoods' development pathways towards the desired future vision.

To follow this process, the workshop was structured into six sessions, and each addressed a specific question (Fig. 5; Appendix I). The structure was designed to encourage the integration of scientific information from other project activities (see Fig. 3) with stakeholders' knowledge to generate shared knowledge. An evaluation exercise was also carried out at the beginning and end of the workshop to assess how participants' perceptions had changed.

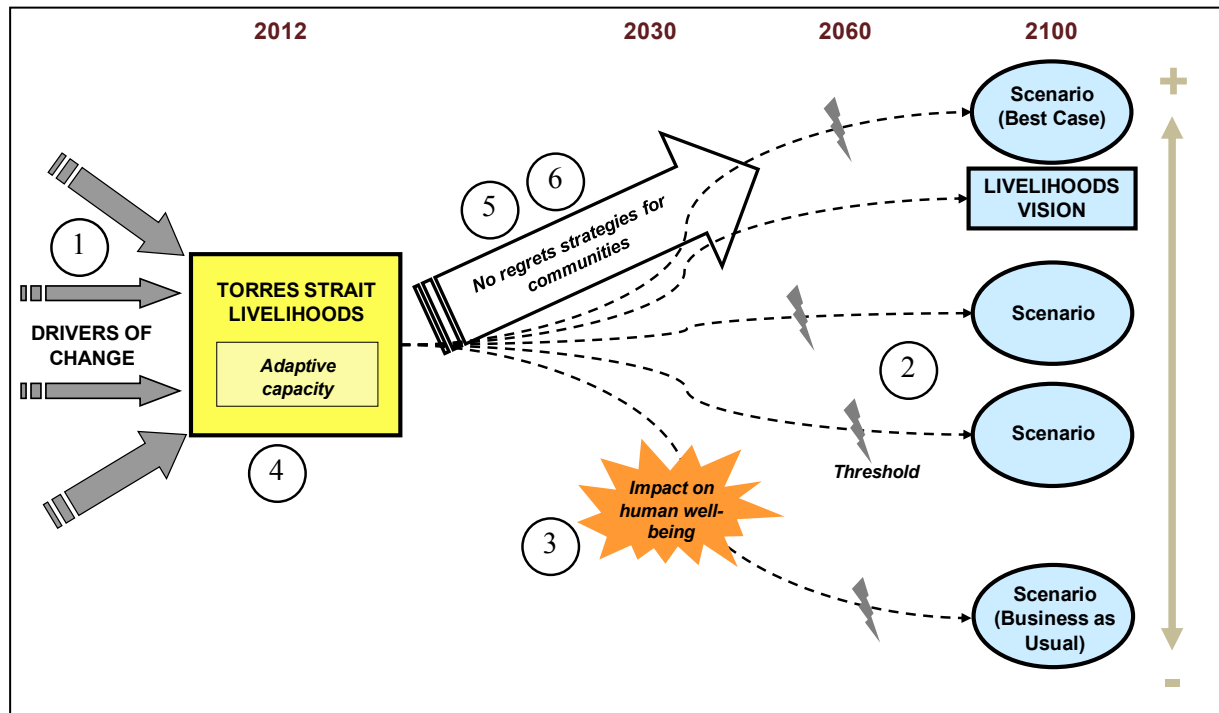


Figure 4. Diagram of the workshop process. Numbers refer to the workshop steps and sessions

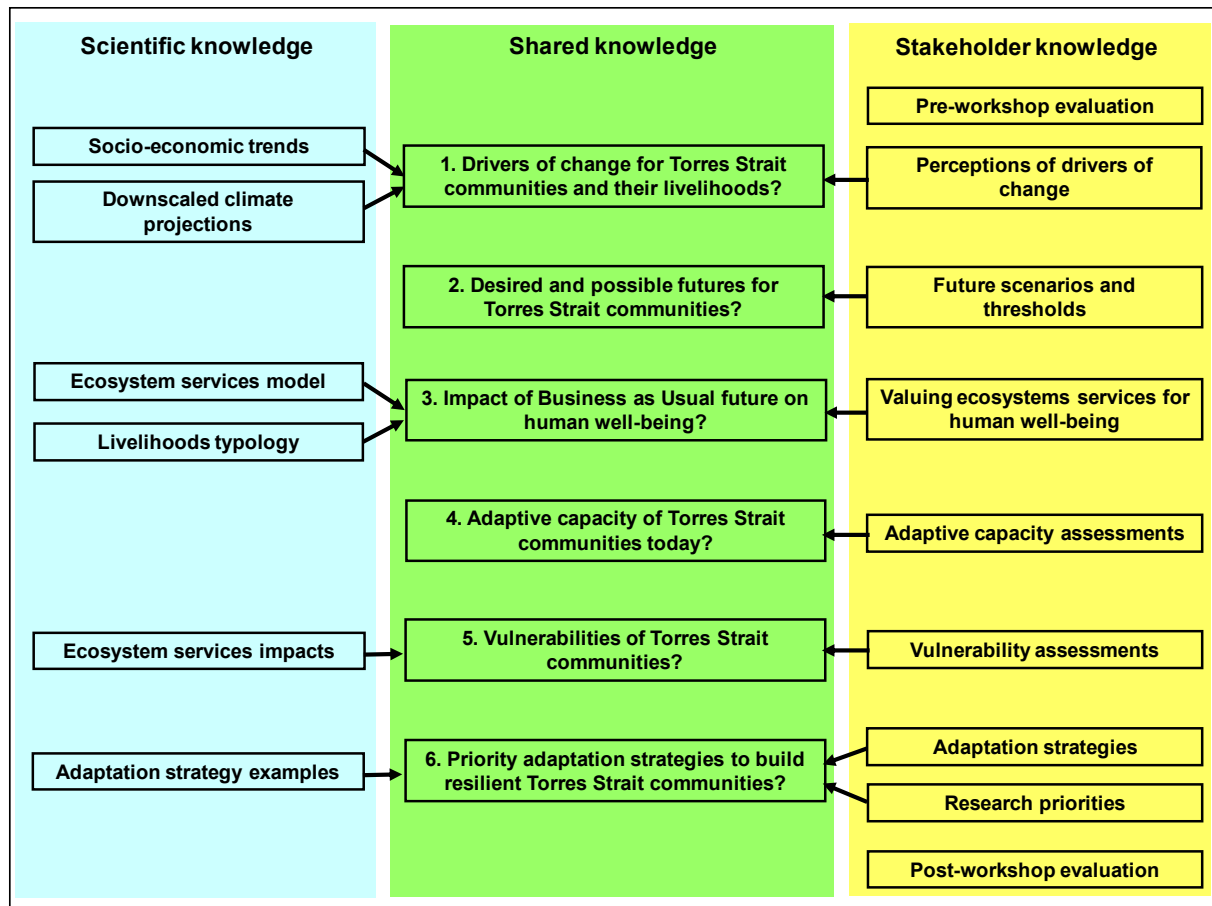


Figure 5. Workshop structure and sessions, showing the role of project outputs (see Fig. 3) and knowledge integration

4. Workshop results

4.1 Session 1: What are the drivers of change for Torres Strait communities and their livelihoods?

Session 1 began with CSIRO and RRRC team members presenting information on the current and projected trends in potential drivers of change for Torres Strait livelihoods. This started with an analysis of global issues (e.g. financial crises, technology, disease epidemics, growth of the Asian economy). Simon Moore (DFAT Torres Strait Treaty Liaison Officer) then presented a summary of the Torres Strait Treaty and ongoing challenges to its operation. Information on the Torres Strait economy, shipping, population and projections of change (Fig. 6), health and cultural trends was then presented, plus a synopsis of current and projected population growth (Fig. 7) and resource development (Fig. 8) in PNG's Western Province. Current climate patterns, climate change projections downscaled to 8 km from the IPCC A2 'high' emissions scenario (Fig. 9, Table 4) using the CSIRO Conformal Cubic Atmospheric Model (CCAM; McGregor and Dix 2008), and examples of sea level inundation risk were presented by Jo Johnson (RRRC). This was followed by a summary of current knowledge on the status and trends of key species and ecosystem assets, collated from current NERP scientists and other past research projects (Fig. 10). Murray Korff (Northern Australia Quarantine Strategy) presented a summary of current and projected biosecurity risks (Fig. 11).

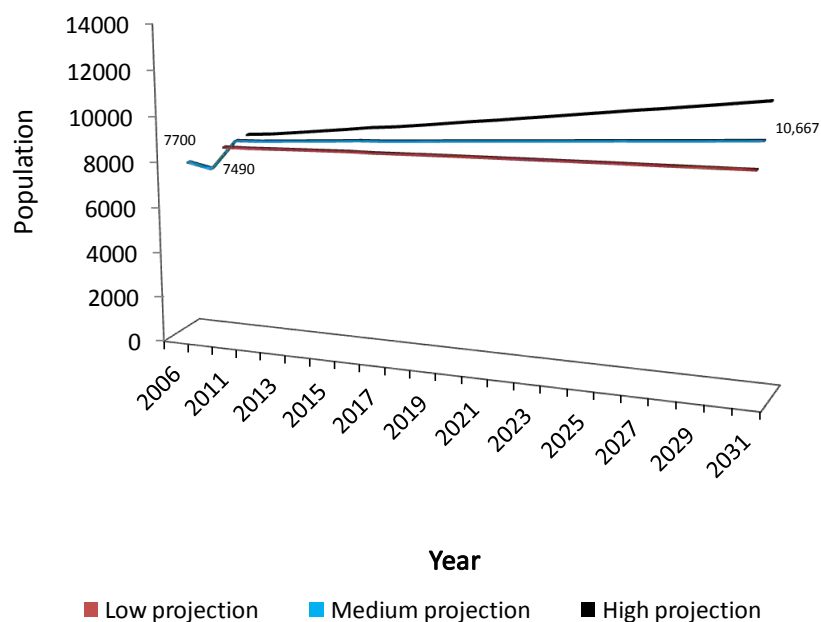


Figure 6. Population census data for the Torres Strait Indigenous Region for 2006 and 2011, and low, medium and high projections until 2031. Note that as well as the 14 TSPZ communities, in 2011 this statistical region included Thursday Island, Horn Island and Hammond Island. Although there was a decline from 7,700 in 2006 to 7,490 in 2011, medium projections indicate a population increase to 10,667 in 2031, at an annual average growth rate of 0.91%. For full details see Butler et al. (2012b).

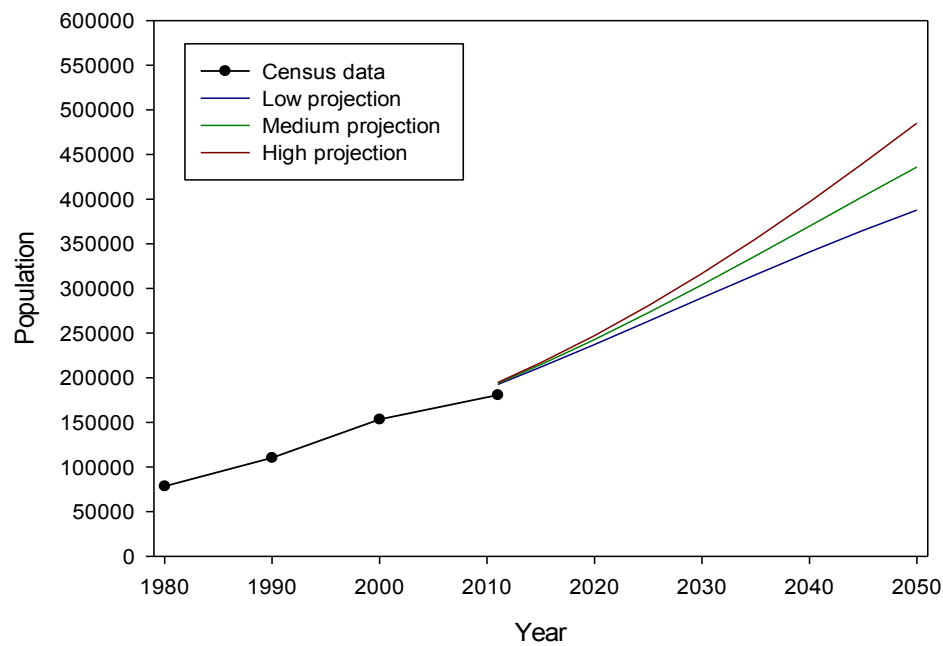


Figure 7. Population census data for Western Province, PNG in 1980-2011, and projected increases between 2012 and 2050 at low, medium and high projections. The average annual growth rate in 2000-2011 was 1.5%. At medium projections, the population may at least double from 180,000 to 420,000 by 2050. For full details see Butler et al. (2012b).

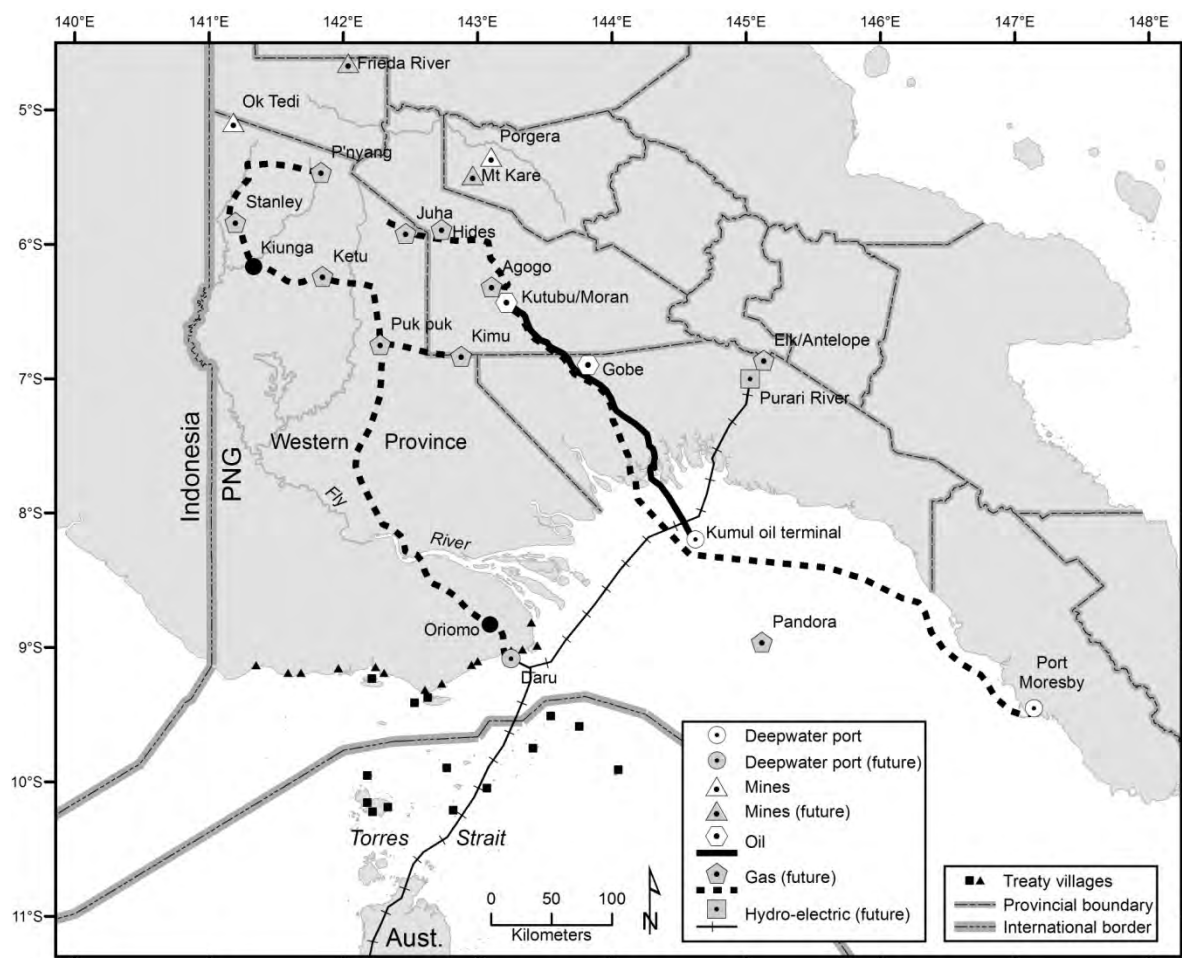


Figure 8. Summary of current and planned resource development projects in PNG neighbouring the Torres Strait. For full details see Butler et al. (2012b).

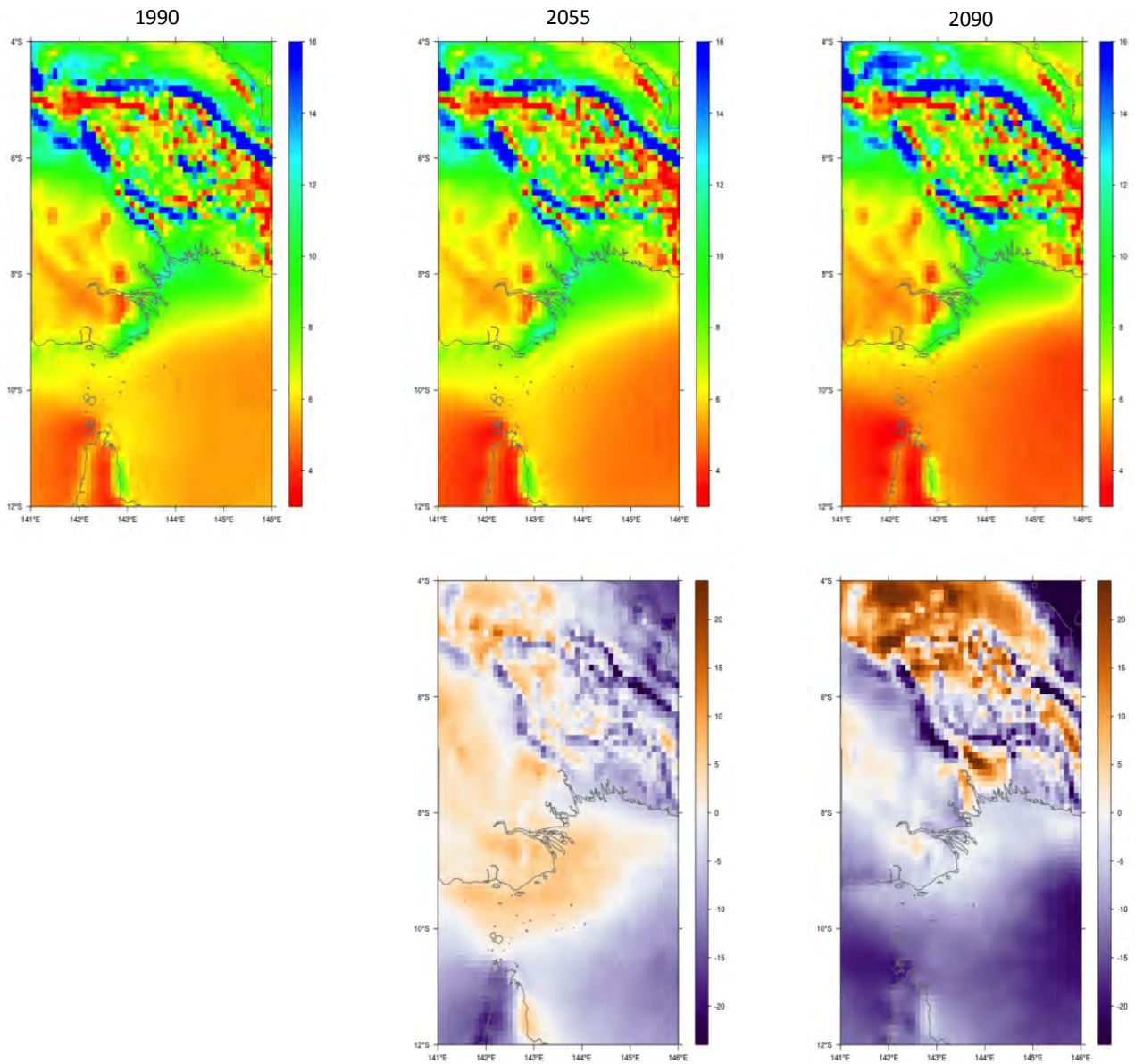


Figure 9. Annual mean rainfall rate (mm day^{-1} , top row) and changes relative to 1990 (bottom row) in the Torres Strait region, downscaled to 8 km using CCAM. For full details see Katzfey et al. (2012).

Table 4. Summary of changes in climate parameters for the Torres Strait from 1990 levels, averaged from downscaled CCAM data across the region. For full details see Katzfey et al. (2012).

A2 scenario	2055	2090
Temperature ($^{\circ}\text{C}$)	+1.3	+2.5
Apparent temperature ($^{\circ}\text{C}$)	+2.2	+4.8
Rainfall (%)	+3.4	-2.9
Relative humidity (% humidity)	+0.5	+0.6
Wind speed (%)	-2.2	-3.5

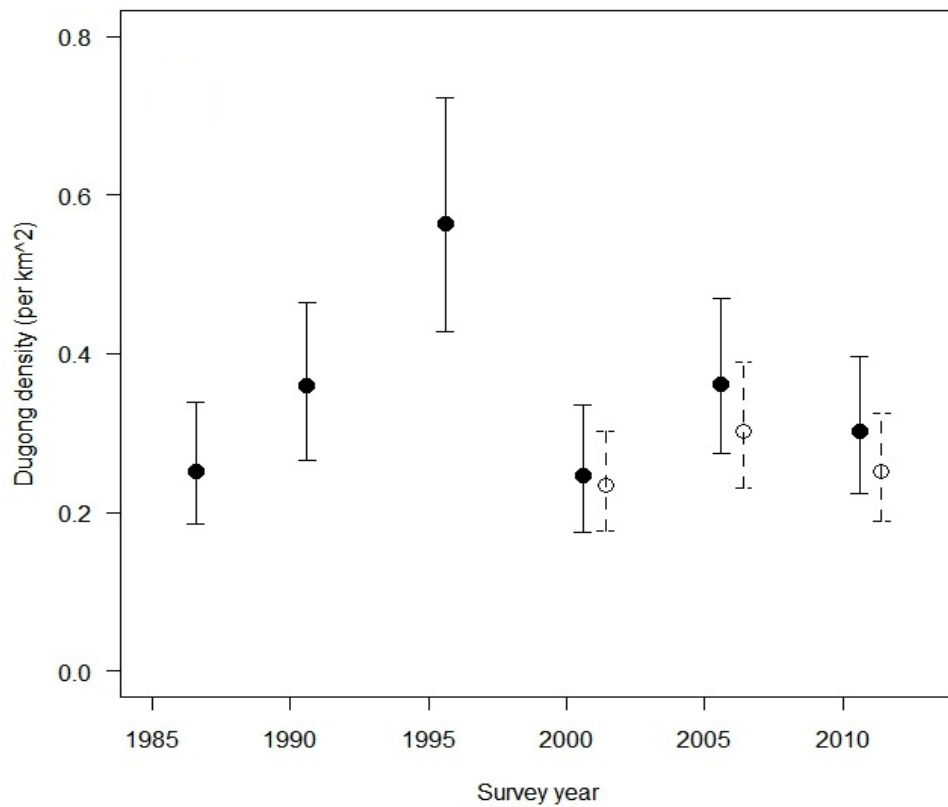


Figure 10. Densities of dugong in the Torres Strait estimated from aerial surveys, 1985-2010 (source: Helene Marsh, JCU)

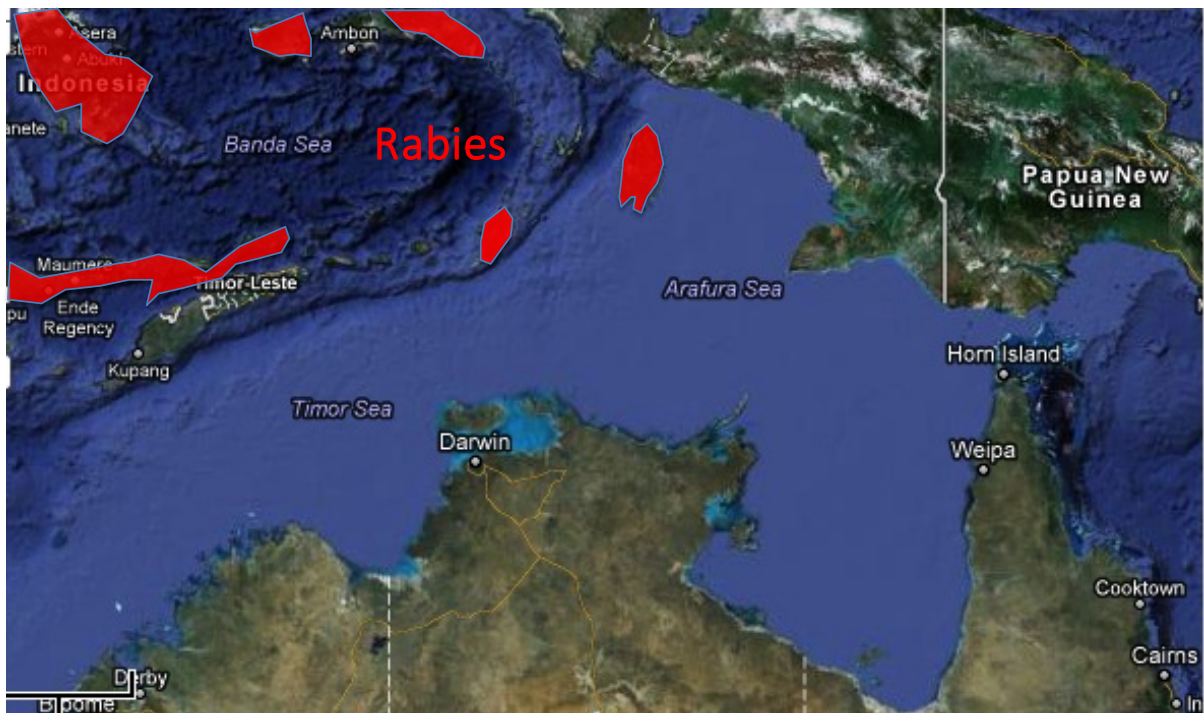


Figure 11. Current range of rabies occurrence in Indonesia (source: Murray Korff, NAQS)

Following these presentations, workshop participants were divided into four groups to discuss their perceptions of the current and imminent drivers of change for Torres Strait communities and their livelihoods. Each group wrote down their selected drivers on sticky note paper, and placed a total of 66 on a large whiteboard. Through discussion these were clustered into themes. After clustering, each participant was given two votes and asked to select the two most important drivers of change for livelihoods, using stickers. The votes were then totalled to identify the two most important themes of drivers (Table 5).

A word cloud analysis illustrates the key words that emerged from the drivers (Fig. 12). 'Cost' was the most frequently mentioned word, followed by 'increasing', 'change', 'development', 'population', 'infrastructure', 'food', 'level' and 'living'.



Workshop participants grouping drivers of change into themes and voting for the most important

Table 5. Drivers of change for Torres Strait communities identified and grouped into themes by participants. The two most important themes selected by voting were politics and economics, followed by institutional and social.

Theme (total votes)	Driver of change
Natural resources (5)	PNG mining pollution
	PNG development
	PNG economic development (mining, logging, fisheries)
	Increasing resource demand
	Access to resources
	Disease encroachment (biosecurity)
	Resource degradation / climate change
	Natural resource stress
	Declining available land and water for development
	Water security
	Declining turtle numbers
	Increasing biosecurity risks
Climate (4)	Severe weather events
	Sea level rise and inundation
	Sea level rise and inundation
	Changing rainfall
	Increasing temperature
	Sea level rise resulting in emigration
	Climate change and temperature increase
	Climate change and sea level rise
Culture (4)	Strength of culture in family, society and identity
	Youth leaving for education resulting in loss of identity
	Loss of cultural ways
	Lawlessness and family issues
	Bicultural lifeways
Politics and economics (20)	Connection to the land / desire to stay and retain way of life
	Prices of fisheries products
	Lack of diversified employment opportunities for livelihoods
	Lack of employment opportunities for locals
	Poor access to food (prices 40% higher than mainland)
	Global economic trends, price of fuel
	Increasing cost of living
	Cost of existence to Torres Strait communities resulting in continued reduction of population
	Cost of living, fuel costs impacting food types, food quality, cultural foods and health
	Fish processing
	Increasing transport and grocery costs, increasing cost of living
	Cost of living
	Funding
	Increasing cost of living and fuel costs
	Political will to support services
	Availability of infrastructure
	Government support levels
	Property prices/cost of living
	Money from somewhere
	Withdrawn government funding
Institutional and social (9)	Health impacts of disease vectors
	Low life expectancy
	Population migration
	Population growth – demand for food, infrastructure, water
	Brain drain from emigration
	Lots of islanders move to mainland Australia
	Population growth
	Relief from over-crowding
	Health decline / poor health

Table 5 continued. Drivers of change for Torres Strait communities identified and grouped into themes by participants.

Theme (total votes)	Driver of change
Institutional and social cont.	Illegal movement of people
	High Court challenge (non-traditional exclusive rights)
	Access to education
	New planning scheme
	Single regional plan federal/state/local infrastructure
	Industry
	Infrastructure improvement
	Research outcomes increasing awareness of opportunities outside Torres Strait
	Population growth
	Increased security (crime) risks
	Movements of people immigration and emigration
	Preparing the community to understand and cope with change

**Figure 12.** Word cloud for Torres Strait drivers of change. The larger the word, the more frequently it was recorded by participants

4.2 Session 2: What are the desired and possible futures for Torres Strait communities?

4.2.1 Desired future vision for Torres Strait livelihoods

Session 2 began with a discussion to develop a collective statement about the desired future vision for Torres Strait livelihoods in 2100. This was summarized as follows:

“Torres Strait Islanders will enjoy a good standard of living in culturally vibrant communities with a strong sense of identity and core values. Torres Strait Islanders will have healthy communities with good access to education and livelihood opportunities, low crime rates, strong traditional culture and knowledge, sustainable natural resources, self-determination and ways of addressing the rising cost of living. Torres Strait Islanders will be able to cultivate the core values which underpin their sense of place and culture: respect, kinship, kindness, sharing and loyalty.”

4.2.2 Future scenarios for Torres Strait livelihoods

Using the two most important themes of drivers from Session 1 (politics and economics, and institutional and social), two axes were created with different extremes of each driver. These axes were described in broad terms as global economic conditions (carbon intensive versus ‘Green Growth’), and Torres Strait culture (strong versus weak) (Fig. 13). The global economic and political conditions had influence on the extent of climate change and sea level rise, Asian economic growth, development and population trends in PNG. Torres Strait culture influenced the regional and local social and institutional conditions, including the strength of Ailan Kastom, resource control and management, leadership, political support and funding, and population migration.

These axes created a matrix of four future scenarios for livelihoods, which combined better or worse levels of the drivers. Workshop participants were divided into four working groups, one for each scenario. They developed a narrative of Torres Strait livelihoods in 2100 for their scenario, drew a picture, and identified any potential thresholds of change and the likely year that these would be encountered. After the workshop, standardized diagrams were created to reflect the key narratives from each scenario (Figs. 14 – 17). Fig. 18 shows the final matrix of scenarios relative to the drivers of change.

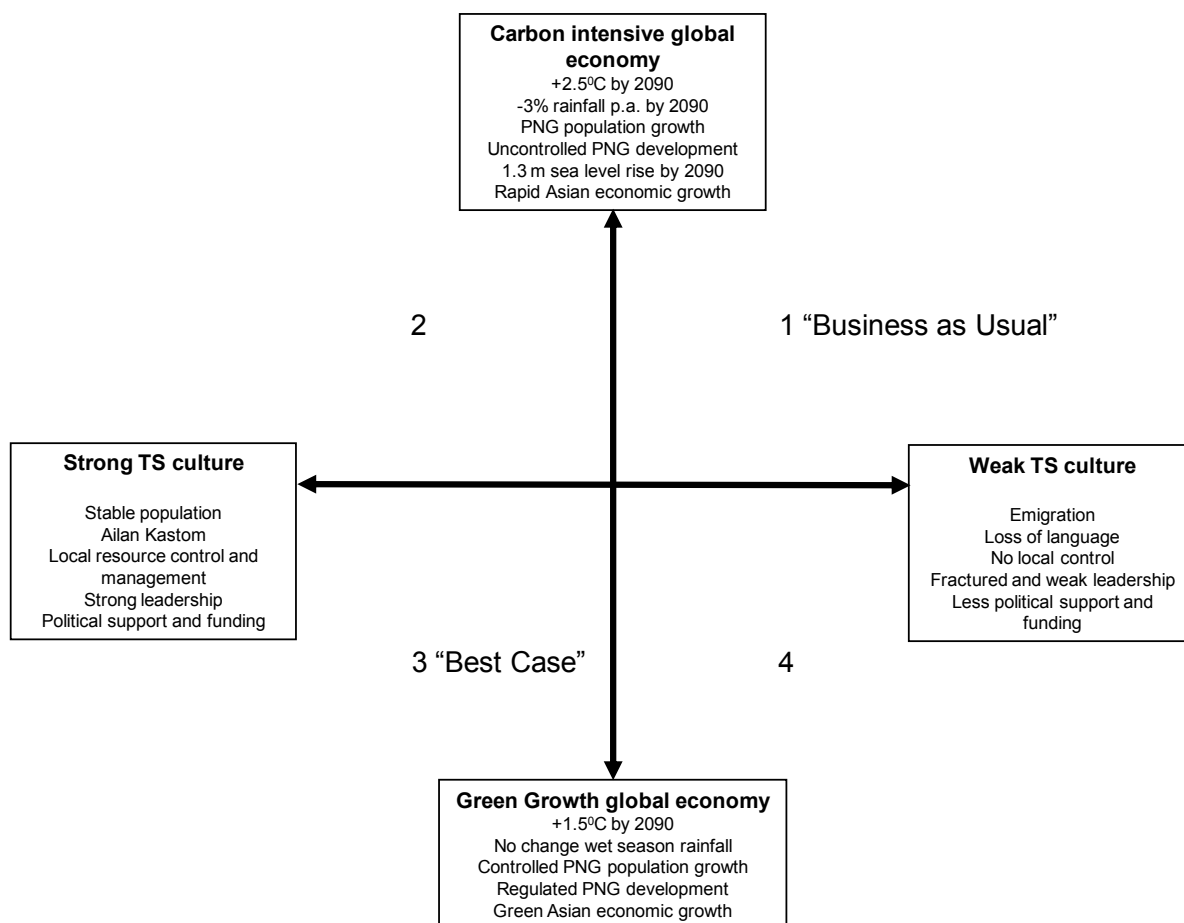
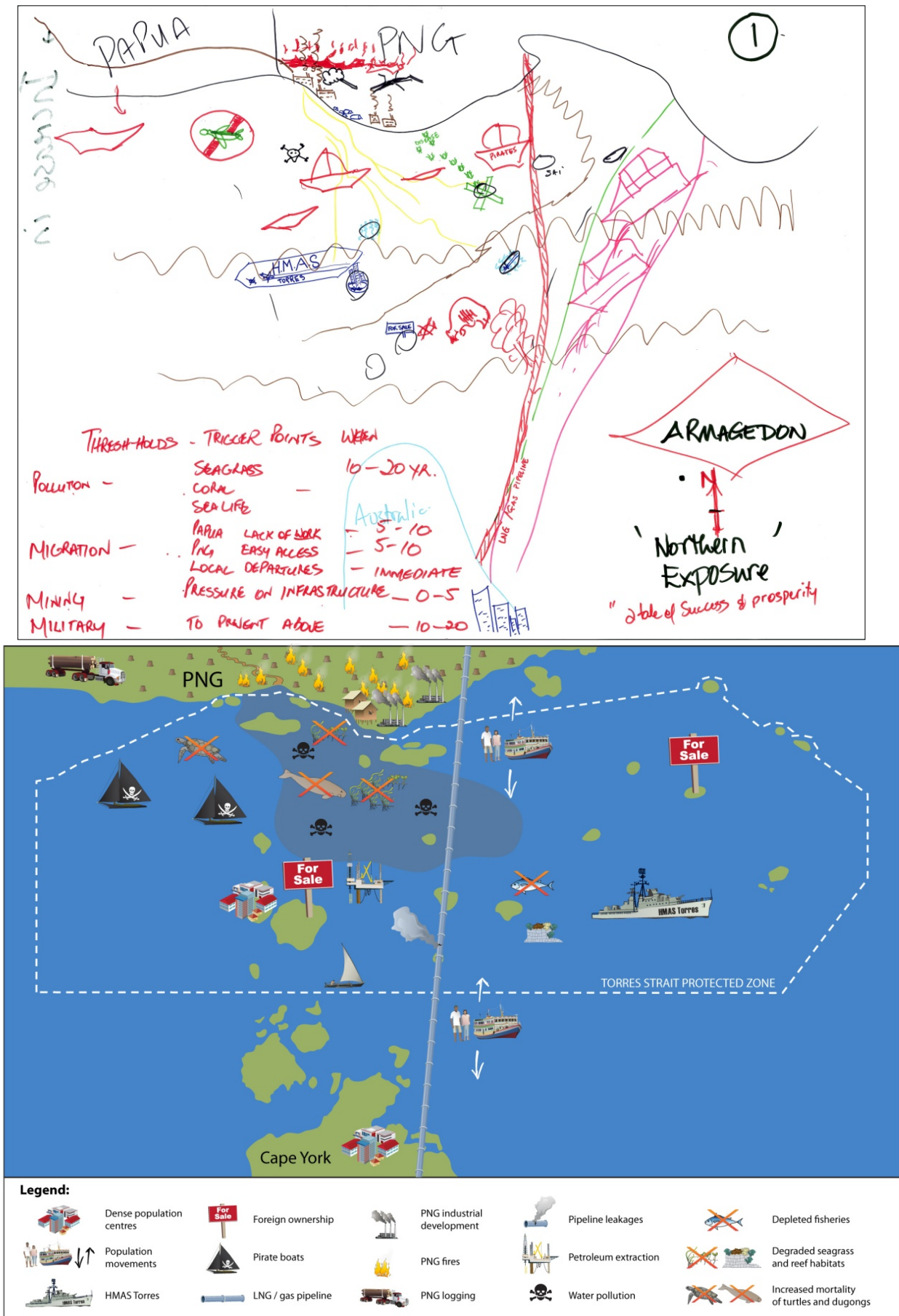


Figure 13. The matrix of four future Torres Strait scenarios created by combining better or worse levels of the two most important driver themes, politics and economics and institutional and social



Workshop participants drawing a scenario picture and creating a narrative

Figure 14. Scenario 1, Northern Exposure (Business as Usual)



Narrative for Scenario 1, Northern Exposure (Business as Usual)

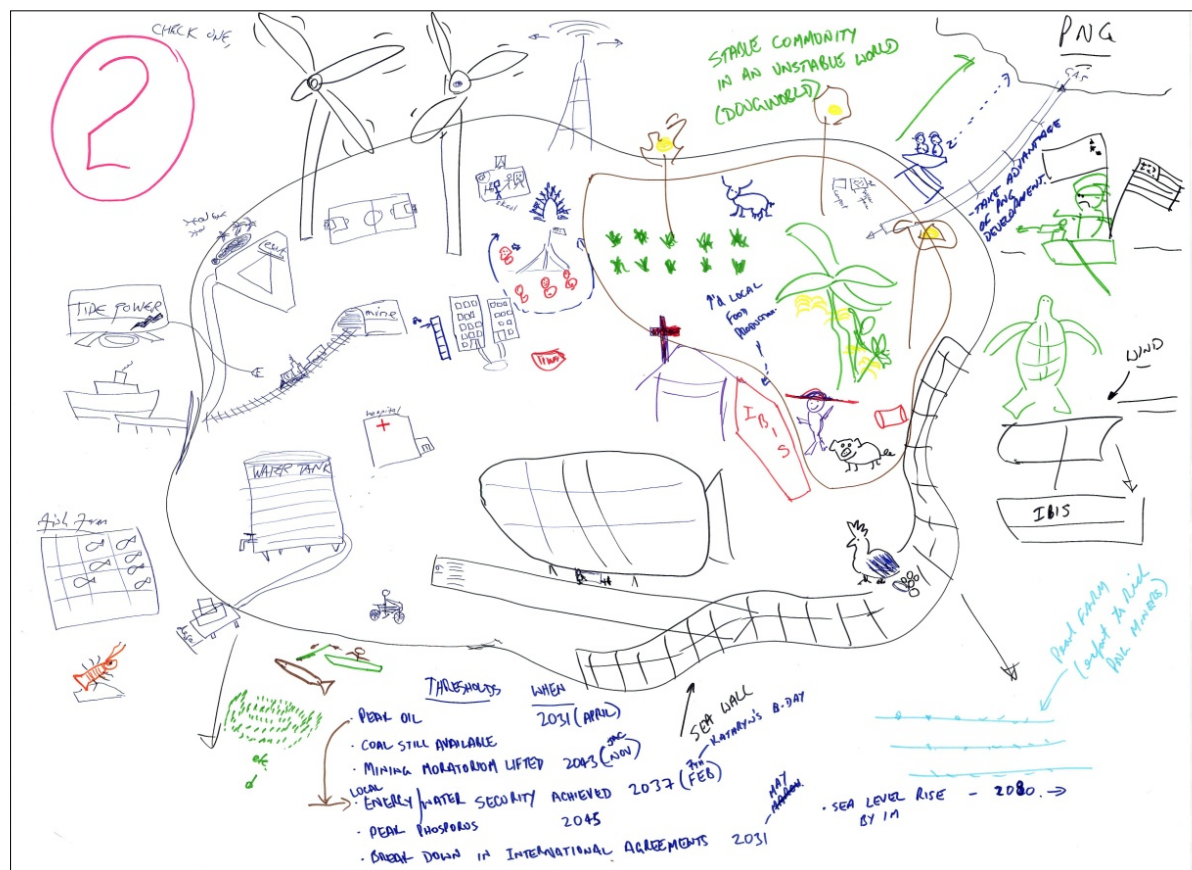
"We considered Northern Exposure to be a tale of success and prosperity: absolutely everything goes, we'd eventually have, PNG's got burning off all its forests and logging everything else, unchecked mining, the flow on of that obviously is potential pollutants into the TS: air-borne pollution, water-borne pollution, roads from Papua into PNG which make another route for uncontrolled immigration. Actually much closer, as someone suggested they can utilise it as a means of income; where we could simply put people in boats and take them to Australia, it would be a much shorter trip. So as a result of that we've got uncontrolled piracy and immigration. We would see increased shipping lanes, container ships would be able to come through unchecked. Gas pipeline coming straight out of PNG and into Cairns; this high rise here is Cairns, that's where all the multi-millionaires from PNG are staying because it's a nice place to live. We have the world's first skinny dugong because there's no more seagrass because of the temperature change; there's no turtles. We have people leaving the islands because they can no longer stay there so they're up for sale, they're not to be used. And the only real major development within the TS is that it's now one of the major strategic navy bases or defence bases as a result of access so close to a rather over-developing northern and north-western neighbour.

The thresholds/trigger points we looked at: obviously they went out the window fairly quickly. Pollution, which would trigger destruction of seagrass, coral and any sea life – we saw probably within 20 years; without the mines, probably 5 years to really get up to speed and start to crank out things before things went horribly wrong. Migration particularly from Papua due to lack of work, and PNG due to ease of access. And local departures was almost immediate, the others maybe 5-10 years. And the pressure on infrastructure would be almost immediate as people started to move out of PNG and look for places. And also the mining areas. The military was probably the trigger for all of the above. We'd like to think that the military would react fairly quickly but we thought they would be 20 years, so probably after everything had bolted before they started doing something. There you go - Armageddon."

Summary of thresholds

1. Mining moratorium lifted in Torres Strait by 2018, placing increased pressure on infrastructure
2. Critical immigration from Papua Province (Indonesia) and Western Province (PNG) by 2022, and immediate emigration of Islanders
3. Pollution peak from PNG by 2032, resulting in die-off of seagrass, coral and related marine species (e.g. turtle and dugong)
4. Increased Australian military presence in 2032 to manage above

Figure 15. Scenario 2, *Doug's World*



Narrative for Scenario 2, *Doug's World*

"Our scenario was about pretty much an unstable world, one focused on rapid growth, resource intensive theories etc., but a focus on maintaining a strong culture and having strong local solutions. So with that, we recognised there was some good and bad. There would be opportunities to take advantage of some of the developments particularly in PNG. We spent a fair bit of time speaking about the peak oil scenario, and so you'd still want to maintain connections with the outside world but some of those connections wouldn't be based on the same arrangements that we have nowadays. For example, we made provision for movements through things like wind power. So we could still rely on a certain amount of food being brought in and other resources being brought in but not in the traditional ways that we've come to know. So air transport, via things like airships and wind power for vessels. There would be some advantages to take in terms of technology and other developments through PNG. So we'd get some energy such as gas and things of that nature. We believe that because you probably wouldn't be able to rely on efficient transport to the extent you can nowadays the islands would have to raise its level of self-sufficiency around food production in particular so we made a fair bit of provision for some local-based agriculture and people feeding themselves. Also use of alternative technologies such as wind power and water, tidal power. We thought in a world characterised by continual resource movements that we'd have an expectation that any moratoriums on exploitation in TS would be lifted fairly soon but the management of those exploitations would come from locally managed arrangements. So we had things like protection of our seagrass. Local lobster production and culture - we have a lobster there. Maybe pearl farming, try to tap into increasing affluence of our neighbours. But probably a recognition as well that in a world where we're trying to retain activities and resources of high cultural value that you would probably need to have a higher level of physical security than we do at the moment. We had the US, China, maybe with some local authorities, helping to protect those resources that we see continuing to be of high value to us, recognising that the threat would be higher than it is at the moment. Still a bit of tourism, some snorkelling. You'd have to come in by your airship of course. Probably high density, high intensity living quarters. And recognition that we would not expect a reduction in populations but maintenance of current levels but we would need to make provision for these extra activities taking place on the islands.

Thresholds: things we mainly took into account were Peak Oil - it's local government, it's run by the TS Islanders. Things like sea level rise, they're coming, so we need to make provision for that through sea walls and other infrastructure. We would have an expectation that probably linked pretty closely to Peak Oil you could expect breakdowns in international agreements that are currently providing protections, that you'd need to have your higher level of physical security offsetting. But a recognition that there is probably an achievement of local energy, water and even food security that would be pretty high priorities that would be linked to the cultural values that are not too much different from what they are at the moment. IBIS is still well and alive, but probably using different strategies to supply parts of the islands and tap into local food production. Maintenance of traditional culture as well. We tried to integrate a number of activities that have current high value to retain that. Education, got schools there, internet going on, access to telecommunications and the outside world. Local institutions, hospitals, schools, parliaments and governments. Natural resources still a high value and a focus on traditional food crops. Sustainable transport – bicycles."

Summary of thresholds

1. Peak oil reached by 2031, resulting in local energy and water self-security by 2037
2. Mining moratorium in Torres Strait lifted by 2043, resulting in mining on islands
3. Break down of international agreements by 2031, resulting in increased immigration from PNG and US-Chinese involvement in resource protection

Figure 16. Scenario 3, Hope Island (Best Case)

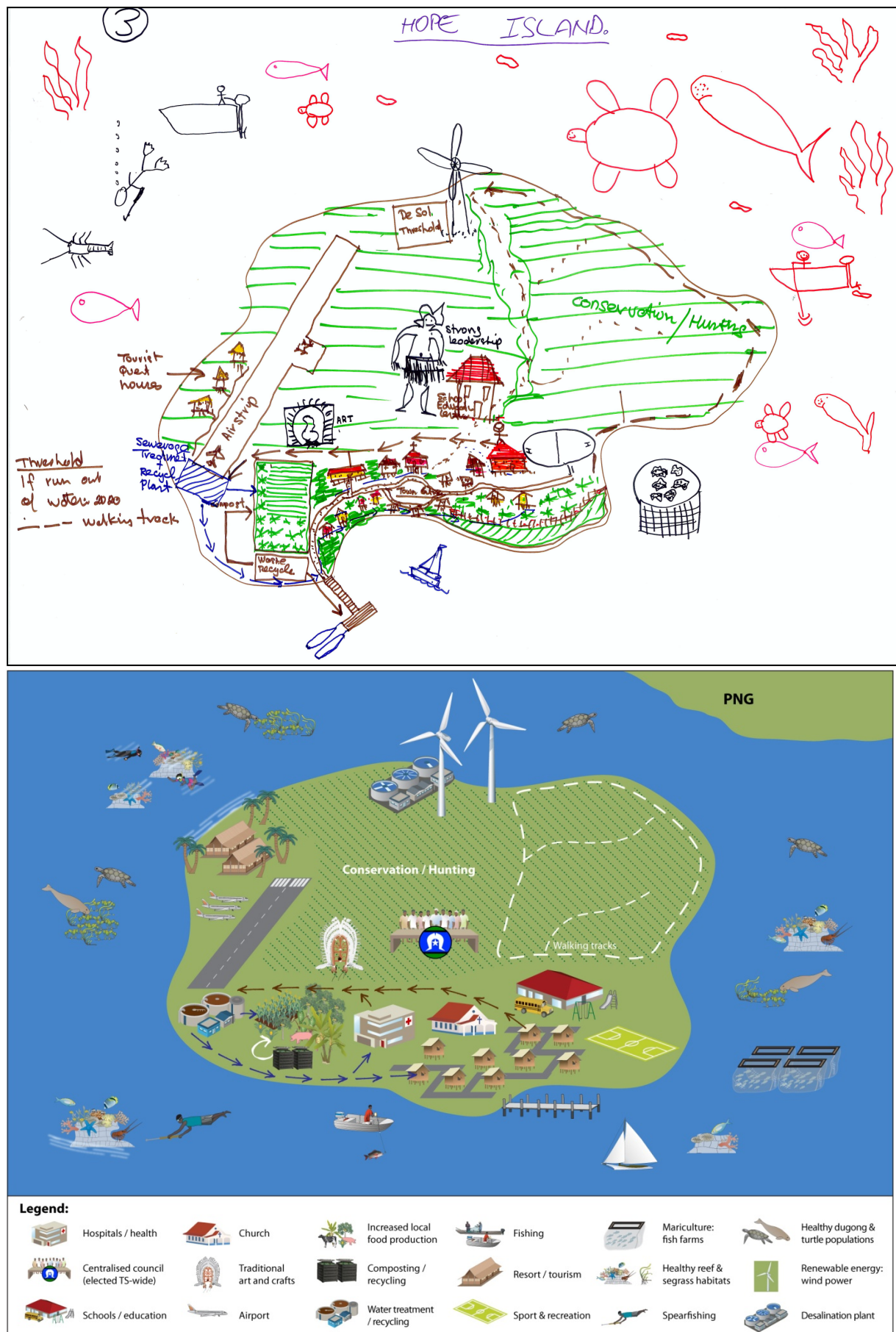
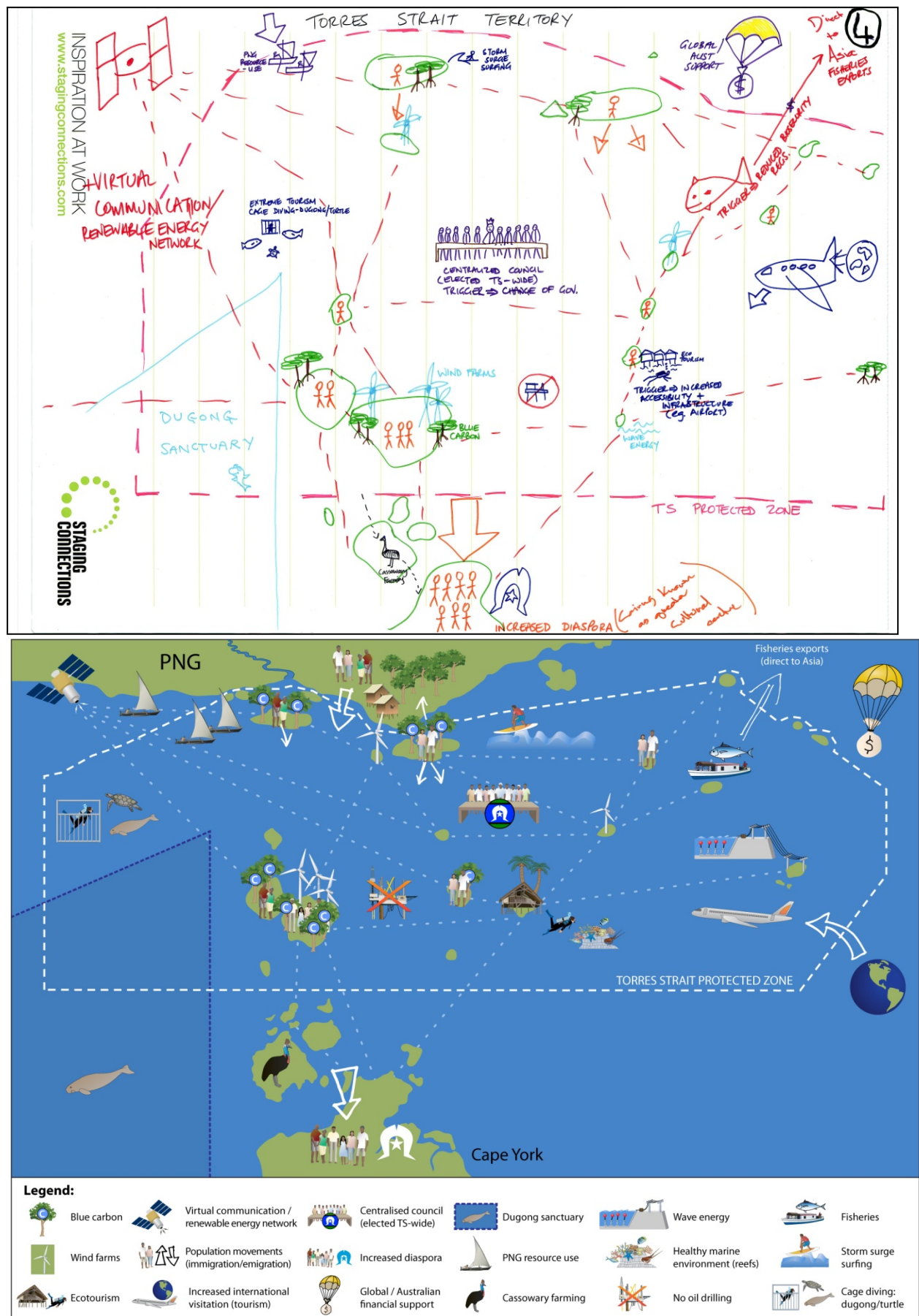


Figure 17. Scenario 4, *Torres Strait Territory*



Narrative for Scenario 4, Torres Strait Territory

"With immigration, people are leaving the Straits and taking their culture with them so there was this loss of culture and this community de-stabilisation. So because of that we felt we were likely to get a centralised council that was elected TS-wide and had a lot of autonomy. Because of the strength of the global economy and global world, we looked a lot to what that would mean for the region so we had lots of virtual communications within the region and also inside the region. Renewable energy again networked within the region. Money coming in, parachuting in from global and Australian interests outside of the region. Increasing exports direct to Asia, coming out of demand from new people. Fisheries exports and that's because if that was reduced by security regulations to make it possible to capitalise on this global environment that was improving but the local one that perhaps was a bit de-stabilised.

So we started thinking about how can we take advantage of external production, external positive influences. So we thought about improving infrastructure, more planes coming in from overseas and other parts of Australia. Ecotourism and extreme tourism: cage diving with dugongs and turtles, storm surge surfing – making the most of it. We started talking about cassowary breeding programs in the quarantine zone. Farming cassowaries to repatriate back to Australia where they're endangered. We felt there would be reasonable continued protection of marine resources. Dugong sanctuaries still there maybe a bit bigger, still have access to fisheries resources, but PNG is an ongoing pressure on those fisheries resources. More blue carbon and green carbon sinks around so maybe some sort of mangrove planting or other carbon sinks. Renewable and solar power networks throughout the region. So it was all about connectivity. Making the most of any external positive processes, locally trying to centralise and account for loss of culture and people to outside the region.

Thresholds: Centralised Torres Strait council. Trigger was loss of culture and change of federal government. The trigger for direct export of fisheries to Asia was reduced biosecurity regulations. Because the region destabilises and wanting to help the region as local population declines. The trigger for tourism was this external affluence, increasing global economy."

Summary of thresholds

1. Centralised TS council by 2020, triggered by the loss of culture and change of governments
2. Increased ecotourism due to establishment of improved transport infrastructure (e.g. airports) and external affluence by 2040
3. Direct export of fish to Asia due to reduced bio-security regulations by 2050

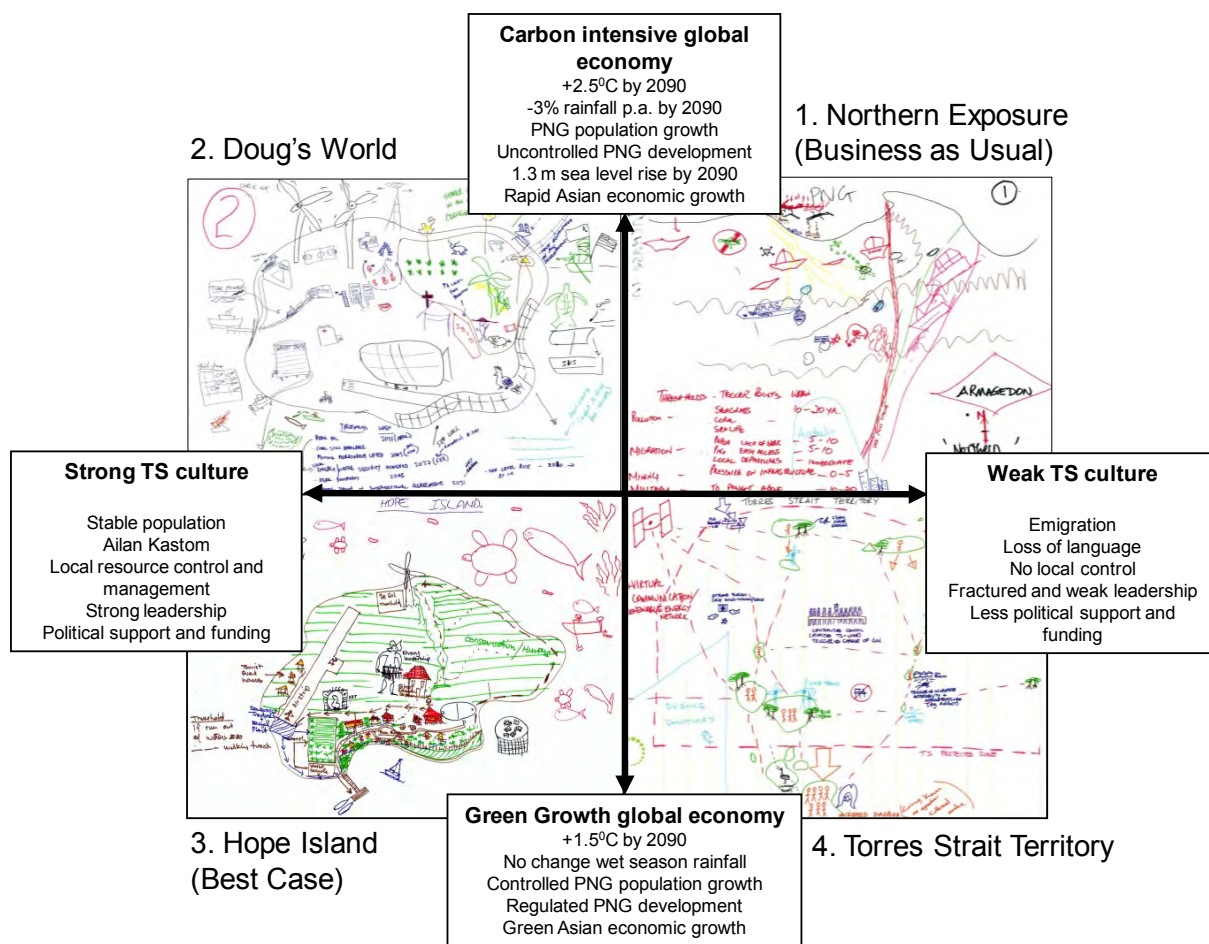
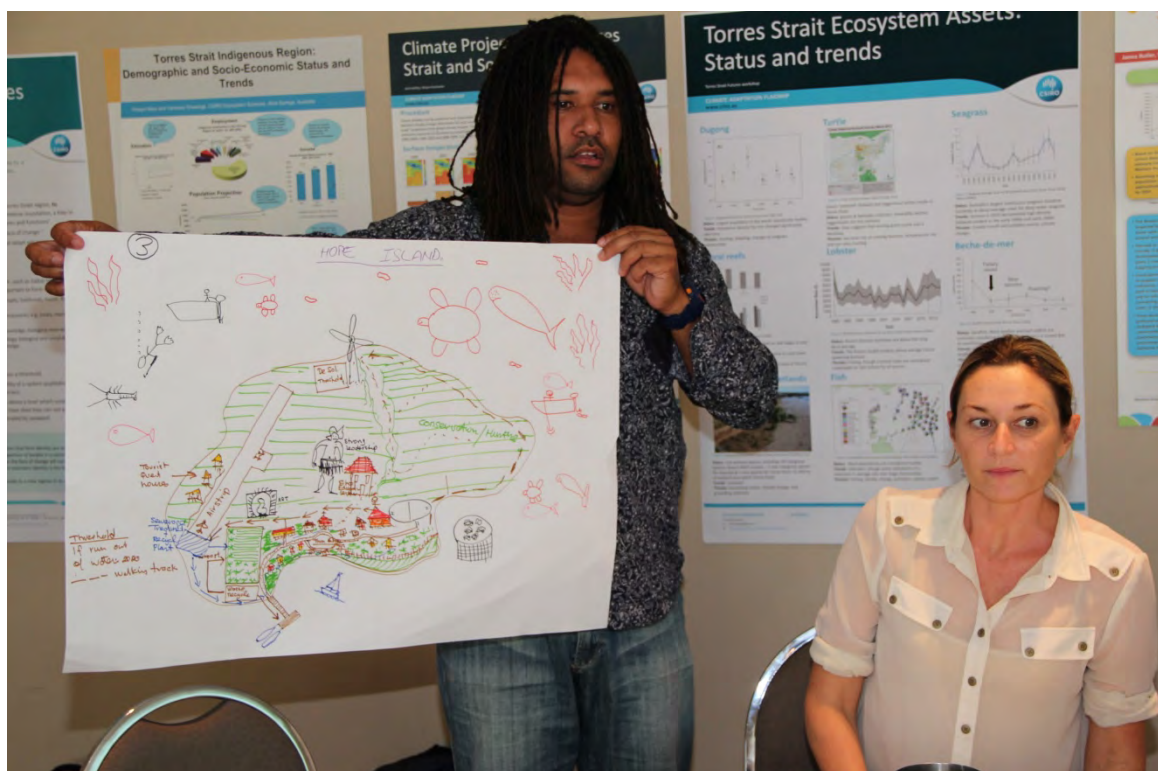


Figure 18. The four final scenarios within the matrix of drivers for the Torres Strait



Workshop participants presenting the narrative for the Best Case *Hope Island* scenario

4.3 Session 3: What impact will the Business as Usual future have on human well-being?

This session explored the potential impacts of the Business as Usual *Northern Exposure* scenario on the natural resource base supporting communities' livelihoods. This was feasible using two sources of quantitative data. First, the extreme climate change predicted by the Business as Usual scenario had been modeled using CCAM, which is based on the high IPCC A2 global emissions projections. Second, population projections were available for the Torres Strait region, which assumes continuing net growth, and thus mirrors the Business as Usual scenario. Although the scenario considers that there will be emigration of Torres Strait Islanders, their numbers will be compensated for and exceeded by immigration from PNG and Indonesia. Impacts were only investigated for 2030 because climate and human population projections are likely to be more realistic in the short term, and any human responses are less likely to have taken effect.

The potential impacts on human well-being were examined using the semi-quantitative ADWIM (Asset-Drivers-Well-being-Interaction-Model; Fig. 19). First, a preliminary list of the ecosystem goods and services (EGS) that support livelihoods in each Torres Strait community was made by TSRA collaborators. During the workshop participants refined the list and estimated the 'production' (i.e. the relative volume produced or exploited) of each EGS for each island, scored from 0-5. They also ranked the relative value (0-5) of each EGS in terms of four indicators of well-being: income, food security, health and culture. Combining this with the 'production' information gave the relative importance of each EGS to human well-being for all 14 communities in the TSPZ (Fig. 20), and each community individually. By applying the downscaled climate and human population growth projections for 2030 for each island (Table 6) the resulting impacts on ecosystem assets, EGS and well-being were estimated for each.

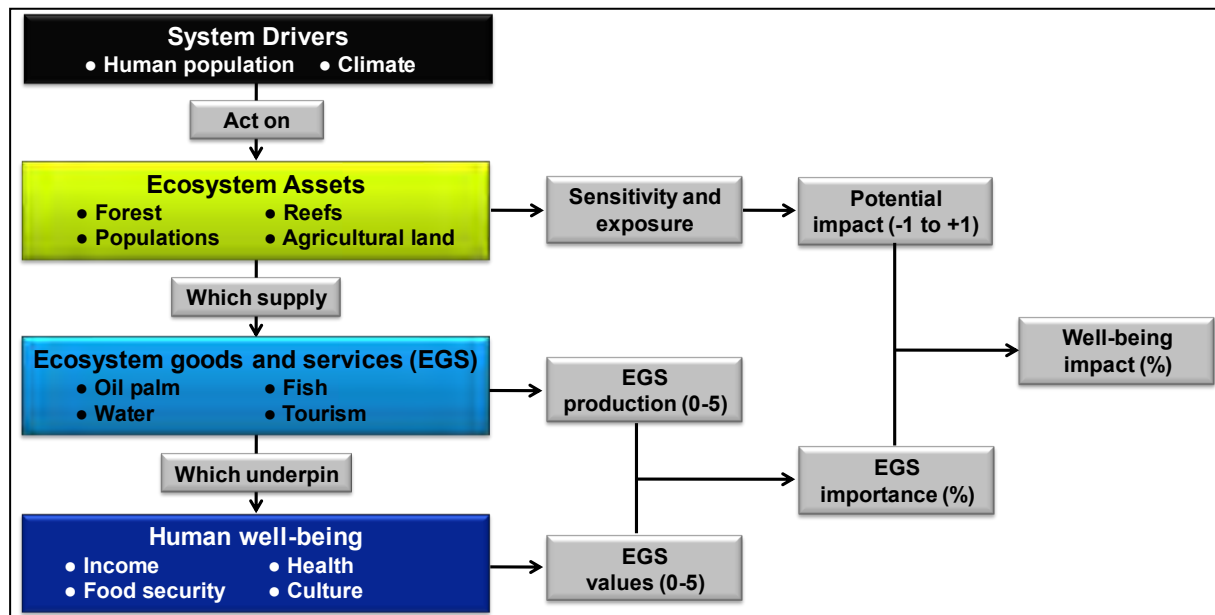


Figure 19. The ADWIM model (see Skewes et al. 2011, 2012) used to estimate the importance of EGS, and the impact on human well-being from the Business as Usual *Northern Exposure* scenario

Results showed that overall impacts on well-being in 2030 were negative for all island communities, and these increased with time (Table 7). In 2030 the most impacted were the northern islands of Dauan (-14.3%), Saibai (-13.7%) and Boigu (-13.6%). For all communities the primary impact on well-being was from human resource use linked to population growth (Fig. 21). Climate drivers were of moderate impact, with sea level rise and increasing ocean acidification having the greatest effect,

plus increased rainfall in the northern islands of Dauan, Saibai and Boigu. Unlike population growth, these climate effects were partially offset by the positive impact of temperature increases on primary productivity. Full lists of EGS, their importance and specific impacts for each island community are shown in Session 6 and Appendix II.

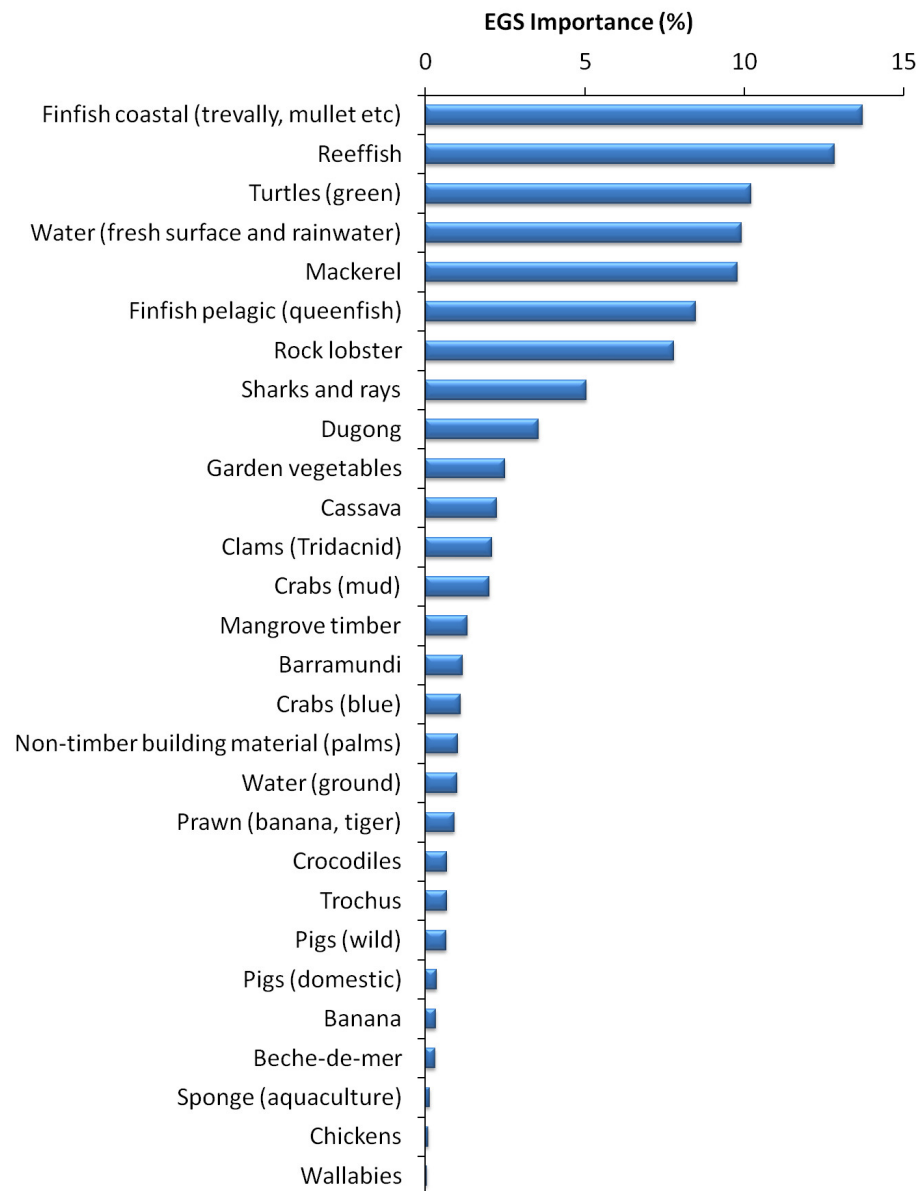


Figure 20. The list of 28 ecosystem goods and services (EGS) identified for all 14 Torres Strait communities in the TSPZ, and their relative importance

Table 6. Projected changes in climate and human population under the Business as Usual *Northern Exposure* scenario for each Torres Strait island, which were applied in ADWIM.

Drivers and threats	Year	Badu	Boigu	Dauan	Erub	Yam	Kubin	Mabuiag	Masig	Mer	Poruma	Saibai	St Paul	Ugar	Warraber
Change in average annual rainfall (%)	2030	1.1	2.8	3.2	2.7	2.4	1.1	1.7	2.5	1.6	2.3	3.3	1.2	3.2	1.5
	2055	2.1	5.3	6.2	5.1	4.6	2.1	3.2	4.8	3.1	4.3	6.3	2.3	6.1	2.9
	2090	-7.0	1.0	1.1	0.2	-3.0	-7.0	-5.8	-1.1	-1.6	-2.4	1.5	-6.5	1.4	-4.2
Air temperature change (deg C)	2030	0.6	0.5	0.5	0.5	0.5	0.6	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
	2055	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
	2090	2.3	2.6	2.4	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.4	2.3	2.3	2.3
Population (persons) [note 1]	2010	915	284	164	365	340	228	276	330	545	194	394	266	85	288
	2030	1104	343	198	440	410	275	333	398	658	234	475	321	103	347
	2055	1282	398	230	511	476	319	387	462	764	272	552	373	119	404
	2100	1489	462	267	594	553	371	449	537	887	316	641	433	138	469
Density, land (people per km ²)	2000	9.0	3.9	44.1	61.1	197.0	1.3	43.2	203.6	127.2	521.8	3.8	1.6	229.3	389.7
	2030	10.9	4.7	53.2	73.7	237.7	1.6	52.2	245.6	153.4	629.5	4.6	1.9	276.6	470.1
	2055	12.6	5.5	61.8	85.6	276.1	1.9	60.6	285.2	178.2	731.1	5.4	2.2	321.3	546.0
	2100	14.7	6.4	71.7	99.5	320.6	2.2	70.4	331.2	206.9	849.1	6.2	2.5	373.1	634.1
Density, sea (people per km ²) [note 2]	2000	0.40	0.18	0.08	0.14	0.13	0.10	0.11	0.12	0.21	0.07	0.21	0.11	0.03	0.11
	2030	0.48	0.22	0.09	0.17	0.15	0.12	0.14	0.15	0.26	0.09	0.25	0.14	0.04	0.13
	2055	0.55	0.25	0.11	0.20	0.18	0.14	0.16	0.17	0.30	0.10	0.29	0.16	0.04	0.15
	2100	0.64	0.29	0.13	0.23	0.21	0.16	0.19	0.20	0.35	0.12	0.34	0.18	0.05	0.17
Density, reef (people per km ²) [note 3]	2000	4.1	342.7	9.7	1.4	2.4	1.0	1.7	2.4	1.9	1.0	26.9	1.1	0.6	3.5
	2030	5.0	413.5	11.7	1.7	2.9	1.2	2.0	2.9	2.3	1.3	32.4	1.3	0.8	4.2
	2055	5.8	480.2	13.6	2.0	3.4	1.4	2.3	3.4	2.7	1.5	37.7	1.5	0.9	4.9
	2100	6.7	557.7	15.8	2.3	4.0	1.6	2.7	4.0	3.1	1.7	43.7	1.8	1.1	5.7

Notes:

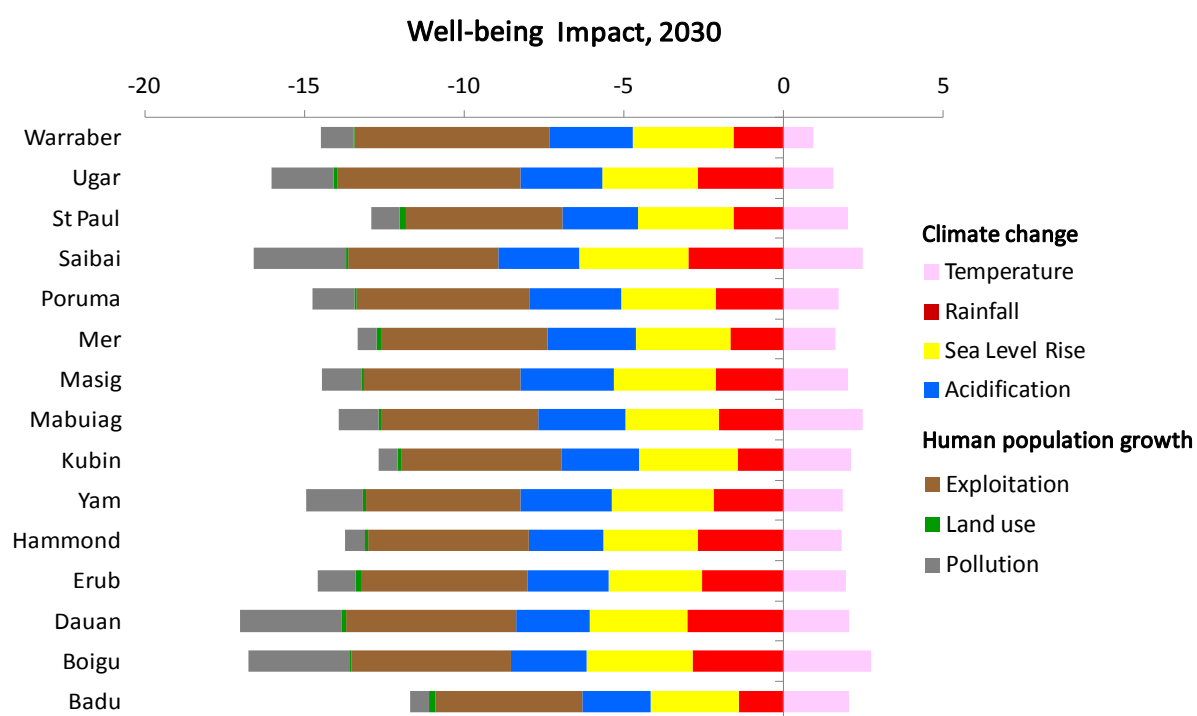
1. Population growth was assumed to be 0.99% p.a. until 2030, and then 0.5% p.a. after 2030, based on Queensland Government projections. While there has been variation in population growth amongst the islands since 2000 (e.g. from -1.89% p.a. for Yorke Island to +3.37 % p.a. for Saibai Island), it was assumed that all the islands will experience the same population growth rate over the next 100 years. (Source: Queensland Government Population Projections, 2011 edition, and QRSIS database maintained by the Office of Economic and Statistical Research).
2. Density of people per km² of sea was calculated from an assumed marine area of 30 km radius around each island.
3. Density of people per km² of reef was calculated from the area of reef within each islands marine area.

In ADWIM, sea level rise was factored (relative to 2000) for all islands to be 0.24 m by 2030, 0.49 m by 2060 and 1.00 m by 2100 (Source: John Rainbird, TSRA). This was used to assess exposure for the marine and coastal EGS. However, data to analyse the percentage inundation of each island's land mass, and hence relative impacts on terrestrial EGS, was not available.

In ADWIM, ocean acidification was factored as a change in the aragonite saturation coefficient (relative to 2000) of -0.31 by 2030, -0.71 by 2060, and -1.31 by 2100. This was applied to all islands (Source: Pacific Climate Change Science Program, 2011).

Table 7. Estimated relative impact on human well-being for each island community in 2030 under the Business as Usual *Northern Exposure* future scenario

Community	Well-being Impact 2030	Well-being Impact 2060	Well-being Impact 2100
Badu	-9.6	-27.2	-66.1
Kubin	-9.8	-30.0	-72.5
St Paul	-10.2	-30.1	-71.2
Mabuiag	-10.8	-31.7	-72.6
Mer	-11.2	-31.5	-63.9
Hammond	-11.3	-32.6	-75.3
Warraber	-11.8	-33.4	-72.2
Masig	-11.8	-33.3	-66.5
Erub	-12.0	-32.5	-61.6
Poruma	-12.2	-34.0	-69.3
Yam	-12.4	-34.2	-70.3
Ugar	-13.5	-35.9	-68.4
Boigu	-13.6	-36.4	-71.4
Saibai	-13.7	-36.0	-69.6
Dauan	-14.3	-36.9	-69.5

**Figure 21.** The relative contributions of population and climate change-derived impacts on human well-being for each island community in 2030 under the Business as Usual *Northern Exposure* scenario

4.4 Session 4: What is the adaptive capacity of Torres Strait communities today?

This session began with a description of the concept of livelihood capitals, based on the Sustainable Livelihoods Framework (Chambers and Conway 1992), which can be used to measure adaptive capacity (e.g. Brown et al. 2010, McNamara et al. 2011):

- Natural capital (e.g. land, fresh water, forests, biodiversity)
- Human capital (e.g. education, health, skills, traditional knowledge)
- Physical capital (e.g. roads, electricity, irrigation systems)
- Financial capital (e.g. money, savings, loans)
- Political capital (e.g. political power, religious power)
- Social capital (e.g. leadership, social networks, institutions)

In addition, enabling agencies and institutions are necessary to mobilise the capitals, and hence these were also considered. Participants were asked to identify indicators for each capital that were important for adaptive capacity in the Torres Strait, and presented 48; a further eight indicators of enabling agencies were identified (Table 8). The most frequently mentioned word was 'ability', followed by 'access', 'change', 'community', 'employment', 'government', 'healthy', 'integrated', 'knowledge', 'marine', 'planning', 'sea' and 'traditional' (Fig. 22). Many of these key words occurred in indicators of adaptive capacity from several capitals.

Following this, participants were asked to discuss the adaptive capacity of each community in terms of the capitals and indicators. Notes were taken of the discussion on a laptop and projected on to a screen. All communities had great strengths based on various indicators of capital, plus some weaknesses (Table 9). These tended to be due their low-lying geography and hence risk of inundation from sea level rise (e.g. Boigu, Saibai, Warraber, Masig), or limited physical capital due to infrastructural issues (e.g. no airstrip on Dauan, poor mobile phone connectivity on Warraber, poor water supplies on Yam). The northern islands of Saibai and Dauan appear to be under greatest pressure from the use of infrastructure by PNG immigrants, due to their very close proximity to the PNG mainland.

Table 8. Indicators of adaptive capacity and enabling agencies and institutions identified by workshop participants for Torres Strait communities

Capital	Indicator
Human	Situational awareness (knowledge and understanding)
	Education and skilled workforce (versatile)
	Education and skills
	Expertise
	Ability to relocate in response to change
	Christianity and belief which shapes their aspirations
	Skills to engage in informal and formal employment (e.g. fishing)
	Diversity of livelihoods
	Traditional ecological knowledge
	Strongly integrated traditional and scientific knowledge
Social	Faith (belief in the need to change)
	Leadership
	Sense of ownership of land and sea tenure
	Ability to re-organise
	Strong communication networks
	Strong sense of culture
	Ability to be able to accept impacts of climate change
	Connection to land (rights to inhabit)
	Ailan Kastom
	Communication amongst key stakeholders
Physical	Sustainable power supply
	Basic health services
	Better infrastructure
	Infrastructure (roads, IBIS, airports, health, water, electricity)
	Services availability
	All weather transport access to islands
Natural	Access to food, freshwater, fuel and power
	Healthy and manageable ecosystems
	Local food security and delivery
	Commercial fisheries as formal employment
	Diversity of physical characters of islands
	Finfish and marine resources
	Healthy marine ecosystems
	Healthy sea country and underutilised fisheries
	Sea sponges as potential marine industry
	Water availability
Financial	A range of income opportunities
	Security of investments
	Commercial enterprises (e.g. tourism)
	Access to credit and loan facilities
	Employment opportunities
	Ability to move because not financially tied
	Money
Political	External non-government funding sources
	Government which is representative of the community
	Community consultation
	Legitimate representation of communities at other scales
Enabling agencies and institutions	Leadership from PBCs, government and traditional owners
	Appropriate collaboration, cooperation, coordination between institutions and communities
	Ability to act on decisions
	Planning and pre-planning
	Cooperation between decision-makers
	Integrated governance arrangements
	Incorporation of community organisations (e.g. PBCs)
	Private investors
	Integrated planning



Figure 22. Word cloud of terms indicating adaptive capacity of Torres Strait communities. The larger the word, the more frequently it was recorded by participants

4.5 Session 5: Which are the most vulnerable communities and livelihoods in the Torres Strait?

In this session the results of the overall potential impacts in 2030 of the Business as Usual *Northern Exposure* scenario on human well-being for each island community was combined with the assessments of their adaptive capacity. Based on this discussion, participants chose to focus on three islands: Saibai, Masig and Dauan. Masig was predicted to have relatively lower impacts on EGS and human well-being from climate change and population drivers (Fig. 21), but is at high risk of inundation and has limited natural water supplies (Table 9). EGS and well-being on Dauan and Saibai are predicted to be highly negatively impacted (Fig. 21), and experience greater influence from PNG immigrants, while Dauan also has limited transport infrastructure (Table 9).



Workshop participants designing adaptation strategies

Table 9. Participants' assessments of the adaptive capacity of Torres Strait communities. The focus islands of Saibai, Masig and Dauan are highlighted.

Community	Adaptive capacity: strengths	Adaptive capacity: weaknesses
Boigu	<p><u>Political capital</u>: Strong leaders with good political capital. TSRA and TSIRC representatives are different people, which is a strength.</p> <p><u>Natural capital</u>: Some fisheries (e.g. mud crab) with high market potential.</p> <p><u>Human and social capital</u>: Strong culture - language and customs retained. Shared language with Dauan and Saibai.</p>	<p><u>Natural capital</u>: No high land - one of the islands most likely to be affected by inundation from sea level rise.</p> <p><u>Human and political capital</u>: Low levels in some aspects (e.g. massive investment in hydroponics, but it is unserviceable because there is nobody to work on it, lack of training).</p>
Dauan	<p><u>Natural capital</u>: High ground, less inundation.</p> <p><u>Physical capital</u>: Brand new IBIS store, with a capacity to serve 300+.</p> <p><u>Human and social capital</u>: Good leadership and higher accountability with representative from the TSRA and TSIRC.</p> <p><u>Adaptability</u> - very connected to Saibai, inter-related families. Shared language with Boigu and Saibai.</p>	<p><u>Physical capital</u>: No airstrip, so supplies have to be barged in from Saibai. Need better heliport, not able to accommodate fixed wing aircraft.</p> <p><u>Social capital</u>: Increasing gap in standard of living with neighbouring PNG Treaty Village communities, resulting in tensions. PNG people buying food from IBIS stores.</p>
Saibai	<p><u>Physical capital</u>: Health clinic. New IBIS store. Has a good, long runway.</p> <p><u>Political capital</u>: A lot of traditional families, strong politically, with a big influence on Thursday Island, well connected.</p> <p><u>Human and social capital</u>: Shared language with Boigu and Dauan. Strong community organisation: community-owned business and other enterprises. Well-connected to other islands and Northern Peninsula Area, Cape York.</p> <p><u>Natural capital</u>: Deer, potential for mud crab and some finfish fisheries. High relative adaptive capacity compared to other islands.</p>	<p><u>Physical capital</u>: PNG communities place massive pressure on health services.</p> <p><u>Social capital</u>: Very close to some PNG Treaty Villages, resulting in tensions.</p> <p><u>Natural capital</u>: No high land - one of the islands most likely to be affected by inundation from sea level rise.</p>
Mabuaig	<p><u>Natural capital</u>: High island which limits inundation risk. Limited natural water supply but has a dam. Access to reefs. Excellent lobster fisheries.</p> <p><u>Human and social capital</u>: Culturally strong. Expert dugong hunters. More accessible to big islands. Close relations with Badu.</p> <p><u>Political capital</u>: Good leadership, very respected elder. First community to have a Land and Sea Ranger Program.</p> <p><u>Physical capital</u>: Hotel/guesthouse owned by TSIRC. Mobile desalination plant.</p>	<p><u>Physical capital</u>: Short runway, and limited options for expansion. Problem with natural water supply in the past, had to barge water in.</p>
Badu	<p><u>Social and human capital</u>: Close connection to Mabuiag. Sense of pride from historical reputation for being entrepreneurial, due to a powerful family that were skippers on a pearling fleet. Human resources, schools, many locals got educated there then get jobs on the mainland – able to bargain and establish commercial enterprises. Land and Sea Ranger station. Local lobster buyers. Well organised and connected. Large (1,100-1,200) population. Art gallery, many local artists who are internationally renowned.</p> <p><u>Natural capital</u>: Good estuary. Quarry.</p> <p><u>Physical capital</u>: Ranger station. Well-established hotel, two retail outlets and takeaway.</p>	<p><u>Physical capital</u>: Lacking a good airstrip and frequent flights – could be much bigger.</p>
Kubin	<p><u>Social capital</u>: Separate council and native title from St. Paul, giving its own representation. Well-connected to Badu.</p> <p><u>Physical capital</u>: Capacity for water storage, dam in centre of island.</p> <p><u>Natural capital</u>: Largest freshwater creek system in TS, potential for crocodile farming. Community is higher set, less vulnerable to inundation than St. Paul. Potential for tidal power potential. Access to good reefs – lobster, dugong and turtle.</p>	<p><u>Political capital</u>: Not as well-connected as Badu.</p> <p><u>Social capital</u>: Do not share same dialect as Badu.</p> <p><u>Physical capital</u>: No fishery processing facility.</p>
Warraber	<p><u>Natural capital</u>: Aesthetic coral island, with tourism value. Good fisheries, turtles, reef fish, crayfish, but not much dugong. Many small islands around Warraber – uninhabited, could be useful.</p> <p><u>Physical capital</u>: Tourist hotel and resort. Has good airstrip, but somewhat isolated. Desalination plant. Health centre. Big waste management plant provided by government.</p> <p><u>Social capital</u>: Strong - set up a fisheries corporation.</p> <p>Warraber and Poruma have inter-related families.</p> <p><u>Human capital</u>: Culturally strong – some language loss but bringing it back.</p> <p><u>Financial capital</u>: Income from tourism. Shipping piloting based there – employment opportunities.</p>	<p><u>Natural capital</u>: Low island vulnerable to inundation.</p> <p><u>Physical capital</u>: Lack of real estate, communities can't go anywhere. High housing densities. Bad mobile communication. Lack of accommodation for service providers, hindering development.</p>

Table 9 continued. Participants' assessments of the adaptive capacity of Torres Strait communities.

Community	Adaptive capacity: strengths	Adaptive capacity: weaknesses
Poruma	<p><u>Financial capital</u>: Shipping piloting opportunities. Income from tourism. Work-experience agreements through CDEP. Employment on boats.</p> <p><u>Social and human capital</u>: Rebuilt an organisation for arts, dancing. Entrepreneurial. Leadership based in Cairns, community leaders are mentored.</p> <p><u>Natural capital</u>: Strong geographical features, attractiveness, iconic. Good lobster fishery.</p> <p><u>Physical capital</u>: Good runway, lot of planes for lobster export. Good infrastructure for fisheries.</p>	<p><u>Social capital</u>: Had an active tourism industry but it went into receivership.</p> <p><u>Natural capital</u>: Limited land area.</p>
Masig	<p><u>Financial capital</u>: Shipping piloting opportunities with Australian Reef Pilots, Torres Pilots. Potential income from tourism. Hub for prawn trawlers. First sponge aquaculture farm in TS.</p> <p><u>Natural capital</u>: Attractive sand island with tourism potential. Was profiled in TV series Remote Area Nurse.</p> <p><u>Physical capital</u>: Facilities for research development (e.g. vessels, diving equipment, divers). Good airport, and used to have a direct flight to Cairns.</p> <p><u>Human capital</u>: Culturally strong, and has become more so. Language being restored amongst youth.</p> <p><u>Social capital</u>: Very active fishing industry.</p>	<p><u>Natural capital</u>: Low sand island with high risk of inundation. Limited natural water supply.</p>
Iama	<p><u>Natural capital</u>: Good lobster fishery.</p> <p><u>Physical capital</u>: Plans to develop lobster processing. Good airstrip.</p>	<p><u>Physical capital</u>: Lack of accommodation for service providers and expensive, hindering development.</p> <p><u>Social capital</u>: Rigid structure of approvals, with many different formal levels required (e.g. PBC, Traditional Owner) resulting in lengthy negotiations for decisions.</p> <p><u>Natural capital</u>: Limited natural water supply.</p>
Erub	<p><u>Natural capital</u>: High island with less inundation risk. Good fisheries, close to mackerel grounds, trochus. Possible game fishing opportunities.</p> <p><u>Physical capital</u>: Good water supply: two dams. Good infrastructure.</p> <p><u>Social capital</u>: Community runs a canteen. Ged Erub Fishing Company and art centre. Strong history of pearl fishing. Strong church influence because 'Coming of the Light' began here. Close marriage connections to Parama Treaty Village, PNG.</p> <p><u>Political capital</u>: Politically well-connected to the Northern Peninsula Association.</p>	<p><u>Physical capital</u>: A lot of infrastructure is low-lying and at risk from inundation. Mobile reception good but not at airstrip.</p>
Mer	<p><u>Natural capital</u>: Good soil suitable for horticulture. High ground with low risk of inundation. Good fisheries – mackerel, coral trout, beche-de-mer.</p> <p><u>Physical capital</u>: Good mobile reception. Excellent infrastructure waiting to be used. Good new school.</p> <p><u>Human and social capital</u>: Strong cultural connections to PNG Treaty villages, especially from Parama. Football club set up by PBC. Very strong culture with pride in history of the Mabo Decision.</p> <p><u>Financial capital</u>: Opnor Bakir Atabur Corporation runs a canteen and guesthouse.</p> <p><u>Political capital</u>: Passionate and well-connected leaders.</p>	<p><u>Social capital</u>: Old land disputes have caused delays with infrastructure development. Land management structure, under a Reserve, not DOGIT. Currently negotiating a transfer to TOs.</p>

4.6 Session 6: What are the priority adaptation strategies required to improve livelihoods in the Torres Strait?

This session began with the facilitator explaining that adaptation strategies could be focussed on both the impacts of change (e.g. declining rainfall and coral bleaching) and adaptive capacity issues (e.g. poor physical capital such as airstrips), and generic examples were given. Participants were then divided into three working groups to design adaptation strategies for the three focus communities, with one group per community. Each group was provided with the graphs of EGS and projected impacts in 2030 specific to each island, and the adaptive capacity summaries for each community from Table 9. From this information, each group listed adaptation strategies in descending order of priority for that island. For each strategy they also listed the following information:

- The impacted EGS and the driver or threat causing that impact
- Alternative strategies which take advantage of underutilised EGS
- The capital requiring improvement to build adaptive capacity
- The resources required to implement the strategy
- The stakeholders required to implement the strategy
- Research priorities to assist the design and implementation of the strategy

Finally, each group was asked to consider whether the strategies identified risked being mal-adaptive if any of the other three scenarios eventuated in the Torres Strait: *Hope Island*, *Doug's World* and *Torres Strait Territory*. Each group then presented their results to the other participants to explain and refine their strategies.

4.6.1 Saibai

The most important EGS is coastal finfish, and this will be negatively impacted, largely by increased exploitation due to a projected increase in human population densities, and related pollution (Fig. 23). Climate factors will also have a negative impact, but will be offset by increased water temperatures potentially increasing marine productivity. By comparison, the second and third most important EGS, reef fish and green turtles will be highly negatively impacted by climate factors. Indeed, green turtles are likely to be the most impacted EGS overall. The fourth most important EGS, surface freshwater, will also be negatively impacted. The adaptive capacity assessment showed that Saibai has relatively strong physical, social, human and political capital, and has great potential for future fisheries development (e.g. mudcrabs, finfish), but is constrained by pressure from PNG communities' dependence on the island's infrastructure, and the high risk of current and future inundation (Table 9).

Participants identified seven adaptation strategies, with management measures for sea level rise (adaptive sea walls, housing and services designs) being the two most important (Table 10). A Border Protection Hub was also recommended to manage projected escalation in cross-border issues and provide local employment. Developing renewable energy and establishing a stronger political voice through the Torres Strait Treaty to influence monitoring of effluent discharge from PNG into the Torres Strait were the next most important strategies. Only the final two strategies, establishing home gardens and subsidising food import prices directly tackled EGS management, by promoting local garden food production to reduce dependence on food imports, and to reduce exploitation rates of all other EGS. The first three strategies would be potentially mal-adaptive if projected sea level rise and increases in PNG population and cross-border movements are not as acute as anticipated (Table 10).

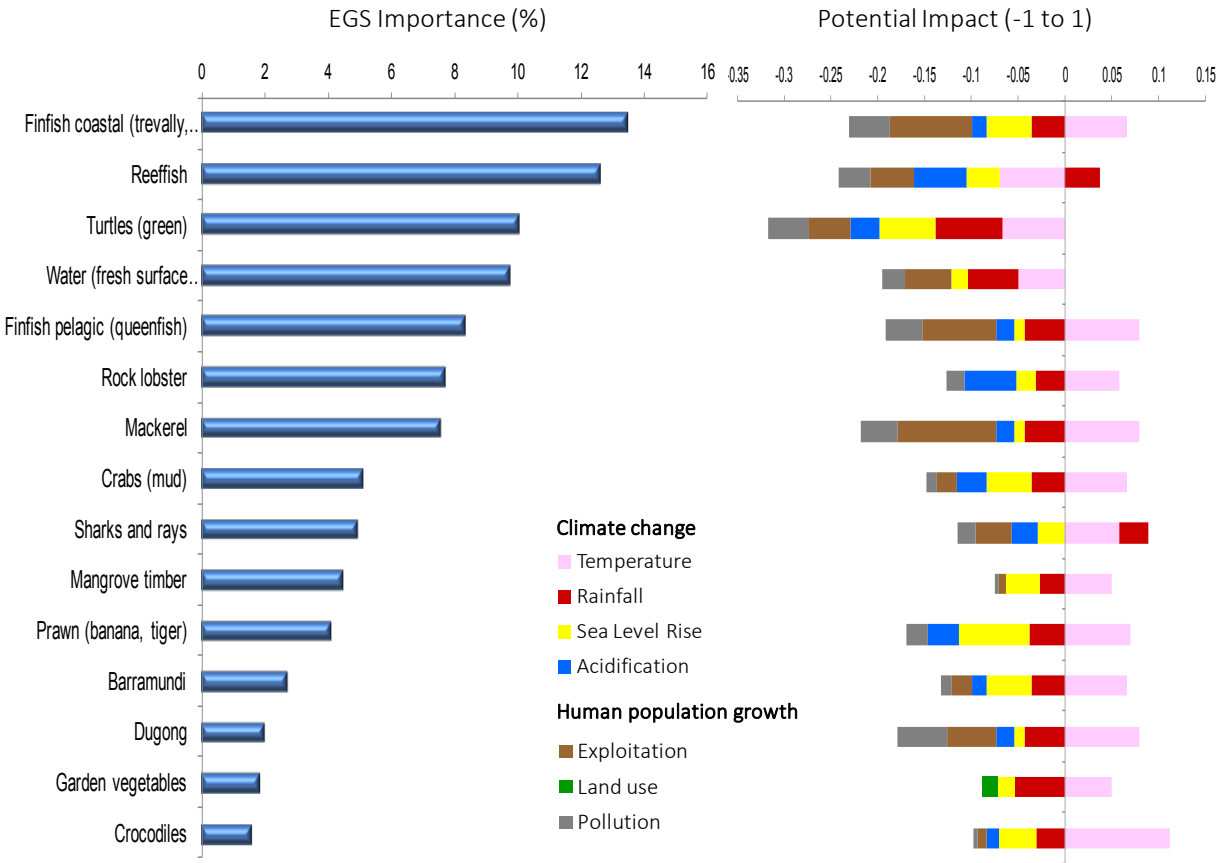


Figure 23. The current top 15 most important EGS (left) and potential impacts for each EGS in 2030 (right) for Saibai under the Business as Usual *Northern Exposure* scenario.

Table 10. Adaptation strategies identified by participants for Saibai

Adaptation strategy	Impacted EGS and threats addressed, or EGS alternatives	Capitals addressed	Resources required to implement strategy	Stakeholders required to implement strategy	Research needed to develop strategy	Scenario 2 <i>Hope Island</i> Risk of mal-adaptation?	Scenario 3 <i>Doug's World</i> Risk of mal-adaptation?	Scenario 4 <i>Torres Strait Territory</i> Risk of mal-adaptation?
1. Engineered solution to sea level rise: adaptive sea walls that can rise with sea level	None	Physical capital, and indirectly all other capitals	Funding Labour Skills (engineering, constructions)	Community leaders Government funding Construction companies Government service providers IBIS Torres Strait Treaty stakeholders	Climate research to assess how large the infrastructure should be; engineering research; social research to assess community perspectives of costs/benefits	Potentially, if sea level rise does not occur as projected	No because sea level rise may occur	No because sea level rise may occur
2. Adaptive housing design to account for sea level rise, and adapted services (sewage, water); sustainable building practices	None	Physical capital, and indirectly all other capitals	Funding Labour Skills (engineering, constructions) Sustainable technologies	Community leaders Government funding Construction companies Government service providers IBIS	Engineering research; social research to assess community perspectives of costs/benefits	Potentially, if sea level rise does not occur as projected	No because sea level rise may occur	No because sea level rise may occur
3. Border Protection Hub to increase government health, military presence, and employment for islanders to offset decreased commercial activity	None – deliberately substituting reliance on declining EGS	Natural, social/cultural, political (strategic importance), financial (employment opportunities)	Government defence funding; infrastructure, transport access, ports, airport, communications upgrade, administrative accommodation	Government defence/service providers Community PNG stakeholders through Torres Strait Treaty	Cost-benefit analyses	Potentially, if trans-boundary pressures do not escalate as projected in this scenario	Potentially, if trans-boundary pressures do not escalate as projected in this scenario	No, because it is will be adaptive for this future projection
4. Develop renewable energy	None	Physical capital, and indirectly all other capitals	Funding Labour Skills (engineering, constructions)	Community leaders Energy companies Government Investors and financial partners	Scoping for potential for renewable energy sources	No, because it will be beneficial under all future scenarios	No, because it will be beneficial under all future scenarios	No, because it will be beneficial under all future scenarios

Table 10 continued. Adaptation strategies identified by participants for Saibai

Adaptation strategy	Impacted EGS and threats addressed, or EGS alternatives	Capitals addressed	Resources required to implement strategy	Stakeholders required to implement strategy	Research needed to develop strategy	Scenario 2 <i>Hope Island</i> Risk of mal-adaptation?	Scenario 3 <i>Doug's World</i> Risk of mal-adaptation?	Scenario 4 <i>Torres Strait Territory</i> Risk of mal-adaptation?
5. Develop strong political voice to influence monitoring of effluent discharge from PNG	All marine EGS	Political and natural	Engagement with PNG stakeholders through Torres Strait Treaty	Torres Strait Treaty stakeholders Community leaders TSRA		No, because it will be beneficial under all future scenarios	No, because it will be beneficial under all future scenarios	No, because it will be beneficial under all future scenarios
6. Establish home gardening	All terrestrial EGS, and to substitute for imported foods	Natural Financial Human (health)	Funding Awareness raising Training	TSRA Community PBC		No, because it will be beneficial under all future scenarios	No, because it will be beneficial under all future scenarios	No, because it will be beneficial under all future scenarios
7. Subsidise imported food supplies	All terrestrial and marine EGS, by reducing harvesting pressure	Natural Financial		TSRA IBIS Government		No, because it will be beneficial under all future scenarios	No, because it will be beneficial under all future scenarios	No, because it will be beneficial under all future scenarios

4.6.2 Masig

The most important EGS are coastal finfish, and these will be negatively impacted, largely by increased exploitation due to a projected increase in human population densities (Fig. 24). Climate factors will also have a negative impact, but will be offset by increased water temperatures which boost marine productivity. Mackerel, the second most important EGS, will be similarly impacted. By comparison the third most important EGS, reef fish will be highly negatively impacted by climate factors due to the impacts of acidification and sea temperature on coral health. The fourth most important EGS, lobsters, will be amongst the least impacted. As for Saibai, green turtles will be highly negatively impacted by climatic stressors, and are the most impacted EGS overall. Surface freshwater is of similar importance as green turtles, and will also be negatively impacted. Although cultured sponges are currently relatively unimportant as an EGS, they are the only one likely to be positively affected due to increasing sea water temperatures. The adaptive capacity assessment indicated that Masig has high levels of all capitals, but is low in natural capital due to its low-lying geography and risk of inundation, plus limited natural water supplies.

Participants identified three adaptation strategies, with improved marine conservation measures the most important, due to projected overall declines in fisheries and other marine-related EGS (Table 11). Tourism and sea sponge development was the second most important strategy. This aims to promote economic development on Masig and take advantage of its high scenic and marine qualities (i.e. natural capital), plus the promotion of sponge aquaculture which may benefit from increased sea water temperatures. The third most important strategy was to climate change-proof terrestrial EGS and infrastructure to potential sea level inundation. Only this strategy would be potentially mal-adaptive if projected sea level rise is not as acute as anticipated under the Business as Usual *Northern Exposure* scenario (Table 11).

4.6.3 Dauan

The most important EGS are coastal finfish, and these will be negatively impacted, largely by increased exploitation due to a projected increase in human population densities plus related pollution (Fig. 25). Climate factors will also have a negative impact, but will be offset by increased water temperatures which boost marine productivity. Reef fish, the second most important EGS, will also be highly negatively impacted by climatic factors due to the effects of acidification and sea temperature on coral health. As for Saibai and Dauan green turtles, the third most important EGS, will be even more negatively impacted by climatic stressors. Green turtles will be the most impacted EGS overall. Surface freshwater will also be negatively impacted, and is of similar importance to turtles. Dauan has high levels of natural, human, social and physical capitals, and is less at risk from sea level rise due to its geography. However, it has poor physical capital due to limited transport facilities, and endures pressure on its resources from PNG communities.

Participants identified four adaptation strategies, with developing alternative protein sources (e.g. through permaculture technology) for neighboring PNG communities the most important, in order to reduce exploitation pressure on coastal finfish, the most important EGS (Table 12). Community-based management of marine natural resources was the second most important strategy. This aims to protect all marine-derived EGS and build natural, social and political capital. The third most important strategy was to raise awareness of water conservation in order to protect freshwater supplies and to promote garden vegetable production for food. The fourth strategy was community-based habitat protection for critical EGS potentially affected by climate change, for example through the establishment of Indigenous Protected Areas. This targeted reef fish, dugong, turtles and barramundi. None of the strategies were potentially mal-adaptive under alternative future scenarios (Table 12).

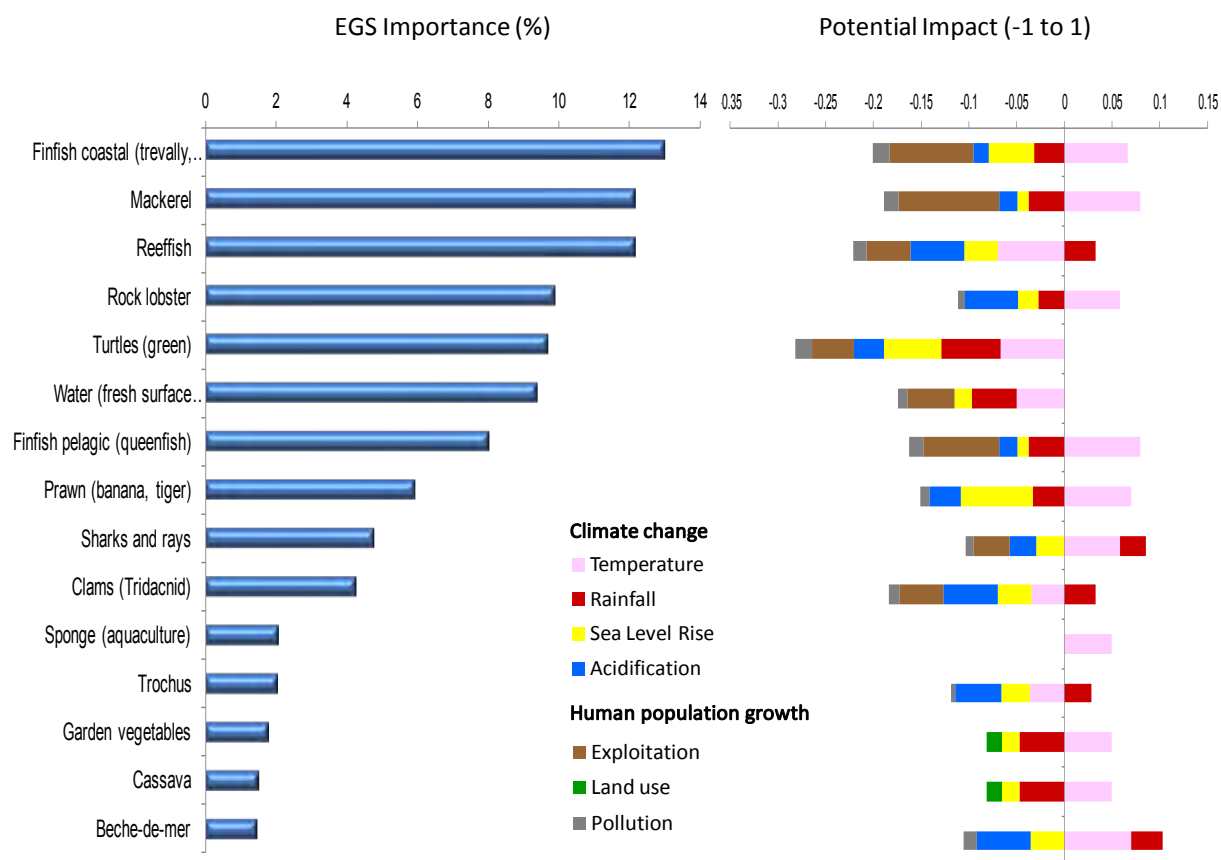


Figure 24. The current top 15 most important EGS (left) and potential impacts for each EGS in 2030 (right) for Masig under the Business as Usual *Northern Exposure* scenario.

Table 11. Adaptation strategies identified by participants for Masig

Adaptation strategy	Impacted EGS and threats addressed, or EGS alternatives	Capitals addressed	Resources required to implement strategy	Stakeholders required to implement strategy	Research needed to develop strategy	Scenario 2 <i>Hope Island</i> Risk of mal-adaptation?	Scenario 3 <i>Doug's World</i> Risk of mal-adaptation?	Scenario 4 <i>Torres Strait Territory</i> Risk of mal-adaptation?
1. Marine resource conservation	Fisheries, nurseries and habitat	Declining fishery stocks (natural capital)	Community participation Community Volunteers Australia	TSIRC Commercial fisheries Government agencies PBCs	Stock assessments and data collection	No, because it is will improve natural resource condition	No, because it is will improve natural resource condition	No, because it is will improve natural resource condition
2. Develop tourism, sea sponge aquaculture	Marine EGS and sponges	Employment, income (natural, social, human capital)	Infrastructural development Community engagement	Communities PBC TSRA TSIRC Investors	Feasibility studies Business plans	No, because it is an investment that will be necessary in all futures	No, because it is an investment that will be necessary in all futures	No, because it is an investment that will be necessary in all futures
3. Climate change-proof terrestrial EGS for sea level rise	All terrestrial EGS	All capitals	Future and current planning processes	Communities PBC TSRA TSIRC Investors	Model and plan for sea level rise impacts	Potentially, if sea level rise does not occur as projected	No because sea level rise may occur	No because sea level rise may occur

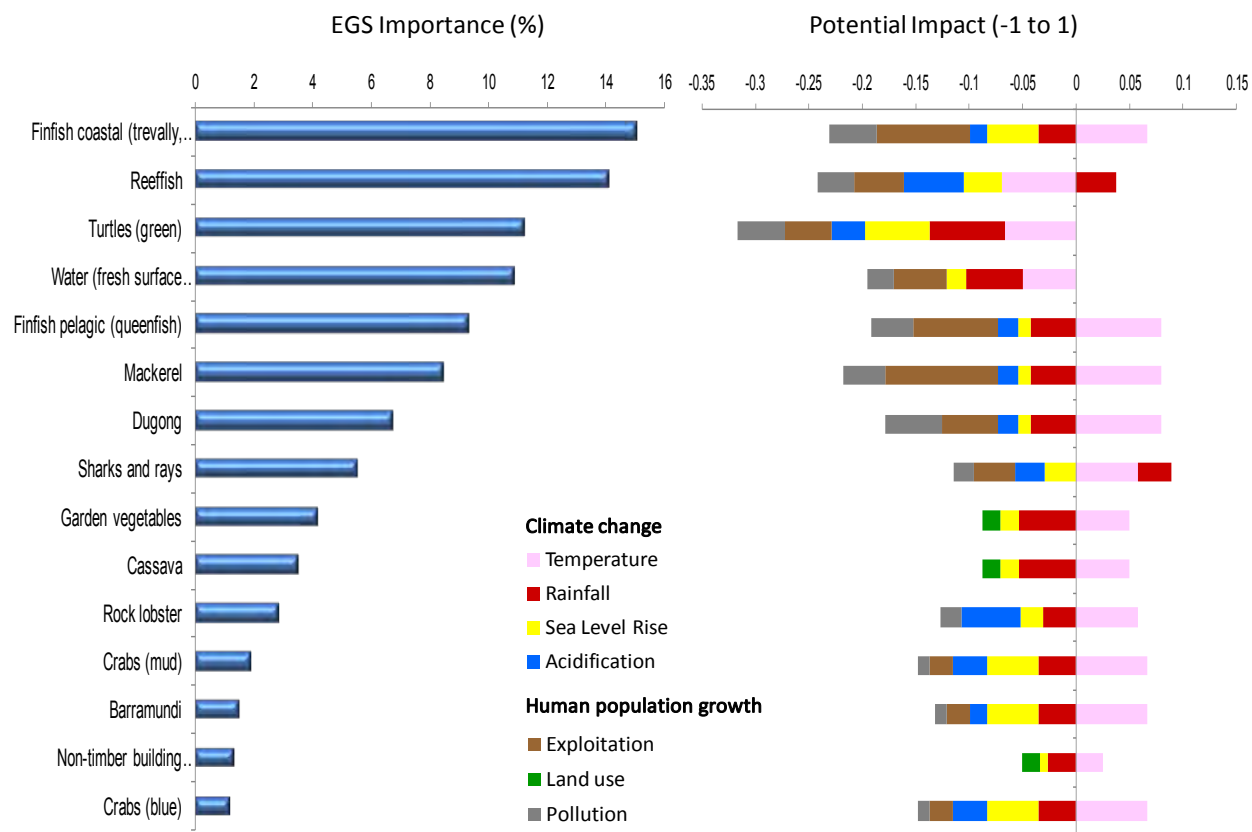


Figure 25. The current top 15 most important EGS (left) and potential impacts for each EGS in 2030 (right) for Dauan under the Business as Usual *Northern Exposure* scenario.

Table 12. Adaptation strategies identified by participants for Dauan

Adaptation strategy	Impacted EGS and threats addressed, or EGS alternatives	Capitals addressed	Resources required to implement strategy	Stakeholders required to implement strategy	Research needed to develop strategy	Scenario 2 <i>Hope Island</i> Risk of mal-adaptation?	Scenario 3 <i>Doug's World</i> Risk of mal-adaptation?	Scenario 4 <i>Torres Strait Territory</i> Risk of mal-adaptation?
1. Develop alternative sources of protein for PNG coastal communities to switch away from coastal finfish and reduce exploitation	Coastal finfish	Declining fishery stocks (natural capital)	Funding, training	TSIRC PNG villages TSRA PBCs Traditional owners	Research on alternative protein sources e.g. permaculture	No, because it is will be adaptive for all futures	No, because it is will be adaptive for all futures	No, because it is will be adaptive for all futures
2. Community based management of natural resources	All marine EGS	Natural, social, political	Funding	TSRA Fisheries authorities	Synthesising and applying existing research	No, because it is will be adaptive for all futures	No, because it is will be adaptive for all futures	No, because it is will be adaptive for all futures
3. Improved water management: raising awareness of water conservation	Freshwater supply	Natural, human, social/cultural human, physical	Funding support to get through water treatment legislation	TSIRC TSRA	Research on community understanding and receptiveness	No, because it is will be adaptive for all futures	No, because it is will be adaptive for all futures	No, because it is will be adaptive for all futures
4. Community based habitat protection for critical EGS affected by climate change (e.g. Indigenous Protected Areas)	Reef fish Turtles Dugong Barramundi	Natural, social/cultural	Training of a local champion, mentoring	Traditional Owners PBC TSRA	Research using school curricula for communicating and awareness raising	No, because it is will be adaptive for all futures	No, because it is will be adaptive for all futures	No, because it is will be adaptive for all futures

4.6.4 Priority research issues

Participants also identified research priorities required to support the design and implementation of the adaptation strategies (Tables 10-12). These could be applied to target future research in the Torres Strait, and are listed in descending order of priority for each island:

Saibai:

1. *Sea walls*: climate research to assess how large infrastructure should be; engineering research; social research to assess community perspectives of costs/benefits
2. *Climate-adaptive housing and services*: engineering research; social research to assess community perspectives of costs/benefits
3. *Border Protection Hub*: cost-benefit analyses
4. *Renewable energy*: scoping for potential renewable energy sources

Masig:

1. *Marine resource conservation*: stock assessments and data collection
2. *Develop tourism and sea sponge aquaculture*: feasibility studies and business plans
3. *Climate change proof terrestrial EGS*: modeling and planning for sea level rise impacts

Dauan:

1. *Develop alternative sources of protein for PNG coastal communities*: research on alternative protein sources (e.g. permaculture)
2. *Community-based management of natural resources*: synthesising and applying existing research
3. *Improved water management and conservation*: research on community understanding and receptiveness
4. *Community-based habitat protection for critical EGS affected by climate change*: research using school curricula for communicating and awareness raising

4.6.5 Case studies and next steps

Fig. 26 illustrates the overall process and results of the workshop sessions. 'No regrets' adaptation strategies were identified for three communities (Saibai, Masig and Dauan) based on their important EGS, impacts by 2030 for the Business as Usual *Northern Exposure* scenario, and communities' adaptive capacity today. Strategies aim to build these communities' resilience and steer their livelihoods towards the agreed vision for the Torres Strait.

The selection of communities as case studies for the community scenario planning workshops will be undertaken in consultation with the TSRA Board and TSIRC Councillors in March 2013. If communities volunteer to participate, these exercises will be undertaken in June-August 2013. If the communities of Saibai, Masig and Dauan wish to participate, their perceptions and those of the stakeholders presented here will subsequently be combined through integration and policy evaluation workshops.

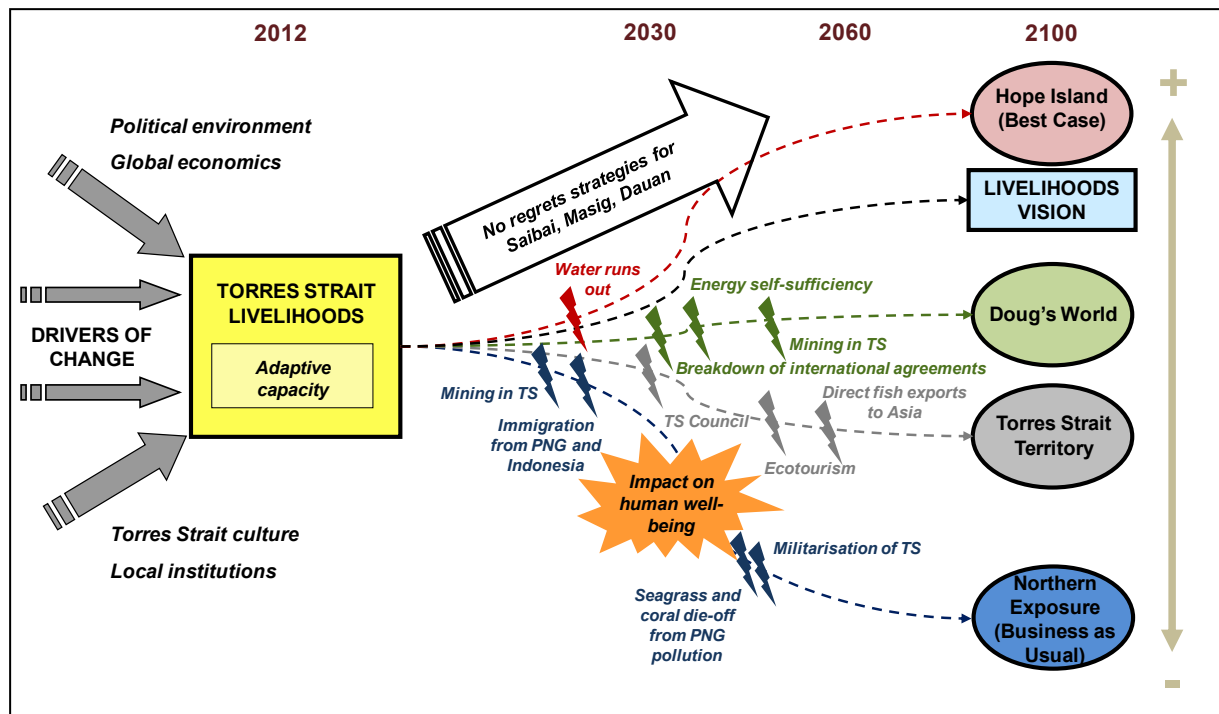


Figure 26. Summary of the workshop process and results for all sessions. Lightning symbols represent thresholds

5. Workshop evaluation

A questionnaire survey carried out before and after the workshop examined how participants' perceptions had changed. To the question "what is the greatest challenge the Torres Strait will face in the future?", a word cloud analysis showed that before the workshop the most frequently mentioned terms were 'change', 'climate' and 'economic' (Fig. 27). After the workshop, 'change' and 'climate' remained the most important terms, but 'PNG' became the third most frequently mentioned. To the question "are the Torres Strait communities resilient to future change?", 46% disagreed before and this fell to 34% after (Fig. 28). To the statement "the Torres Strait's climate adaptation policies are enabling the region to be ready to cope with climate change", 14% agreed before the workshop, but none agreed after the workshop. Similarly, 9% disagreed before, increasing to 42% after (Fig. 29).

The low numbers of participant responses after the workshop ($n=12$) relative to before ($n=22$) may have limited the validity of these comparisons. However, the results do indicate that the workshop process had changed participants' perceptions of Torres Strait futures, and necessary adaptation strategies.

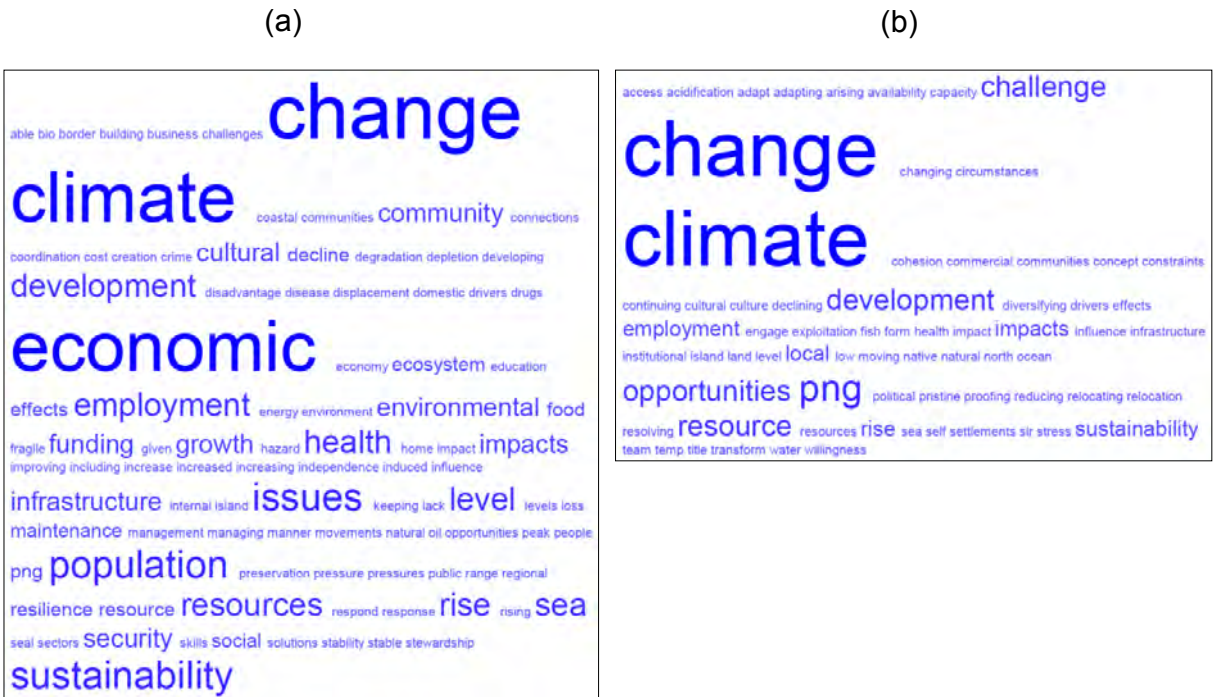


Figure 27. Word cloud analysis of responses to the question “what is the greatest challenge the Torres Strait will face in the future?” (a) before (n=22) and (b) after (n=12) the workshop

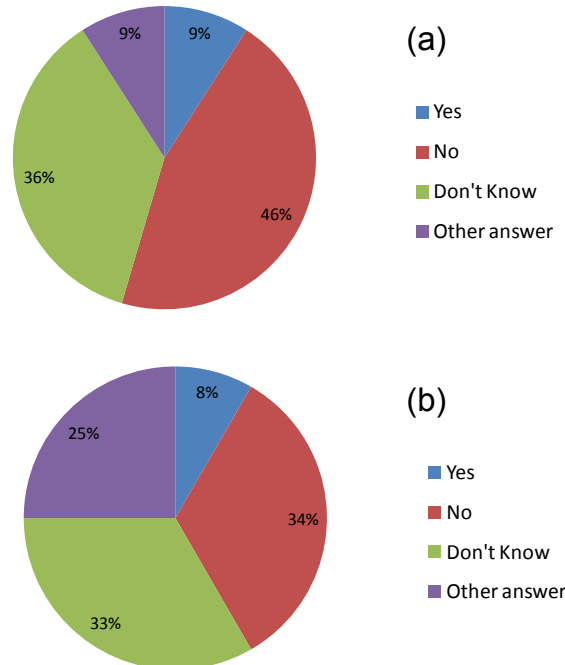


Figure 28. Participants' responses to the question “are the Torres Strait communities resilient to future change?” (a) before (n=22) and (b) after (n=12) the workshop

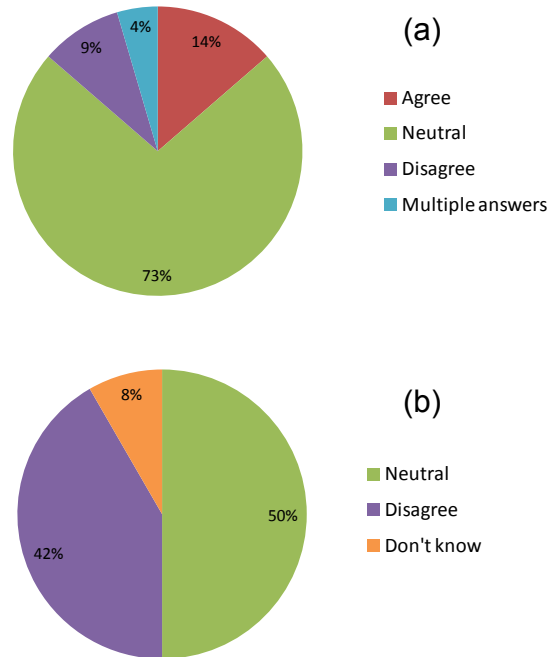


Figure 29. Participants' responses to the statement "the Torres Strait's climate adaptation policies are enabling the region to be ready to cope with climate change" (a) before (n=22) and (b) after (n=12) the workshop

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Appendix I: Workshop agenda

**NERP Tropical Ecosystems Hub
Building resilient futures for Torres Strait Futures**

TORRES STRAIT FUTURES WORKSHOP

Monday 22nd – Tuesday 23rd October 2012
Shangri-La Hotel, Cairns

Workshop objectives:

1. Explore possible future change in the Torres Strait
2. Identify the most vulnerable communities and livelihoods in the Torres Strait
3. Identify priority adaptation strategies for communities

Summary of workshop activities

DAY 1: Monday 22nd October, 9 am – 5.30 pm

Session 1: What are the drivers of change for Torres Strait communities and their livelihoods?

Session 2: What are the desired and possible futures for Torres Strait communities?

Session 3: What impact will the Business as Usual future have on human well-being?

DAY 2: Tuesday 23rd October, 8.30 am – 5 pm

Session 4: What is the adaptive capacity of Torres Strait communities today?

Session 5: Which are the most vulnerable communities and livelihoods in the Torres Strait?

Session 6: What are the priority adaptation strategies required to improve livelihoods in the Torres Strait?

WORKSHOP PROGRAM

DAY 1: Monday 22nd October

9:00 Opening address and prayer

9:30 – 10:00 Introduction, definition of terms, pre-workshop questionnaire evaluation and consents: James Butler CSIRO (Facilitator)

10:00 – 10:30 **Session 1: What are the drivers of change for Torres Strait communities and their livelihoods?**

Activity	Activity time	Subject	Presenter	Materials, aids etc.	Outputs
Presentation	15 mins	Global futures	Erin Bohensky (CSIRO)	Powerpoint, poster	Poster
Presentation	15 mins	The Torres Strait Treaty	Simon Moore (DFAT)	Powerpoint	

10:30 – 11:00 Morning tea

11:00 – 12:40 **Session 1 continued**

Activity	Activity time	Subject	Presenter	Materials, aids etc.	Outputs
Presentation	20 mins	Social and economic trends and resilience (TS and PNG)	Sara Busilacchi (CSIRO) Yiheyis Maru (CSIRO)	Powerpoint, posters	Posters
Presentation	15 mins	Torres Strait climate, climate change and sea level rise	Jo Johnson (RRRC)	Powerpoint, poster	Poster
Presentation	15 mins	Biodiversity and ecosystem asset trends	Tim Skewes (CSIRO)	Powerpoint, poster	Poster
Presentation	10 mins	Biosecurity	Murray Korff (NAQS)	Powerpoint	

Introduction	10 mins	Describe session on drivers	James Butler	Powerpoint	
Four working groups identify drivers	20 mins	List drivers of change	Working groups facilitated by CSIRO-RRRC team	Cards for each group and white board	Drivers grouped on board
Voting	10 mins	Rank groups of drivers by importance	James Butler	White board and stickers	Ranked groups of drivers

12:40 – 1:00 Lunch

1:00 – 3:30 **Session 2: What are the desired and possible futures for Torres Strait communities?**

Activity	Activity time	Subject	Presenter	Materials, aids etc.	Outputs
Four working groups and discussion	30 mins	Future vision for Torres Strait livelihoods	James Butler	Central flip chart	Statement of desired future in terms of income, health, food security, social cohesion, freedom of choice
Presentation	15 mins	Introduce scenario planning, select and describe two most important drivers	James Butler Erin Bohensky (CSIRO)	Central flip chart to explain 2x2 matrix and describe drivers	
Four working groups develop scenario narratives	1 hour	Describe scenarios with narratives and pictures for 2090, identifying thresholds and management actions needed for impacts	Four working groups, facilitated by CSIRO-RRRC	Flip chart and pens for each group	Narrative and pictures for each scenario, one working group per scenario, thresholds and management actions identified
Four working groups	40 mins	Presentation of scenarios by four groups	Four working groups	Tape recorder to tape narratives	Feedback from audience and refining of scenarios

3:30 – 4:00 Tea

4:00 – 5:30

Session 3: What impact will the Business as Usual future have on human well-being?

Activity	Activity time	Subject	Presenter	Materials, aids etc.	Outputs
Presentation	30 mins	EGS modelling for Torres Strait	Tim Skewes (CSIRO)	Powerpoint and printed maps of typologies	
Four working groups discussion	1 hour	Production and valuation of EGS for each island	Tim Skewes (CSIRO)	EGS list spreadsheets	Four completed sheets of EGS production and values

DAY 2: Tuesday 23rd October

8:30 – 10:00

Session 3 (continued): What impact will the Business as Usual future have on human well-being?

Activity	Activity time	Subject	Presenter	Materials, aids etc.	Outputs
Review Day 1 Preview Day 2	30 mins	Review of drivers, desired future, selected scenario, and preview Day 2	James Butler	All posters, flip charts from Day 1, working groups scenarios grouped on walls	
Presentation	1 hour	Results of EGS production, values and impact for island	Tim Skewes (CSIRO)	Powerpoint	

10:00 – 10:30

Tea

10:30 – 12:30

Session 4: What is the adaptive capacity of Torres Strait communities today?

Activity	Activity time	Subject	Presenter	Materials, aids etc.	Outputs
Four working groups and discussion	1 hour	Measuring adaptive capacity using capitals and agency	James Butler (CSIRO)	Flip chart and cards	Indicators of adaptive capacity under the capitals and enabling factors
Discussion	1 hour	Plenary discussion of communities' adaptive capacity and explanations	James Butler, Tim Skewes (CSIRO)	Recording onto laptop table of adaptive capacity strengths and weaknesses	Identification communities' adaptive capacity and explanations

12:30 – 1:30

Lunch

1:30 – 2:00

Session 5: Which are the most vulnerable communities and livelihoods in Torres Strait?

Activity	Activity time	Subject	Presenter	Materials, aids etc.	Outputs
Discussion	30 minutes	Vulnerability analysis	Tim Skewes (CSIRO)	EGS impacts and adaptive capacity table	Discussion of relative vulnerabilities and selection of case study islands

2:00 – 3:30

Session 6: What are the priority adaptation strategies required to build resilient communities in the Torres Strait?

Activity	Activity time	Subject	Presenter	Materials, aids etc.	Outputs
Introduction	15 mins	Adaptation strategies and policies	James Butler (CSIRO)	Powerpoint examples of adaptation strategies and policies	
Working groups	45 mins	Adaptation strategies required for each selected island	Working groups, one island per group, facilitated by CSIRO-RRRC	Butcher's paper, printed graphs of EGS impacts and adaptive capacity tables for each island	Adaptation strategies described for each island

Presentation of strategies	30 mins	Presentation of strategies by participants	Working groups representatives	Butcher's paper result sheets for each group	Adaptation strategies described for each island
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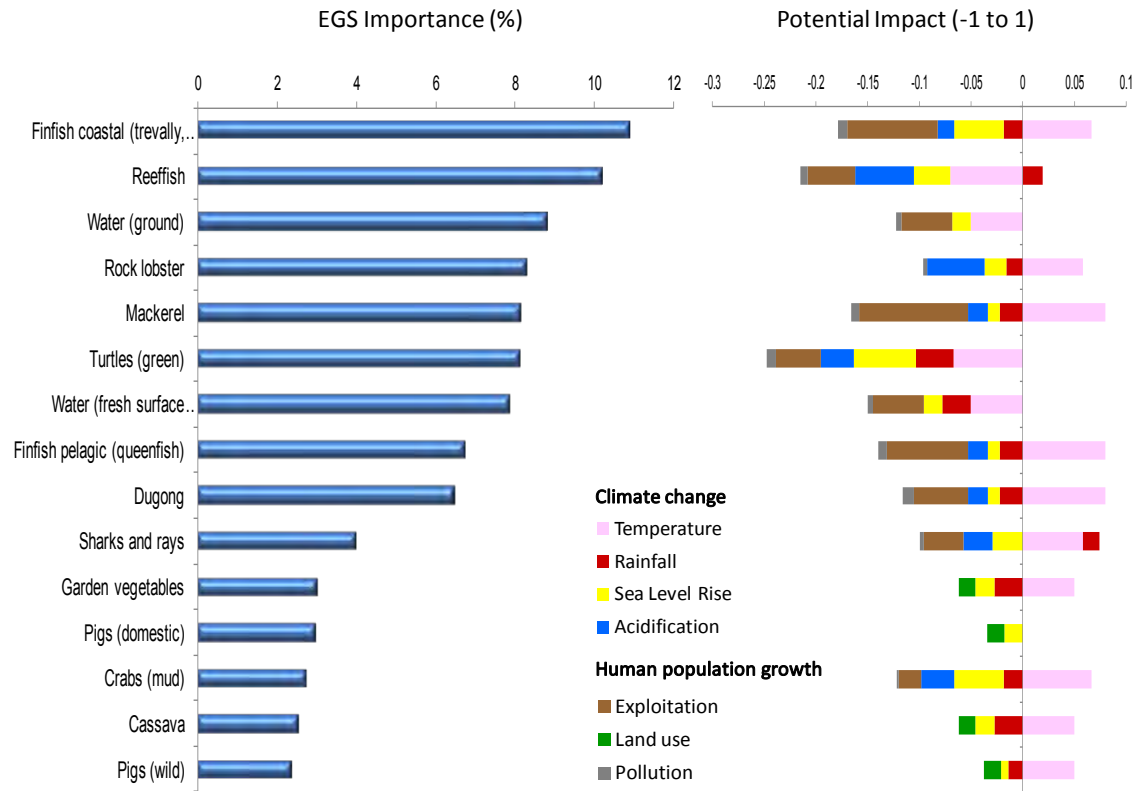
3:30 Working tea and post-workshop evaluation questionnaire

4:30 – 5:00 **Conclusions and next steps**

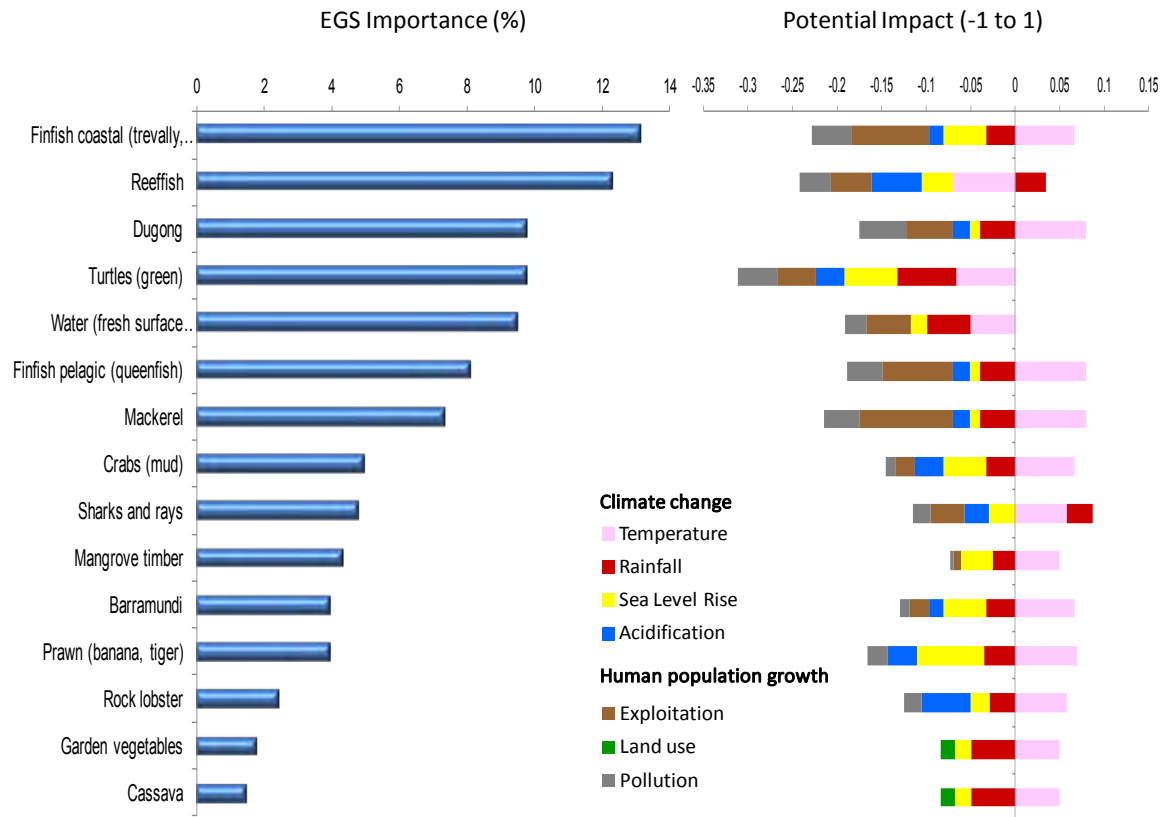
Activity	Activity time	Subject	Presenter	Materials, aids etc.	Outputs
Discussion	30 mins	Workshop evaluation, case studies, next steps	James Butler (CSIRO)	Central flip chart	Workshop evaluation, workshop statement

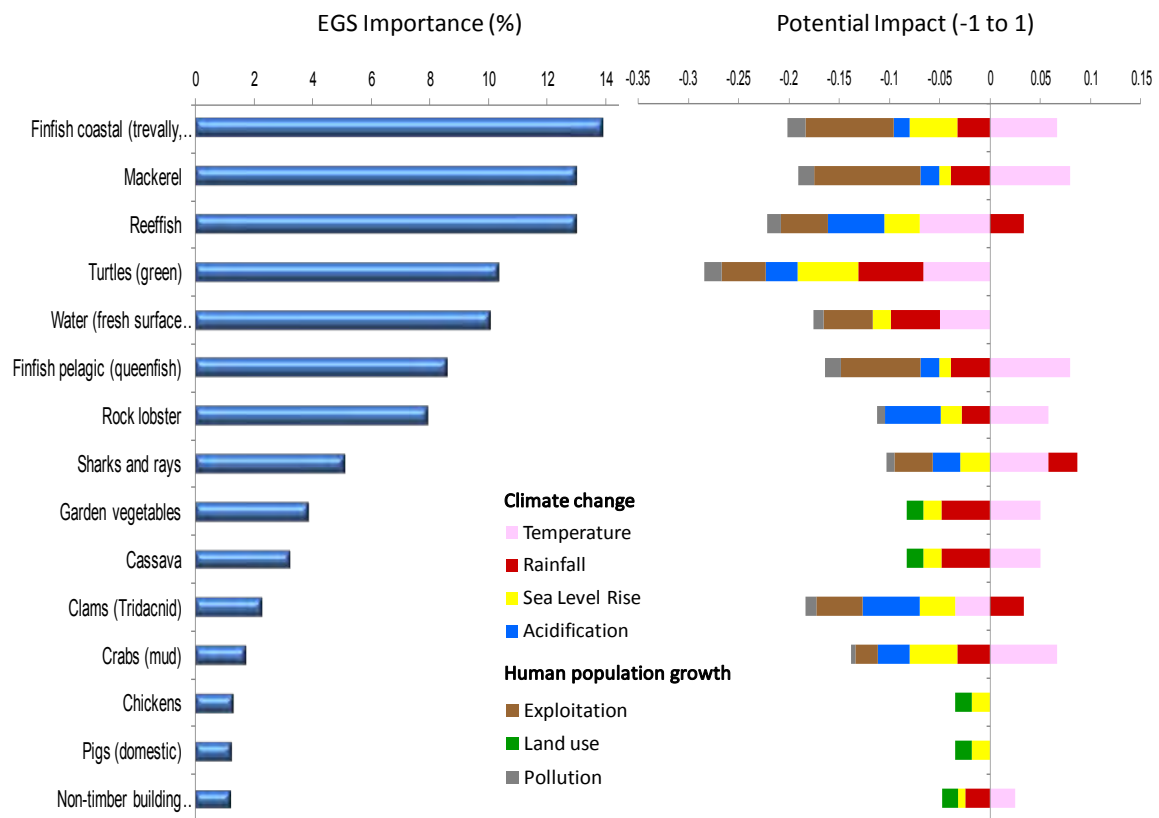
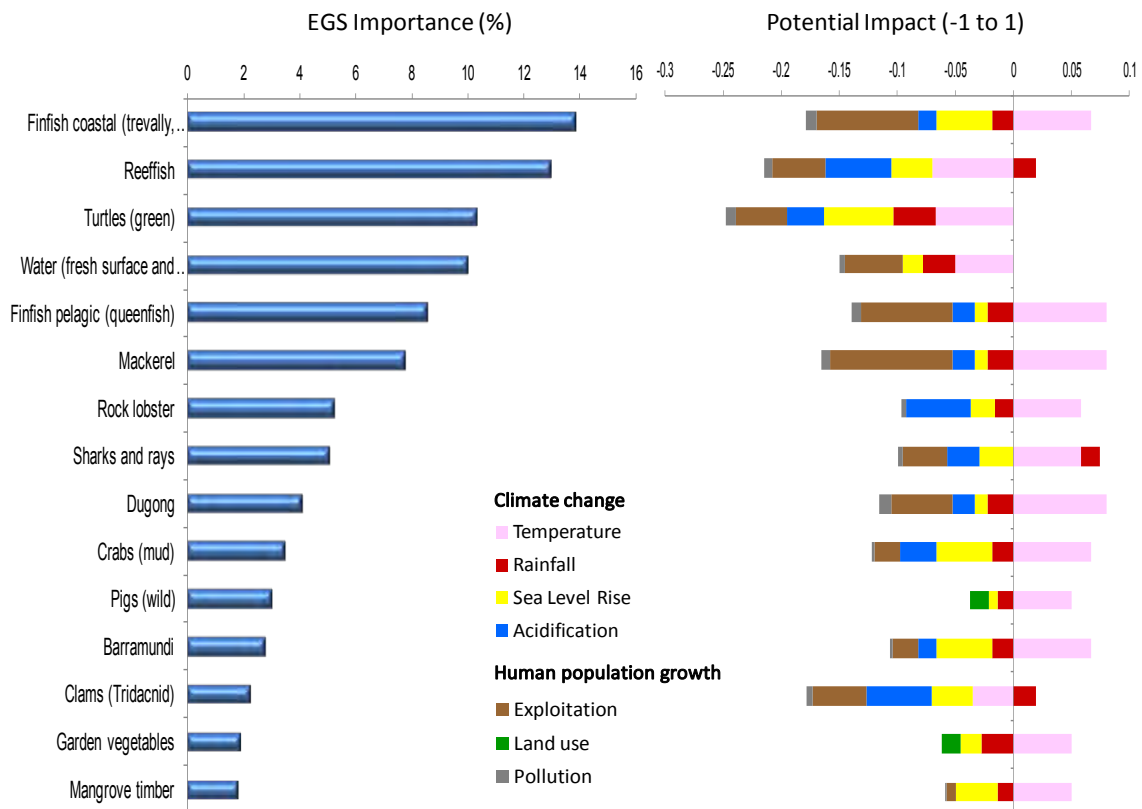
Appendix II: 2030 EGS impacts for communities

Badu (15 most important EGS)

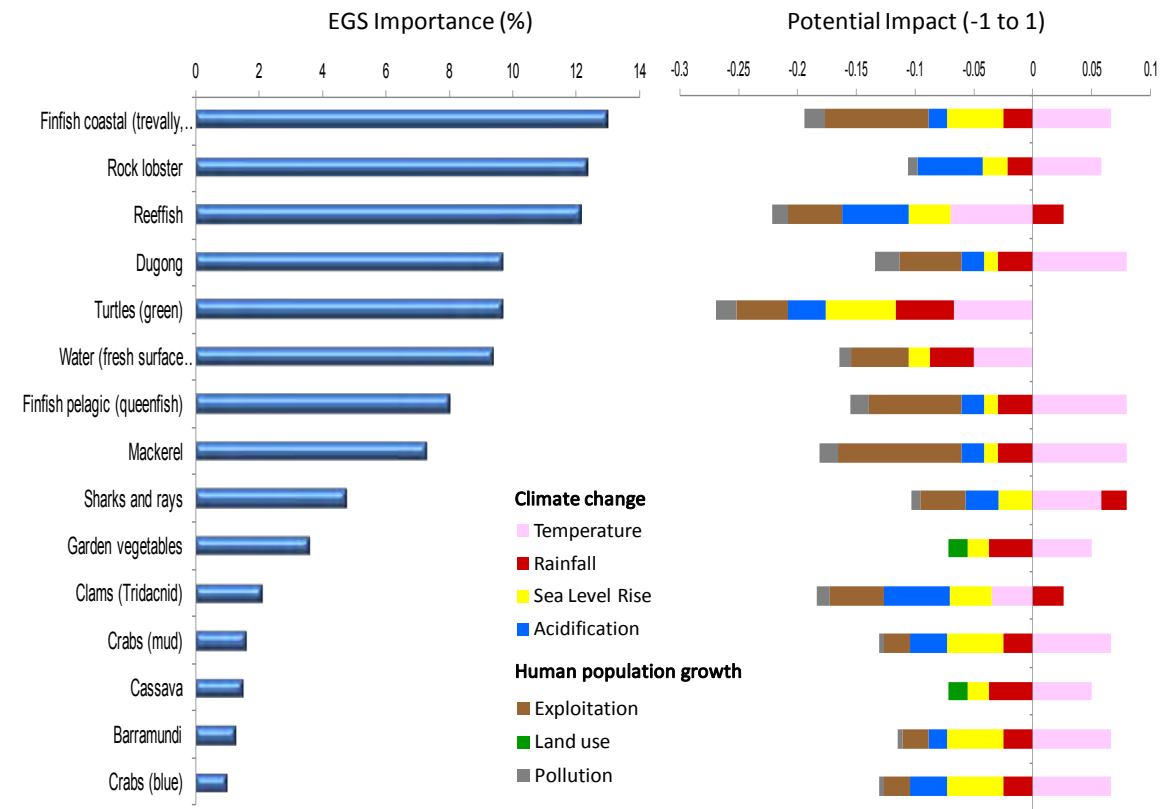


Boigu (15 most important EGS)

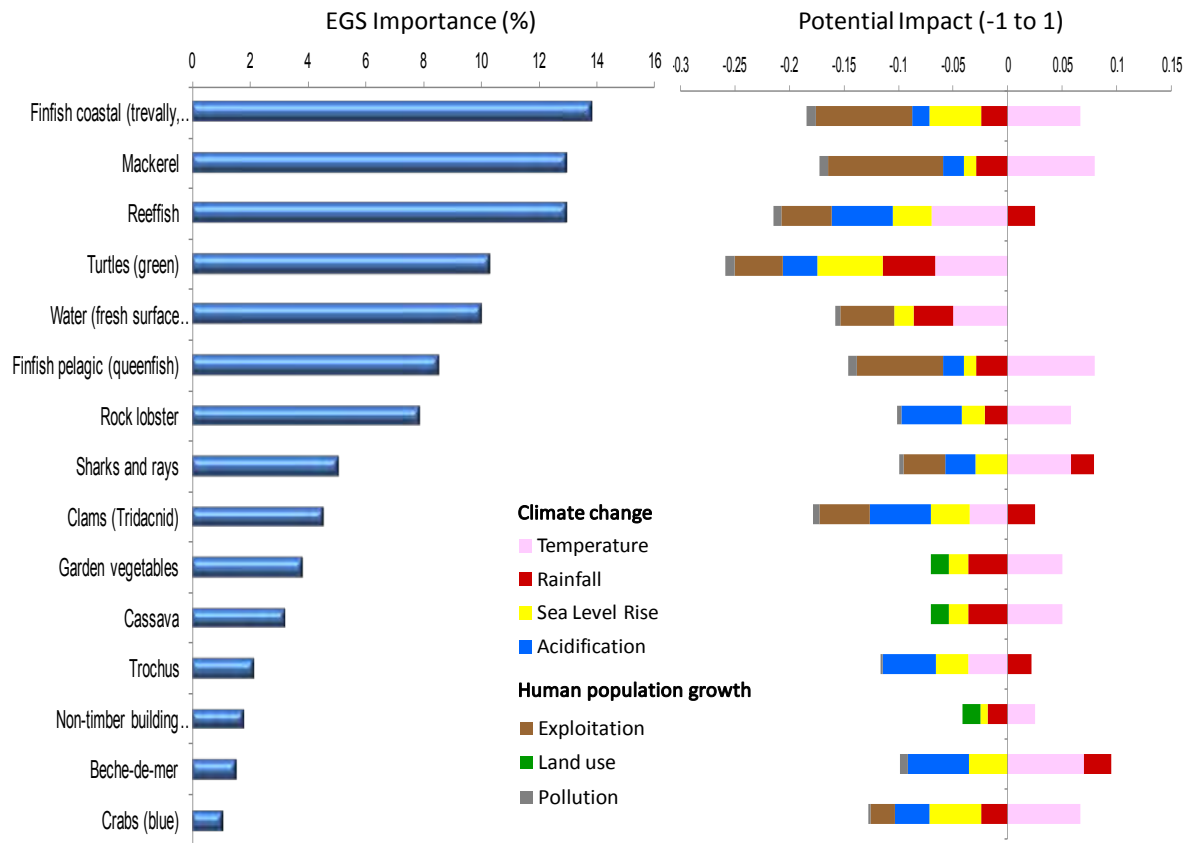


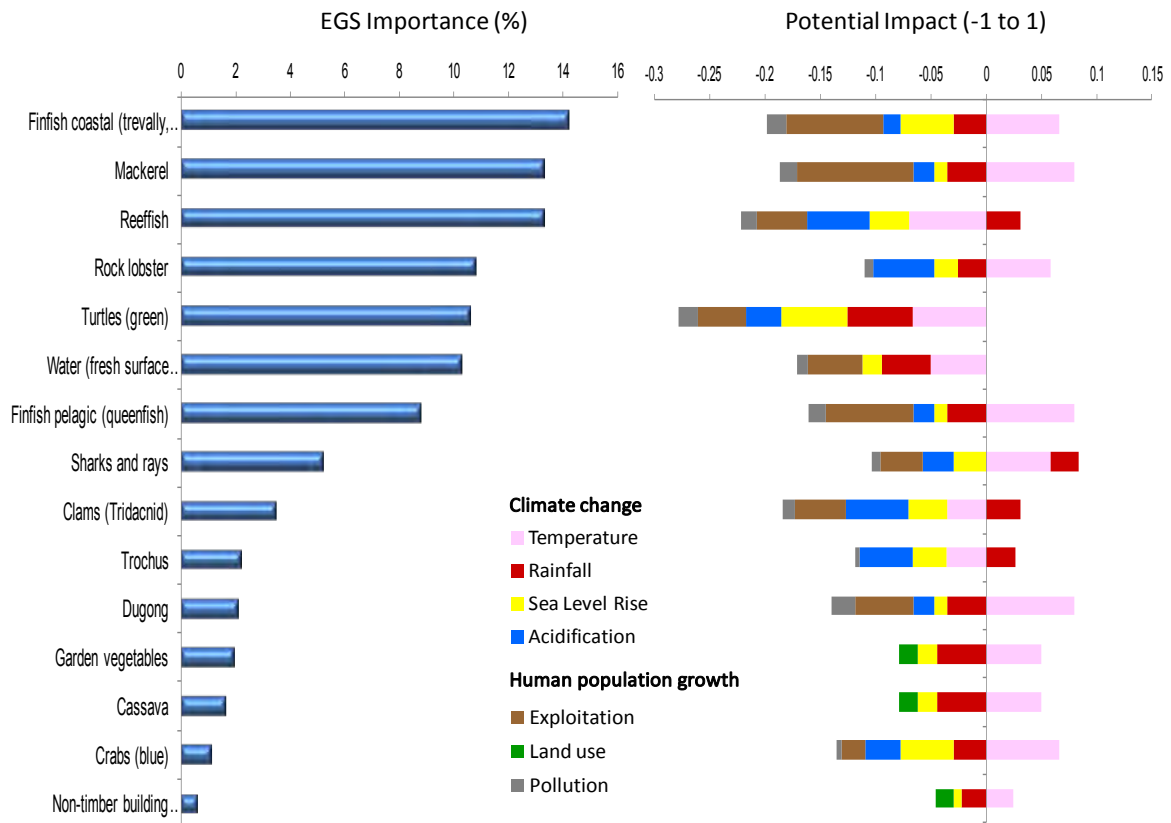
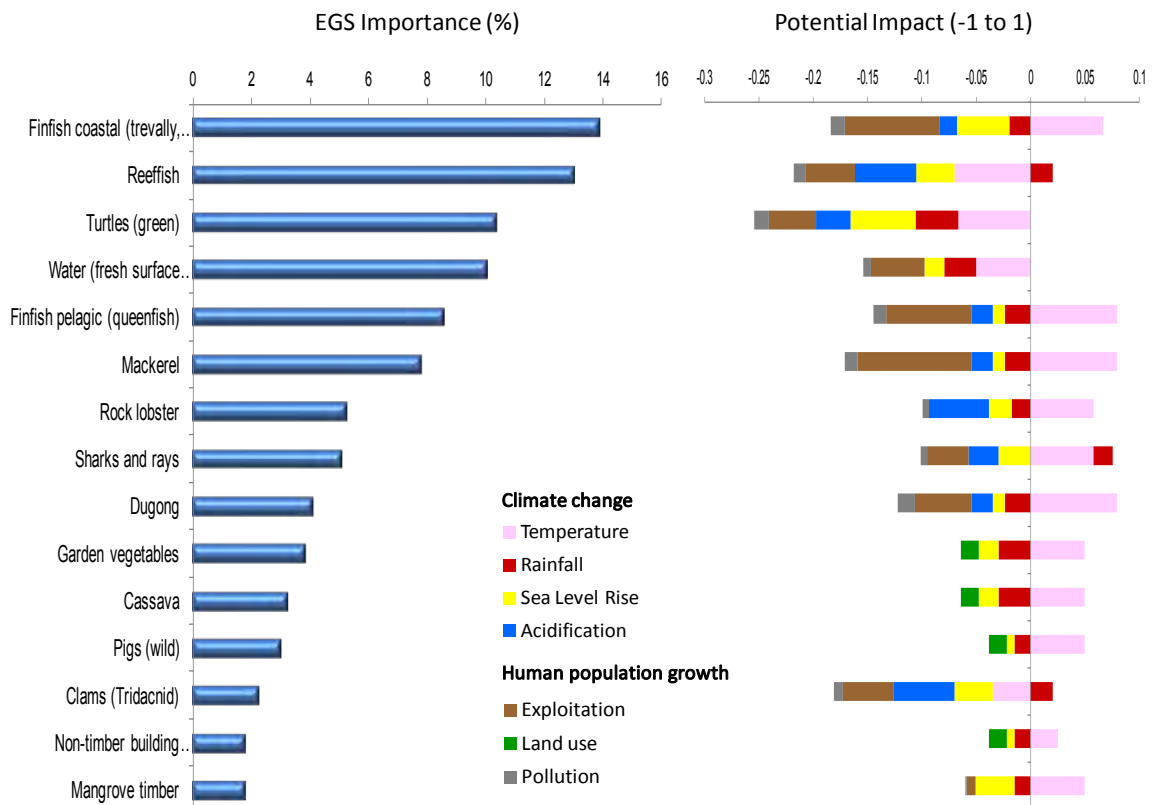
Erub (15 most important EGS)**Kubin** (15 most important EGS)

Mabuia (15 most important EGS)

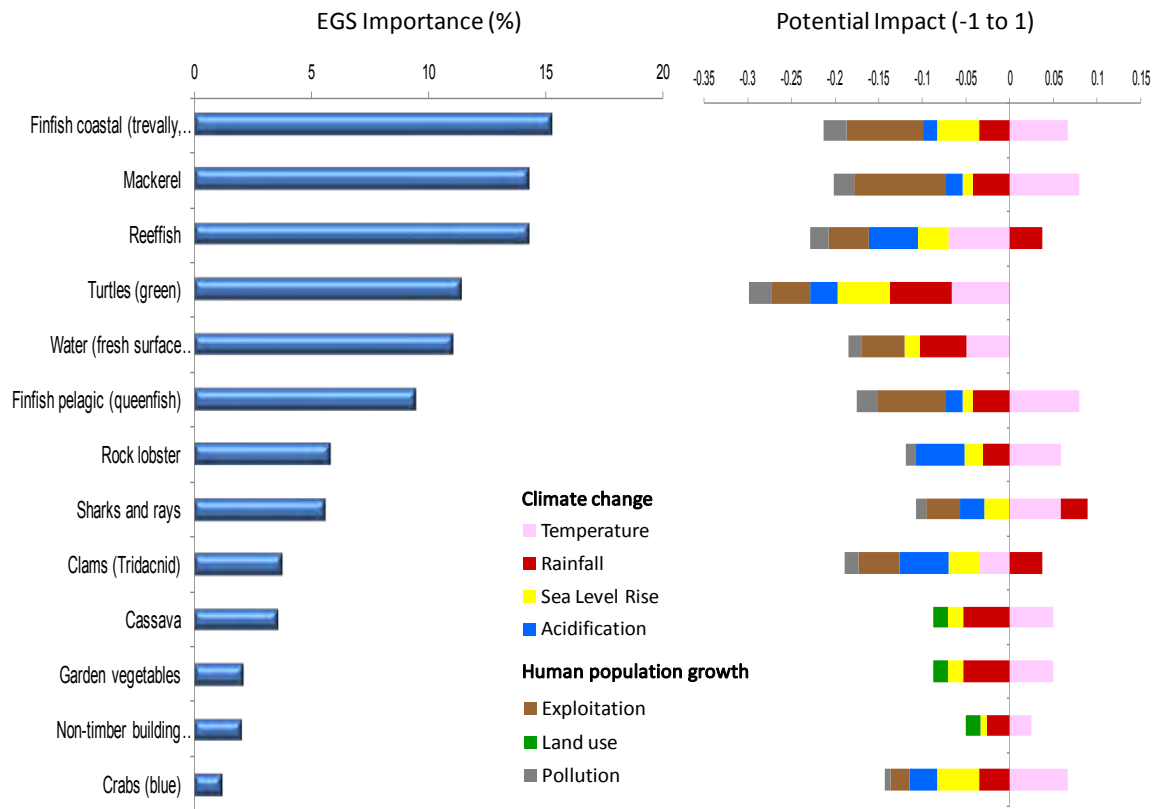


Mer (15 most important EGS)

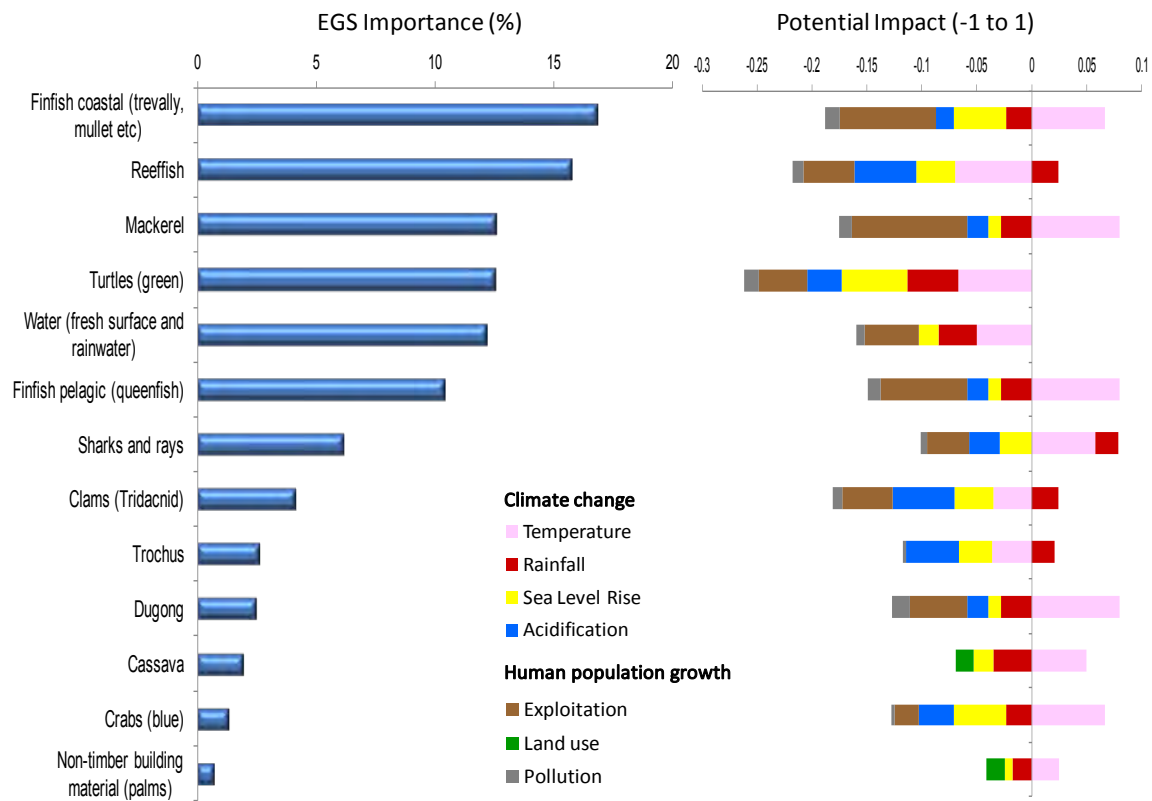


Poruma (15 most important EGS)**St. Paul** (15 most important EGS)

Ugar (15 most important EGS)



Warraber (15 most important EGS)



Yam (15 most important EGS)

