



[www.csiro.au](http://www.csiro.au)

# Sustainable Futures for Milne Bay

Workshop Report, April 27<sup>th</sup> and 28<sup>th</sup> 2009

James Butler, Erin Bohensky, Tim Skewes (CSIRO)  
David Mitchell (Conservation International)

Supported by



Australian Government  
AusAID



## **Acknowledgements**

This workshop was supported by a grant from Conservation International for a project entitled *Demonstration Sites of Integrated Conservation and Development Planning in Melanesia* for the period July 2008-June 2009. This funding covered the workshop costs and attendance by James Butler and Erin Bohensky (CSIRO). Tim Skewes (CSIRO) was supported by a grant from AusAID for the project *Melanesian Marine Ecosystem Assets* for the period July 2008-June 2009. CSIRO acknowledges the support of these funders.

Enquiries should be addressed to:

Dr. James Butler  
CSIRO Sustainable Ecosystems  
Australian Tropical Forest Institute  
James Cook University  
PO Box 12139  
Earlville BC  
Cairns  
QLD 4870  
Australia  
[james.butler@csiro.au](mailto:james.butler@csiro.au)

## **Copyright and Disclaimer**

© 2009 CSIRO To the extent permitted by law, all rights are reserved and no part of this publication covered by copyright may be reproduced or copied in any form or by any means except with the written permission of CSIRO.

## **Important Disclaimer**

CSIRO advises that the information contained in this publication comprises general statements based on scientific research. The reader is advised and needs to be aware that such information may be incomplete or unable to be used in any specific situation. No reliance or actions must therefore be made on that information without seeking prior expert professional, scientific and technical advice. To the extent permitted by law, CSIRO (including its employees and consultants) excludes all liability to any person for any consequences, including but not limited to all losses, damages, costs, expenses and any other compensation, arising directly or indirectly from using this publication (in part or in whole) and any information or material contained in it.

Cover photo: Planning exercise Upper Milne Bay (*Erin Bohensky*)

# CONTENTS

<b>Summary</b>	<b>1</b>
<b>1. Introduction</b>	<b>2</b>
1.1 Ecosystem services and sustainable development	2
1.2 Sustainable Futures for Milne Bay	2
<b>2. Sustainable development planning</b>	<b>5</b>
2.1 The Millennium Ecosystem Assessment	5
2.2 Integrated planning process	7
2.3 CSIRO-CI approach	8
<b>3. Workshop process and results</b>	<b>10</b>
3.1 Workshop participants	10
3.2 Preliminary integrated assessment of Upper Milne Bay	10
3.3 Results of preliminary integrated assessment	13
<b>4. Discussion of results</b>	<b>33</b>
<b>5. Next steps</b>	<b>35</b>
<b>6. References</b>	<b>38</b>
<b>Appendix I: Workshop attendees</b>	<b>39</b>
<b>Appendix II: Workshop agenda</b>	<b>40</b>

## SUMMARY

Human well-being, livelihoods and sustainable development are dependent upon the management of ecosystems and the ecosystem services they provide. While demands on services are increasing with human population growth, human actions are diminishing the ability of many ecosystems to meet these demands. Future drivers including climate change are likely to alter the function of ecosystems and the services they provide.

Milne Bay is the eastern-most province of Papua New Guinea (PNG), consisting of more than 150 islands and the easternmost extremity of mainland PNG. It is an area of global importance for terrestrial and marine biodiversity, combined with unique cultural diversity. However, current planning processes do not integrate natural resource management, human well-being, livelihoods and adaptation to drivers such as climate change. In 2008 CSIRO and Conservation International (CI) partnered in a project, *Sustainable Futures for Milne Bay*, to support the Milne Bay Administration to undertake sustainable development planning.

On April 27<sup>th</sup> and 28<sup>th</sup> 2009 a workshop was held in Alotau, Milne Bay, with representatives from the Administration's health, land, agriculture, economic services and planning divisions, the tourism and oil palm industries, resource owners, CSIRO, CI and AusAID. A preliminary integrated planning exercise was carried out for the 375 km<sup>2</sup> Upper Milne Bay area, which is experiencing coastal erosion and inundation from sea level rise and competing demands for resources by oil palm, logging, subsistence agriculture, fisheries and tourism. Using a CSIRO-CI approach, participants mapped current ecosystem services, their trends in condition, trade-offs between services and stakeholders, future drivers of services and human well-being, and management strategies required to sustainably manage ecosystem services.

Group assessments indicated that freshwater provision, gardens, hunting, carbon storage and erosion regulation are declining in condition, and local communities are suffering the most from these trends. Tourism is growing, with benefits for private business and local communities. The major drivers are human population growth, food security, climate change, sea level rise, and the over-exploitation of fisheries. Suggested adaptation measures included transmigration of communities to adapt to sea level rise, re-zoning of oil palm for food production, protection of mangroves to buffer coastal erosion, protection of forest for potential biodiversity and carbon storage payments, and integrated management for fisheries and dive tourism.

Milne Bay Administration representatives agreed that this form of integrated natural resource planning was necessary to introduce a bottom-up, multi-stakeholder process, and should be incorporated into District Plans through the Provincial Planning Office. Esa'ala, Kiriwina Islands, Louisiades Islands, Egum and Budibudi atolls, and the Alotau area are priority areas which could benefit from more detailed integrated planning assessments due to pressure from human population growth, food security, fisheries collapse and sea level rise. However, further funding is required to continue this project beyond June 2009.

# **1. INTRODUCTION**

## **1.1 Ecosystem services and sustainable development**

Human well-being and progress towards sustainable development are dependent upon the management of the Earth's ecosystems. While demands for ecosystem services such as food and drinking water are increasing with human population growth, human actions are diminishing the ability of many ecosystems to meet these demands. Future drivers such as climate change are also likely to alter the function of ecosystems and the services they provide.

Sound policy and management decisions can reverse or mitigate possible ecosystem degradation, but this depends on an understanding of the ecological and social systems involved, and the possible nature of future changes. Because the inter-relationships between human actions, ecological responses and human reactions to these responses are complex, any planning for natural resource management must include all stakeholders to achieve as complete an understanding as possible.

The conservation of biodiversity is a key component of managing ecosystems and natural resources. Biodiversity represents the dynamic complex of plant, animal and micro-organism communities and the processes that link them in ecosystems. As such biodiversity is the life support system underpinning humans and livelihoods, and the management of sustainable development depends upon the identification, understanding and conservation of biodiversity.

## **1.2 Sustainable Futures for Milne Bay**

In 2008 CSIRO and Conservation International (CI) partnered in a project to support the Milne Bay Administration to undertake sustainable development planning in Milne Bay Province. Milne Bay is the eastern-most province of Papua New Guinea (PNG), consisting of more than 150 small islands and a relatively small area of mainland PNG (Figure 1). It is recognised for its globally significant terrestrial biodiversity values, with several threatened endemic species, and marine biodiversity values due to its location in the Solomon Sea sector of the Coral Triangle, while also having related intact cultural diversity. However, there is no provincial plan which considers current natural resource condition, future trends and their potential impacts on human well-being. Nor is there an integrated approach to plan for the future impacts of climate change and population growth on biodiversity, ecosystems and livelihoods.

In order to better understand the potential impacts of climate change on the marine assets of the region, AusAID and CSIRO also began a partnership project in 2008 entitled *Melanesian Marine Ecosystem Assets*. The project aims to develop methods to identify and assess the status of coastal and marine ecosystem assets in Milne Bay, and describe the processes that sustain or threaten them, including linkages between these assets and the terrestrial system.

The coincidental starting of the two projects provided an opportunity to combine information and approaches. Hence on 27<sup>th</sup> and 28<sup>th</sup> April 2009 CSIRO, CI and AusAID held a workshop in Alotau, Milne Bay to plan a *Sustainable Futures for Milne Bay* project with the Milne Bay Administration, local community and industry representatives. A full list of attendees is provided in Appendix I.

The aims of the project are:

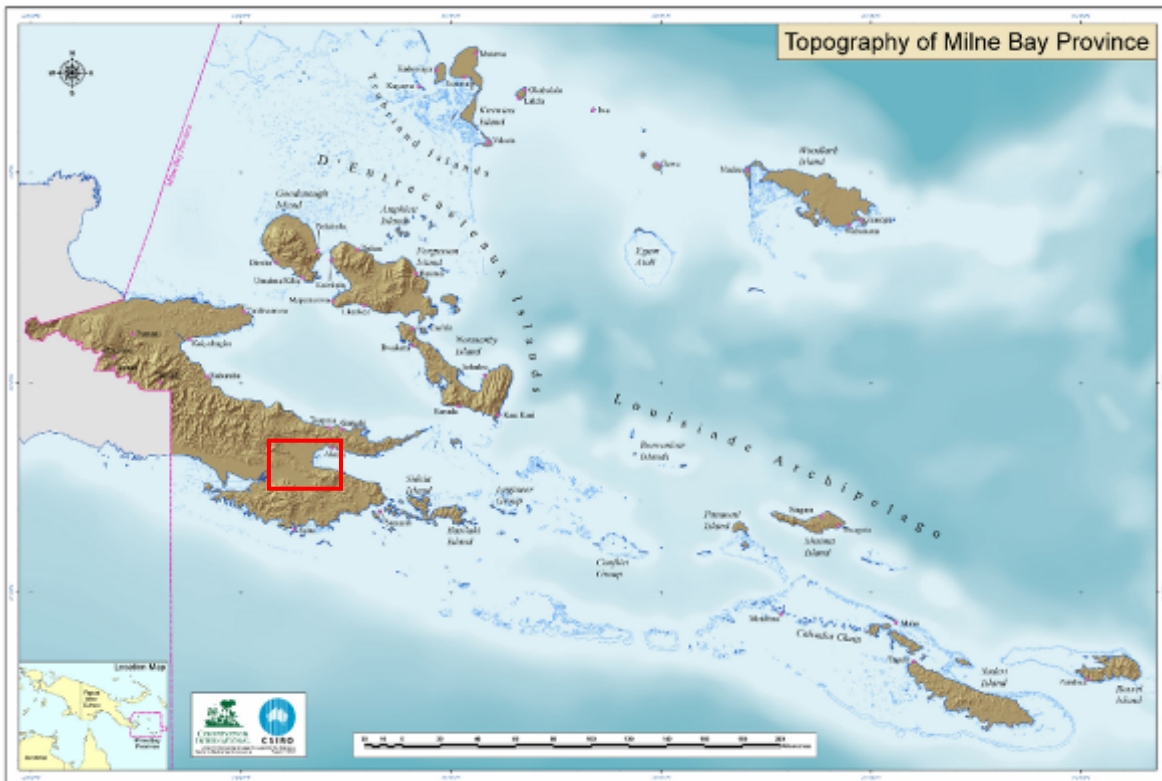
- Work with local government, industry and community stakeholders to identify sustainable development options
- Explore impacts of future drivers (e.g. climate change) on sustainable development and livelihoods
- Begin examples of participatory planning for sustainable development

The aims of the workshop were:

- Introduce the project to Milne Bay Administration, industry and community stakeholders
- Illustrate the project by carrying out a preliminary planning exercise
- Consider next steps for the project (e.g. form stakeholder reference group, identify scales and areas of priority)

The workshop also provided an opportunity to establish linkages with AusAID which is represented in the province by two officers under their *Sub-national Strategy*. This has a goal of improved service delivery in PNG by supporting the sub-national levels of government which have significant responsibility for the delivery of basic services. The Milne Bay Administration agreed to host two AusAID officers in 2008 to assist them in their corporate reform program and to help build capacity in core public administration areas. The AusAID officers also coordinate and support AusAID activities in the province and ensure those activities are addressing service delivery needs and issues.

This report summarises the outcomes of the workshop, and provides results of a preliminary integrated planning exercise carried out for the Upper Milne Bay area. The workshop agenda is provided in Appendix II.



**Figure 1.** Milne Bay Province, Papua New Guinea, showing the Upper Milne Bay study area used in the workshop

## 2. SUSTAINABLE DEVELOPMENT PLANNING

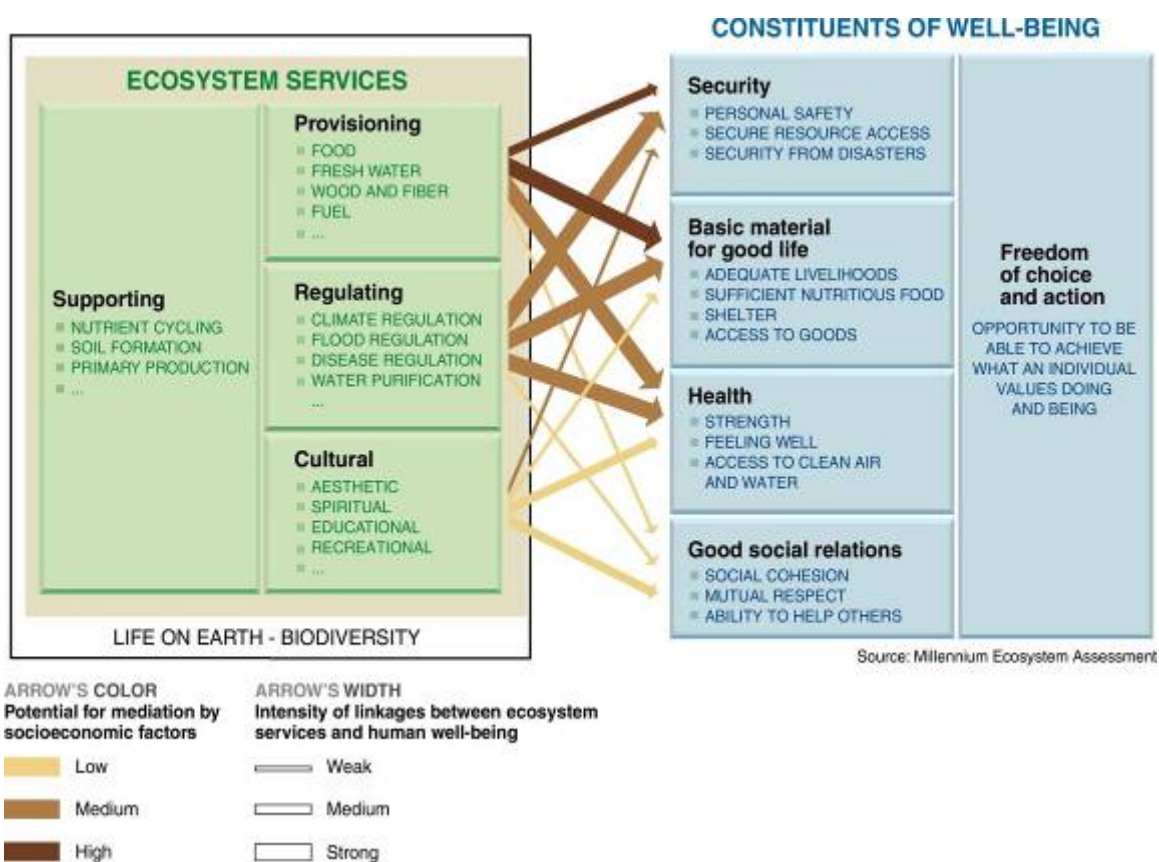
### 2.1 The Millennium Assessment

The Millennium Ecosystem Assessment (MA, 2005) was the first global attempt to assess the current status of ecosystem services, human demands and pressures on those services, and potential future development trajectories based on these assessments.

The MA used several key terms and concepts which are explained below:

- ***Ecosystem services*** are the benefits that people obtain from ecosystems. These were categorised by the MA as provisioning (e.g. food, water), regulating (e.g. erosion control, carbon storage), cultural (e.g. recreational or spiritual benefits). A fourth category, supporting services (e.g. soil formation, nutrient cycling) underpins the other three (Figure 2).
- ***Human well-being*** is at the opposite end of a continuum from poverty, which has been defined as a ‘pronounced deprivation in well-being’. Constituents of well-being include basic materials for a good life, freedom of choice, health and security. Well-being is linked to ecosystem services through a complex series of relationships which can be mediated through policy and management (Figure 2).
- ***Sustainable livelihoods*** are defined by Scoones (1998) as the ‘capabilities, assets and activities required for a means of living which can cope with and recover from stresses and shocks, maintain or enhance its capabilities and assets, while not undermining its resource base’. Livelihoods are based partly on ecosystem services (e.g. fish stocks for fisheries).
- ***Trade-offs*** are the choices that can be made between different options provided by sets of ecosystem services. Trade-offs can occur between different locations in space (e.g. upstream and downstream in a catchment) and between different points in time (e.g. between present and future generations).
- ***Valuation of ecosystems and ecosystem services*** is the quantification of the flow of benefits provided by ecosystems. This is complicated by the difference between utilitarian values (i.e. those derived from the use or non-use of ecosystems), and intrinsic values (i.e. inherent values regardless of the service they provide when used). These require different methods of valuation which can often not be easily compared. Although challenging, valuation is a useful tool for assessing trade-offs.
- ***Drivers of change*** are the factors which cause changes in ecosystems and ecosystem services either directly or indirectly over time. These may include human factors such as population growth, or biophysical factors such as climate change. Drivers can be managed or mitigated by governance decisions introduced at scales appropriate to the driver.

- **Thresholds** are the tipping points beyond which drivers of change or the condition of ecosystem services, well-being or livelihoods can quickly change. For example, species diversity of a landscape may decline steadily with increasing habitat degradation to a certain point, and then fall sharply after a critical threshold of degradation is reached. Thresholds at which irreversible changes occur are especially of concern to decision-makers.
- **Future scenarios** are plausible descriptions of how the future may develop, based on sets plausible sets of interactions between drivers of change in the future, and their outcomes for ecosystem services, human well-being and livelihoods.



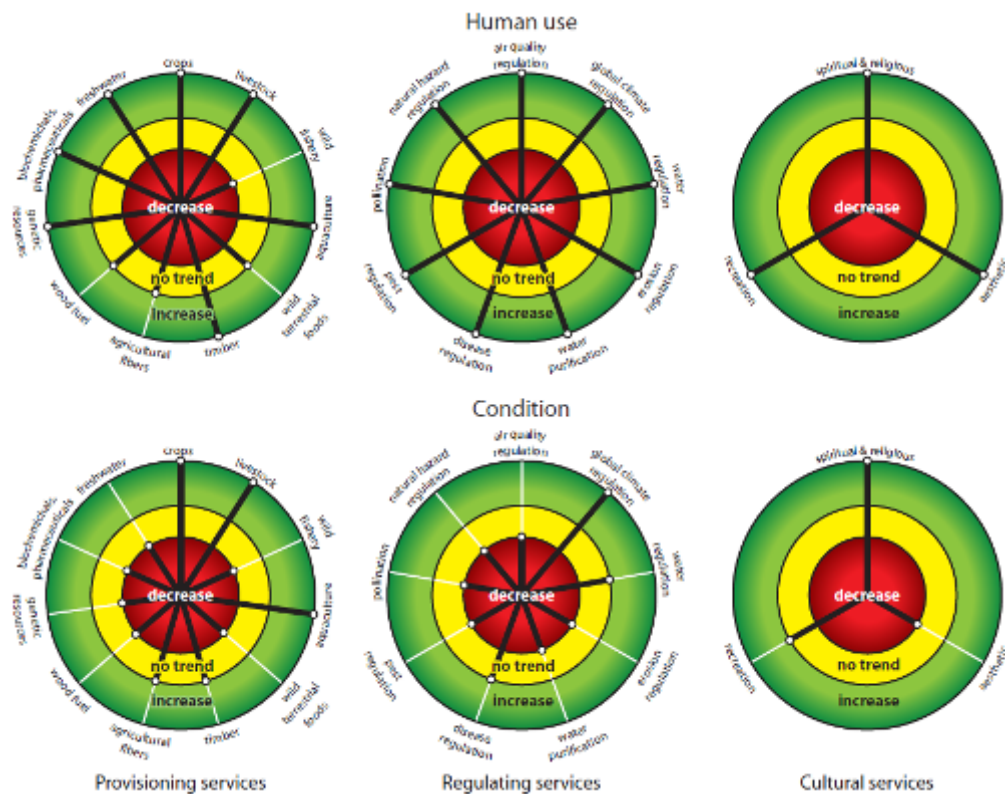
**Figure 2.** Categories of ecosystem services and possible links to the constituents of human well-being (MA, 2005).

The MA also highlighted the multiple spatial scales of ecological and human systems and their interactions, ranging from the plot and individual level, to the global and international level. Most direct interactions occur between humans and ecosystems at the local scale (e.g. individuals, families, villages and ecosystems or landscapes), and it is at this scale that most management of natural resources must occur.

This approach is also advocated by CI, which aims to conserve biodiversity at sites nested within the scale of land/seascape, through human governance at this scale (e.g. community; local and provincial governments).

## 2.2 Integrated planning process

To undertake an integrated assessment of current ecosystem services, links to human well-being and potential future pathways for sustainable development, a process of staged questions can be followed. The MA (2005) posed a series of over-arching questions which were addressed at both global and sub-global scales. Key to this was the assessment of the current trends in ecosystem service use and their condition, and possible trade-offs using radial diagrams (Figure 3).

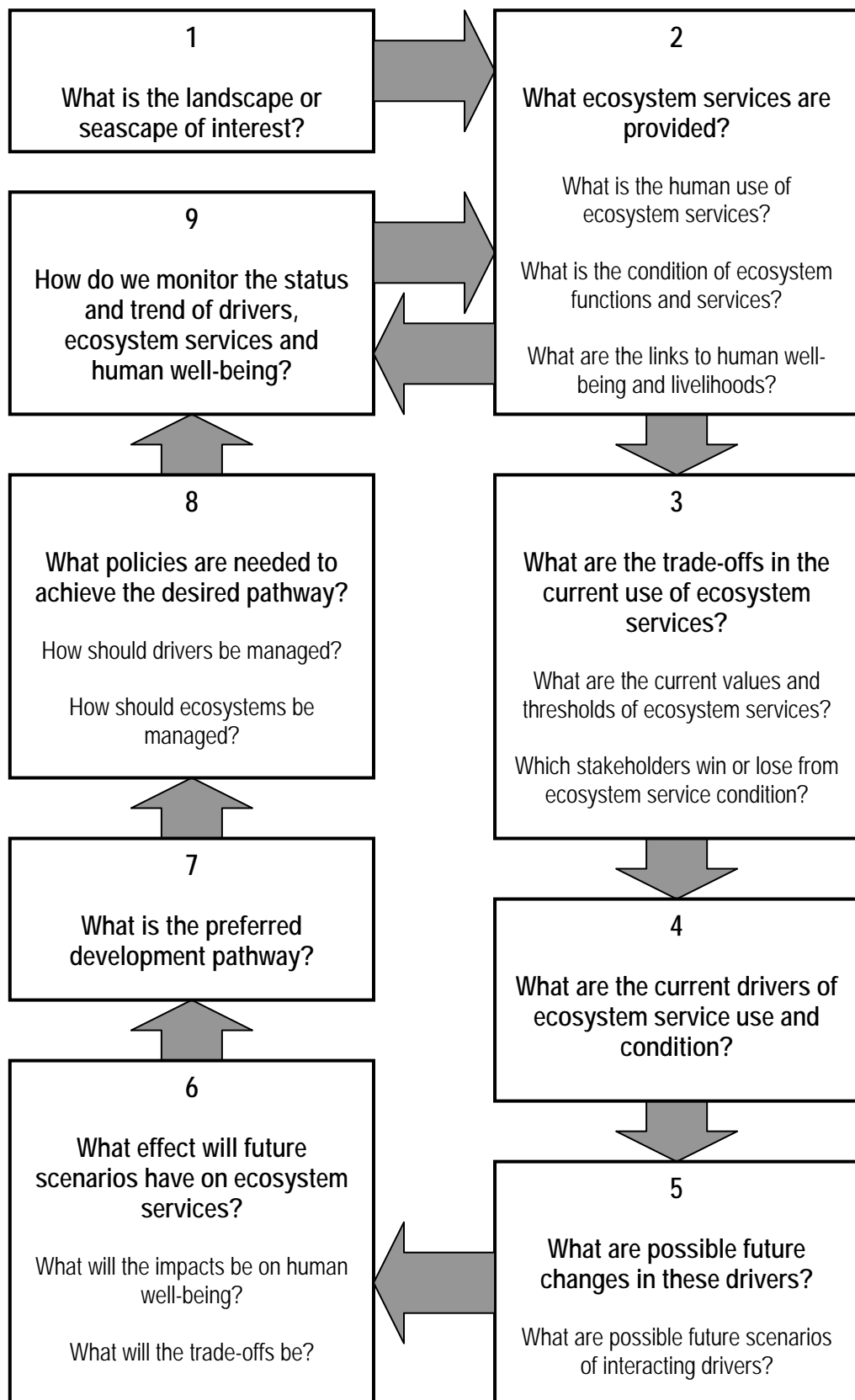


**Figure 3.** Radial diagrams showing trends in human use (upper) and condition (lower) of ecosystem services at the global scale. Provisioning, regulating, or cultural ecosystem services are shown in left, centre, and right, respectively. Length of black radial lines shows the degree of change in human use or condition of the service. Modified from the MA (2005) by Carpenter *et al.* (2009).

De Groot (2006) also presented a series of steps for landscape-scale planning of natural resource use. First, an analysis is undertaken of the current range of functions and services provided by the landscape, and their condition. Second, the different functions and services are valued. Third, conflict analysis is used to bring stakeholders together to examine trade-offs in ecosystem services and collectively examine future options that optimise values.

### **2.3 CSIRO-CI approach**

To undertake integrated assessments for Milne Bay, we combined the approaches and terms of the MA (2005) and de Groot (2006). This involves a series of 9 questions and sub-questions about the landscape or seascape of interest (Figure 4). To achieve a balanced assessment of ecosystems, their values and trade-offs, it is important that this process is undertaken collectively with all stakeholders. For technical input biophysical and social scientists can support the process, although in many cases there may be significant gaps in science and local knowledge will be essential to provide necessary information. This inclusive, participatory approach also generates ‘deliberative democracy’, where decision-making results not from the aggregation of separately measured individual preferences, but from open public debate (de Groot, 2006).



**Figure 4.** The steps for the integrated assessment of sustainable development pathways

### **3. WORKSHOP PROCESS AND RESULTS**

#### **3.1 Workshop participants**

A cross section of relevant stakeholders was invited to attend a two day workshop on 27<sup>th</sup> and 28<sup>th</sup> April at the International Hotel, Alotau, Milne Bay Province. Representatives of the Milne Bay Administration, including the Administrator and the offices of health, lands, policy, agriculture, and mines liaison attended. In addition major industries were represented by the Milne Bay Tourism Bureau, Forestry, Milne Bay Estates, the Oil Palm Industry Corporation (representing village oil palm producers) and Oil Palm Research Association. Community interests were represented by the Milne Bay Church Development Fund Association and village tour operators. AusAID officers based in the Administration under the *AusAID Sub-national Strategy* also attended.

#### **3.2 Preliminary integrated assessment of Upper Milne Bay**

Due to the limited time it was not possible to complete all steps of the CSIRO-CI approach in detail, but some primary questions were addressed. It was decided to focus on the Upper Milne Bay area to the west of Alotau, an area of approximately 375 km<sup>2</sup>, since this landscape provided examples of oil palm development, logging, fisheries, tourism, human population growth and sea level rise impacts due to climate change (Figure 5). On Day 1 the workshop participants were taken on a field trip to examine a representative 'transect' of the area and discuss current issues influencing it.

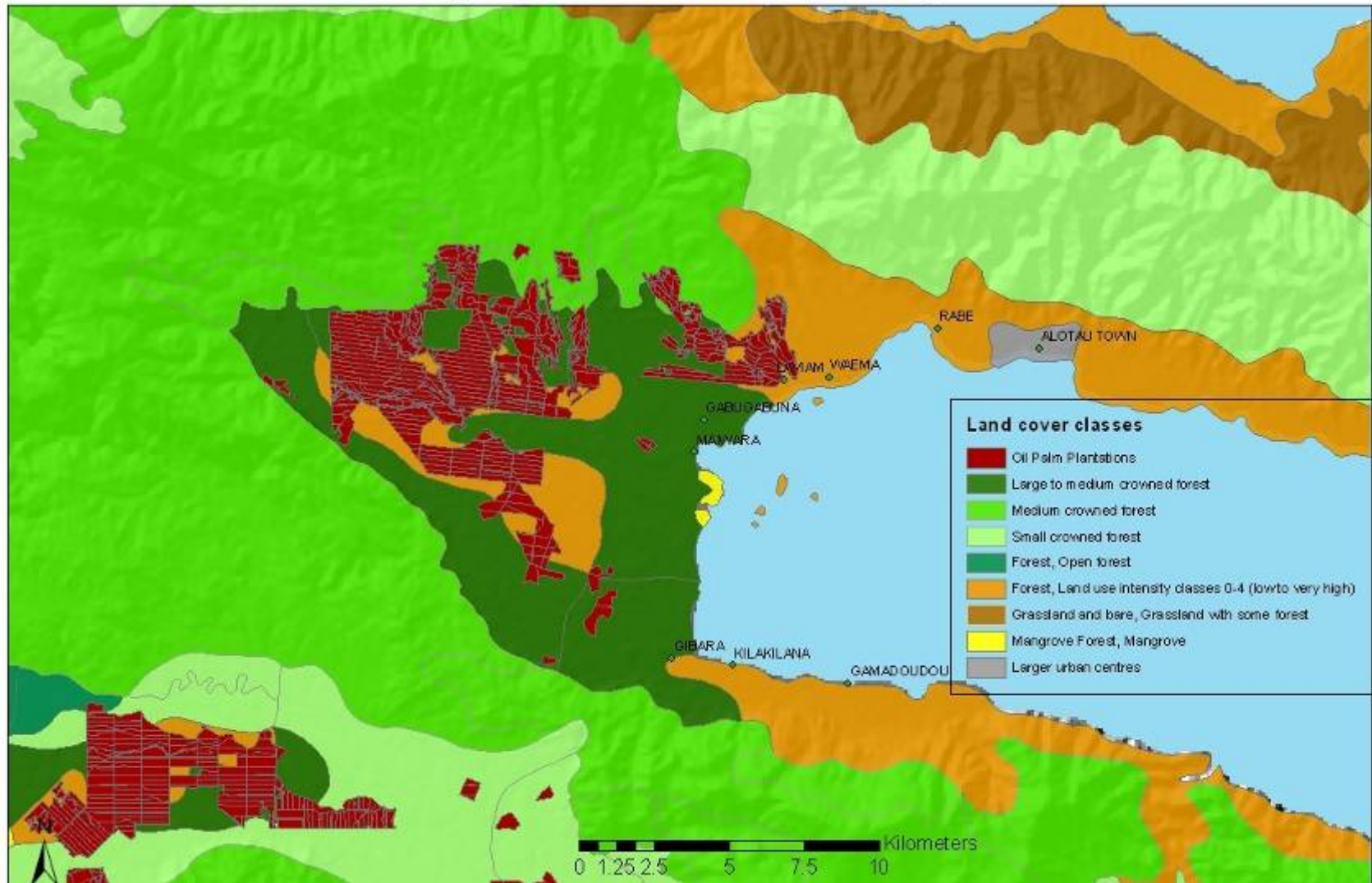
The participants were then divided into four groups of 4 to 6 people each. For the rest of the working sessions the groups were asked to consider the following five questions (see agenda in Appendix II):

- a) *What are the current ecosystem services in the Upper Milne Bay area, and where do they occur in the land and seascape?* This question aimed to partly fulfil Step 2 (see Figure 4), and participants were given Google Earth images of Upper Milne Bay and coloured markers to map ecosystem services.
- b) *What are the current trends in condition of the ecosystem services?* This question also aimed to fulfil part of Step 2. Radial diagrams as shown in Figure 3 were used to depict perceived condition and trends.
- c) *What are the trade-offs between ecosystem services, and who are the stakeholders who win or lose?* This aimed to fulfil part of Step 3.
- d) *What are the current drivers of ecosystem service use and condition, and how are they likely to change in the future?* On Day 2 of the workshop presentations were given from local industry representatives, the forestry, mining and health departments of the Milne Bay Administration, CSIRO for climate change and

- e) *How should Upper Milne Bay be managed to account for these future drivers and achieve sustainable development?* Participants were asked to design and apply management strategies to maximise ecosystem services, human well-being and sustainable livelihoods in Upper Milne Bay given the potential future drivers. These were mapped onto new Google Earth images of the study area. This fulfilled Steps 7 and 8



Workshop participants on the field trip viewing coastal erosion in Upper Milne Bay (left) and an oil palm plantation (right). (Photos: Erin Bohensky, James Butler).



**Figure 5.** The Upper Milne Bay study area, showing land use and the location of Alotau

### 3.3 Results of the preliminary integrated assessment

#### a) *What are the current ecosystem services in the Upper Milne Bay area, and where do they occur in the land and seascape?*

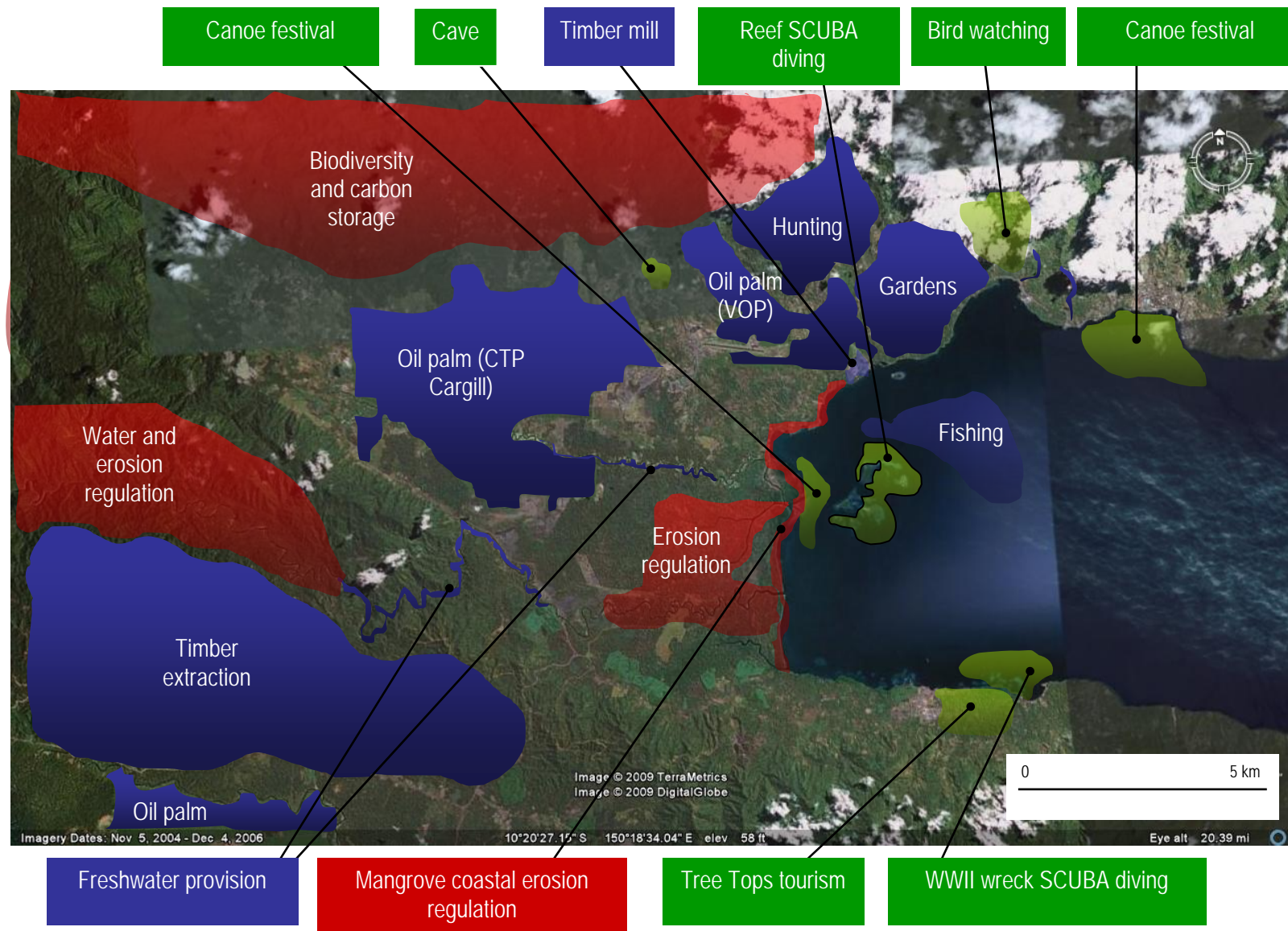
The groups mapped their perceptions of the types and locations of ecosystem services. Only provisioning, regulating and cultural services were mapped. Supporting services (e.g. soil formation, nutrient cycling) were not considered since they are comparatively intangible in a spatial sense, and occur at time scales less likely to be influenced by human policy interventions. The results from each group are shown in Figures 6 to 9.

All groups identified similar areas for the following ecosystem services:

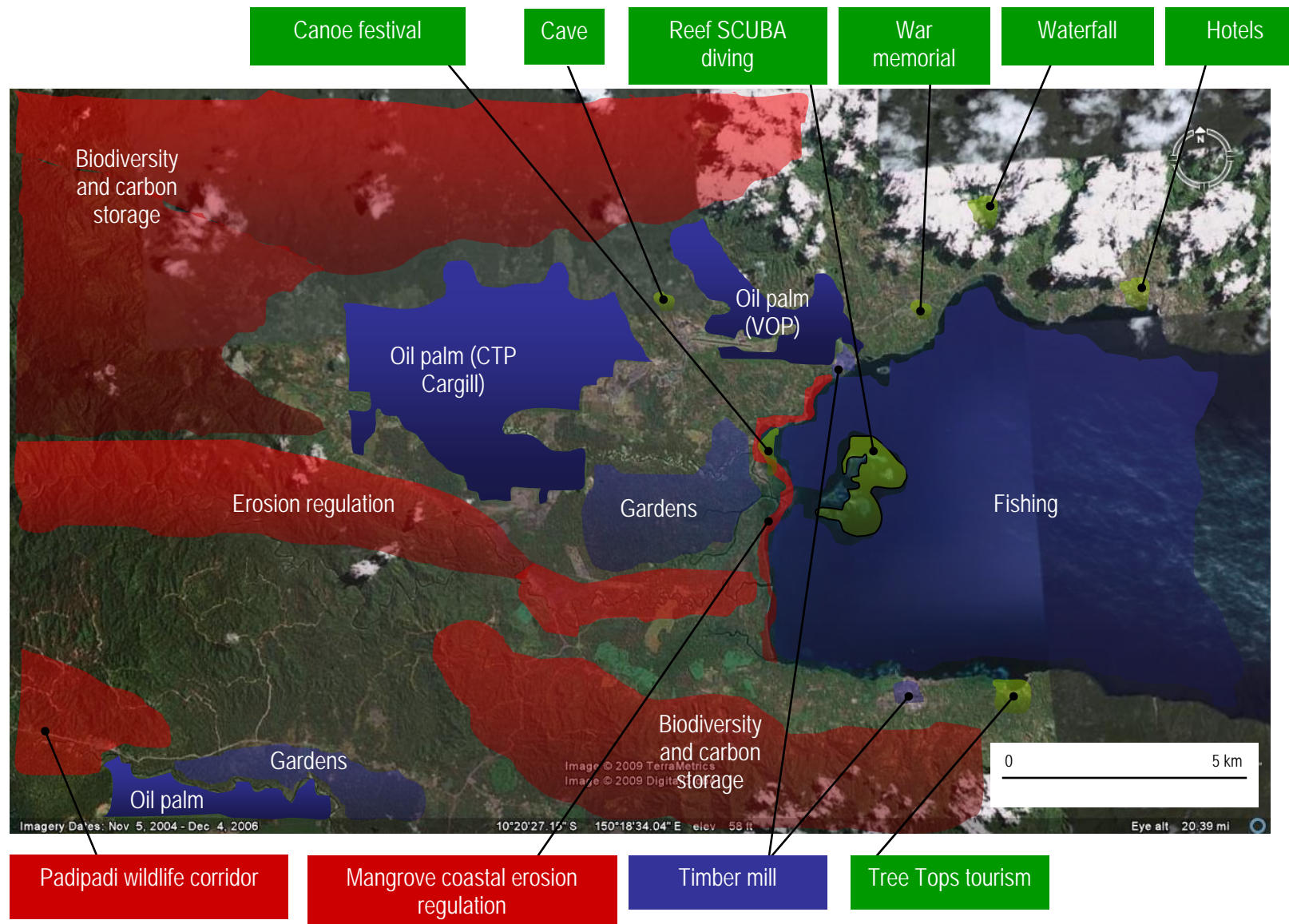
- *Provisioning services:* Oil palm (Cargill and Village Oil Palm (VOP)) was easily located by all groups. Fishing areas were identified across the marine area in Upper Milne Bay.
- *Regulating services:* Erosion regulation and biodiversity were the only two services identified by all groups, although each mapped them into differing parts of the study area.

However, there were many services which were only identified by some groups:

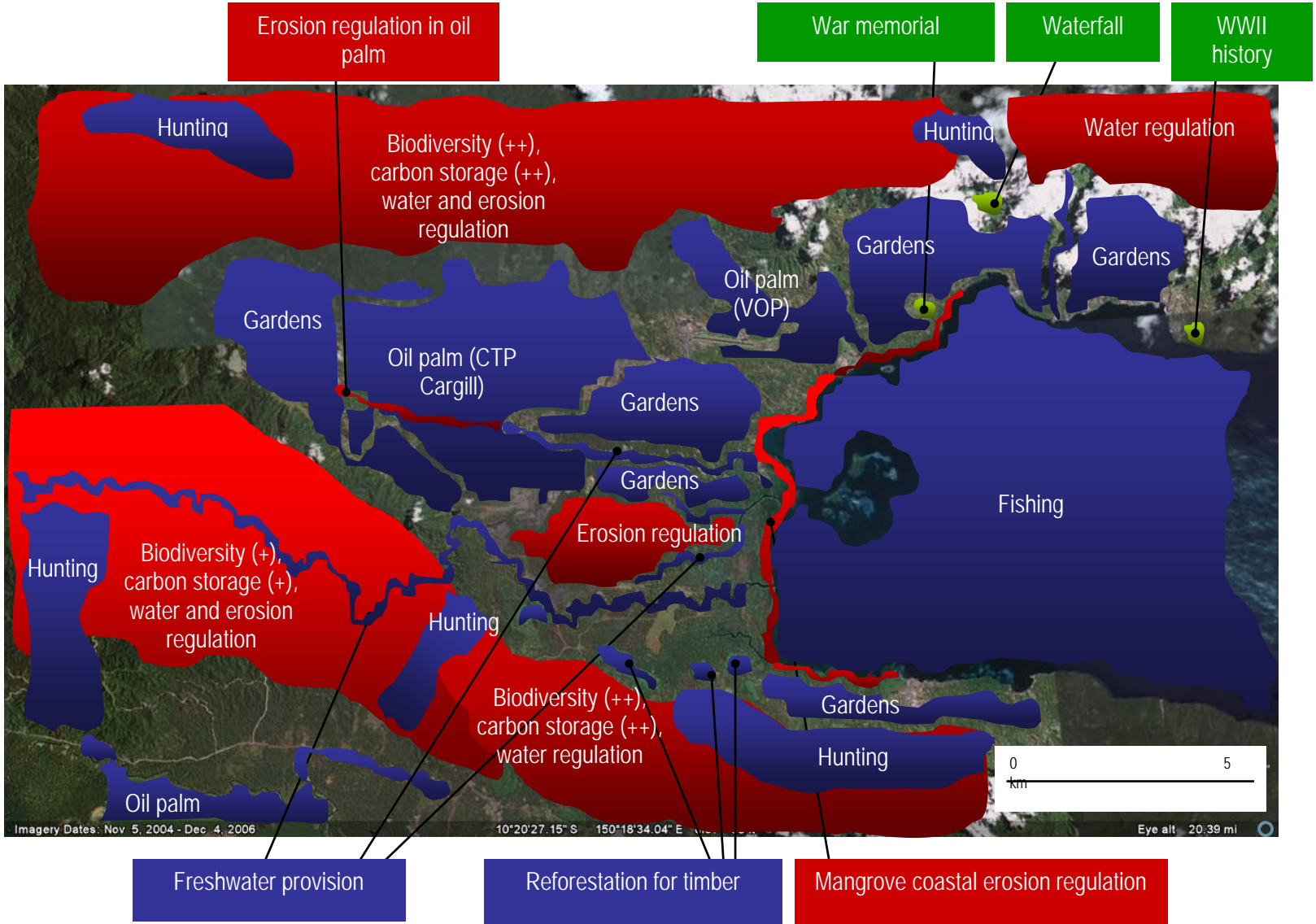
- *Provisioning services:* Gardens for subsistence food production, hunting areas, freshwater supplies from rivers, and timber extraction, reforestation or mills were identified throughout the study area by different groups.
- *Regulating services:* Carbon storage, erosion regulation by riparian vegetation and mangroves along the coast, and water regulation were located throughout the study area. Carbon storage and water regulation in particular were located in more mountainous and forested upper catchment areas. Group 3 provided assessments of relatively important (++) or less important areas (+) for biodiversity and carbon storage (see Figure 8).
- *Cultural services:* There was broad identification of locations for these services by all groups. For tourism, caves, waterfalls, bird watching, SCUBA diving on coral reefs and WWII wrecks, WWII memorials and history, hotels in Alotau, Tree Tops tourist lodge and locations for the annual canoe festival were all identified. Group 3 also identified sacred sites and cemeteries as areas of local cultural significance, but these were too numerous to effectively map.



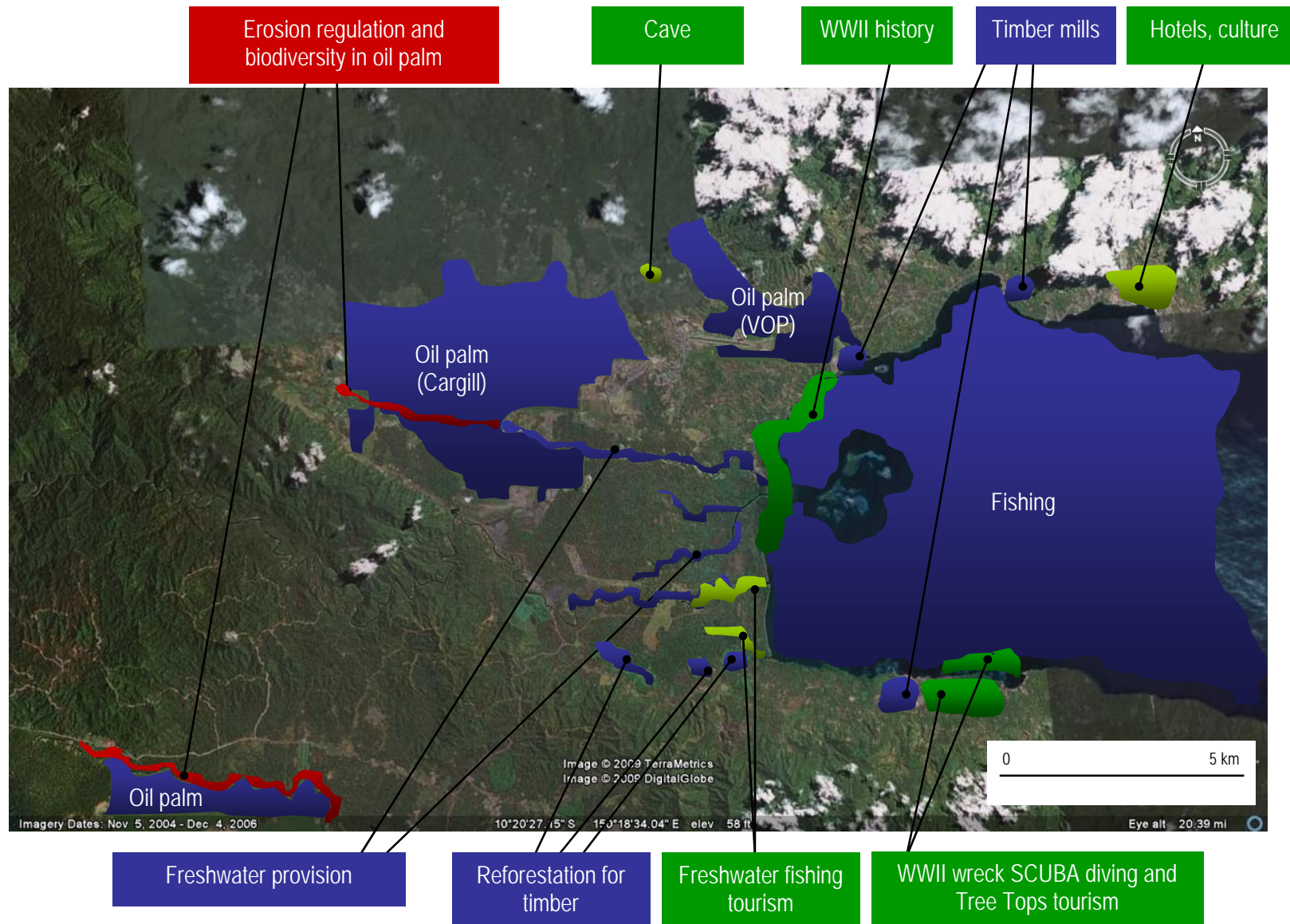
**Figure 6.** Group 1's mapping of ecosystem services in the Upper Milne Bay study area. Blue represents provisioning services, red regulating services and green cultural services.



**Figure 7.** Group 2’s mapping of ecosystem services in the Upper Milne Bay study area. Blue represents provisioning services, red regulating services and green cultural services.



**Figure 8.** Group 3's mapping of ecosystem services in the Upper Milne Bay study area. Blue represents provisioning services, red regulating services and green cultural services.



**Figure 9.** Group 4’s mapping of ecosystem services in the Upper Milne Bay study area. Blue represents provisioning services, red regulating services and green cultural services.

**b) What are the current trends in condition of the ecosystem services?**

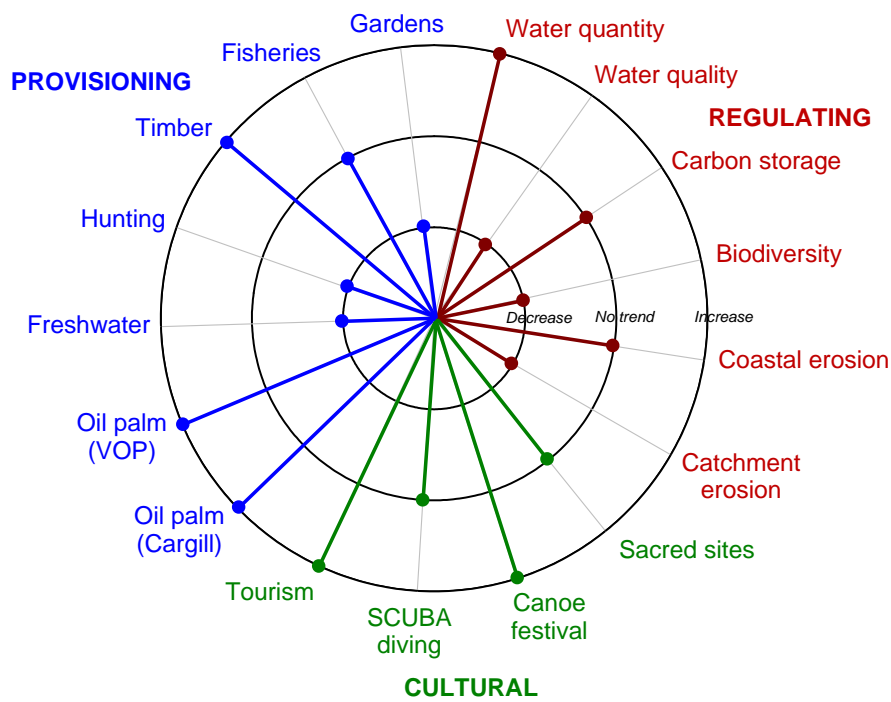
Using radial diagrams, each group assessed the current trends in condition of the ecosystem services they had mapped. These were measured as either ‘increasing’, ‘no trend’ or ‘decreasing’ (Figures 10 to 13).

To summarise the groups’ conclusions we averaged the scores given to each of the 16 ecosystem services identified (Figure 14). The results were:

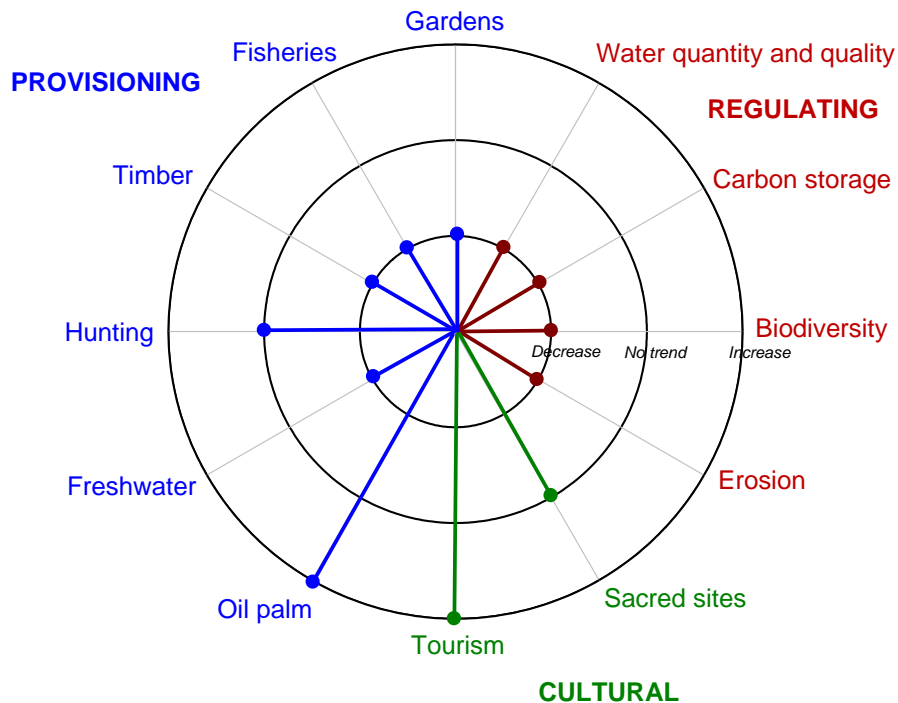
- *Provisioning services:* Of the six ecosystem services identified, only oil palm (Cargill and VOP combined) scored above ‘no trend’. Gardens, hunting, fisheries and timber all averaged between ‘no trend’ and ‘decreasing’. Freshwater for drinking averaged the lowest with a decreasing trend and all groups agreed on this. For oil palm, timber and fisheries there was wide variation around the average score, with each assessed as both increasing and decreasing in condition by groups.
- *Regulating services:* Of the five ecosystem services identified, all averaged between ‘no trend’ and ‘decreasing’. Erosion regulation (coastal and catchment combined) had the lowest score, followed by carbon storage, and there was relative consensus from the groups as demonstrated by the small range in values for each. For water quality, water quantity and biodiversity there was wide variation around the average score, with each assessed as both increasing and decreasing in condition.
- *Cultural services:* The condition of tourism and the canoe festival was perceived to be increasing. SCUBA diving and cemeteries averaged ‘no trend’ and sacred sites average slightly below ‘no trend’. Compared to provisioning and regulating services there was relative consensus on these scores, with no or small ranges around them. However, SCUBA diving and the canoe festival were only scored by one group and was therefore not an average.



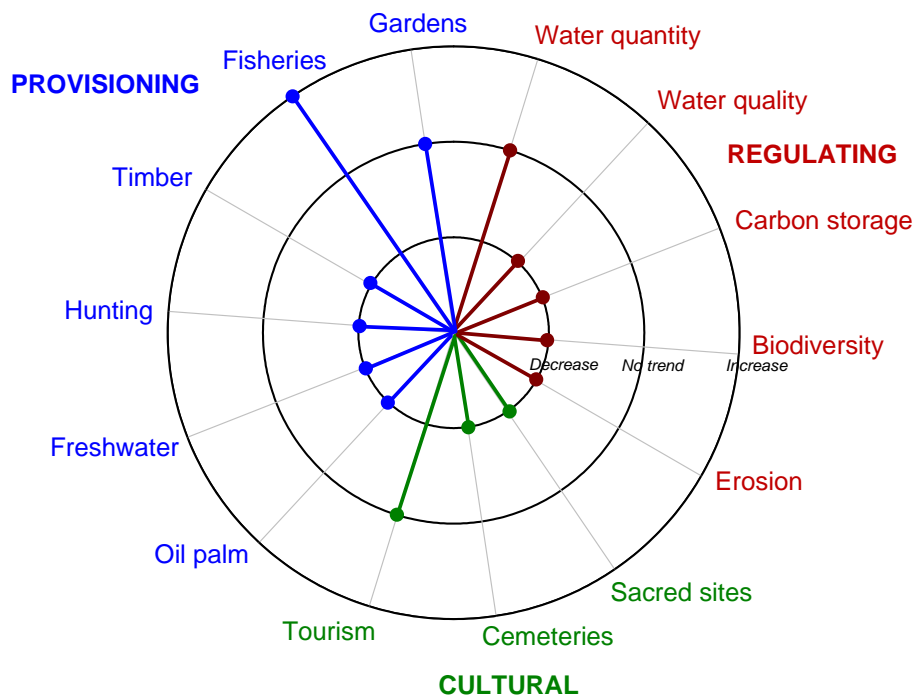
Workshop groups mapping ecosystem services in Upper Milne Bay (left) and presenting a radial diagram illustrating the trends in condition of ecosystem services identified (right). (Photos Erin Bohensky).



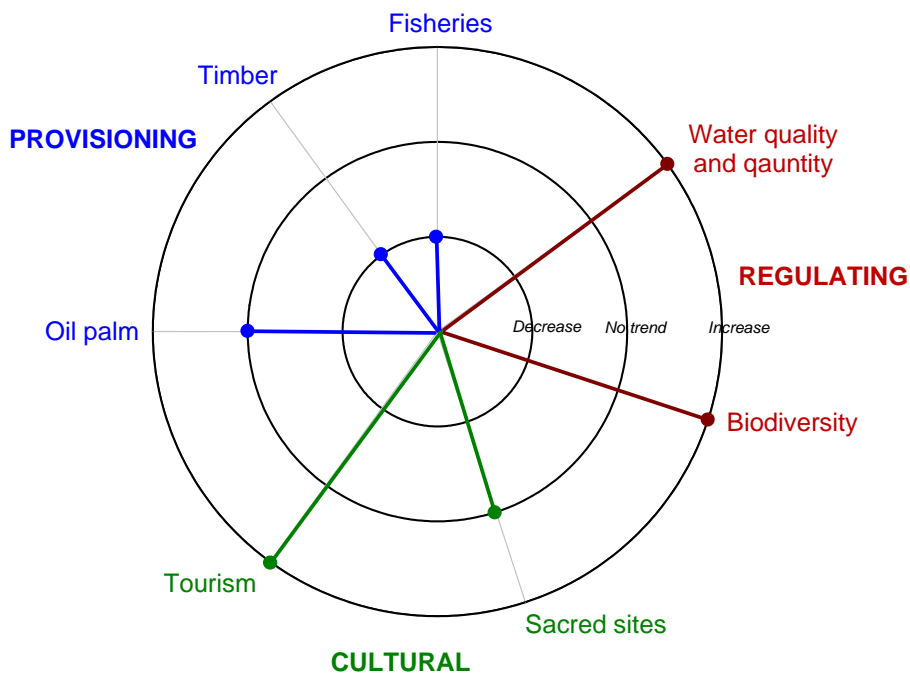
**Figure 10.** Group 1’s radial diagram illustrating the current trend in condition of the ecosystem services mapped in Figure 6. The inner ring represents a ‘decrease’ in condition, the middle ‘no trend’, and the outer an ‘increase’.



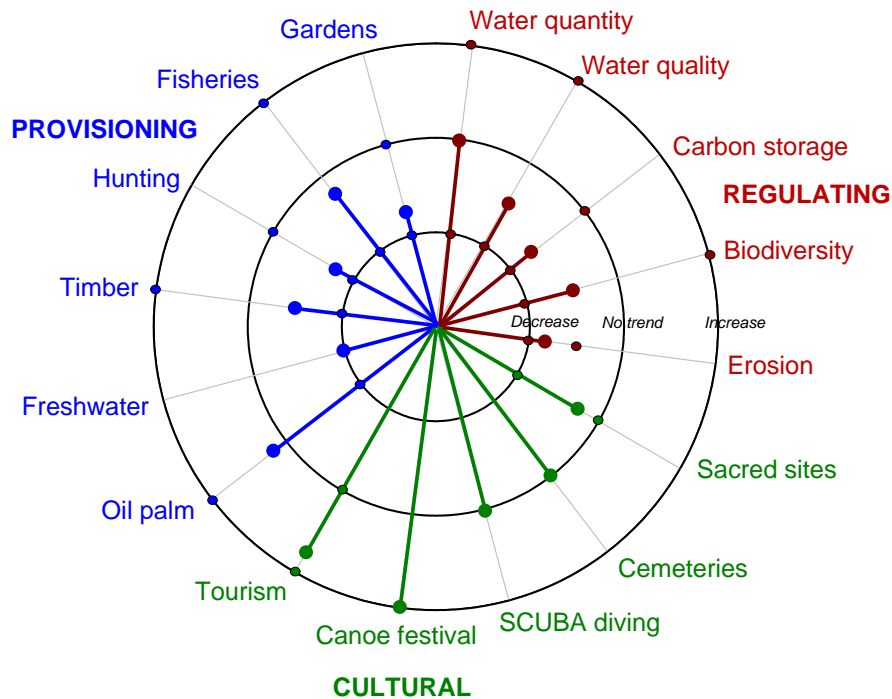
**Figure 11.** Group 2’s radial diagram illustrating the current trend in condition of the ecosystem services mapped in Figure 7. The inner ring represents a ‘decrease’ in condition, the middle ‘no trend’, and the outer an ‘increase’.



**Figure 12.** Group 3's radial diagram illustrating the current trend in condition of the ecosystem services mapped in Figure 8. The inner ring represents a 'decrease' in condition, the middle 'no trend', and the outer an 'increase'.



**Figure 13.** Group 4's radial diagram illustrating the current trend in condition of the ecosystem services mapped in Figure 9. The inner ring represents a 'decrease' in condition, the middle 'no trend', and the outer an 'increase'.

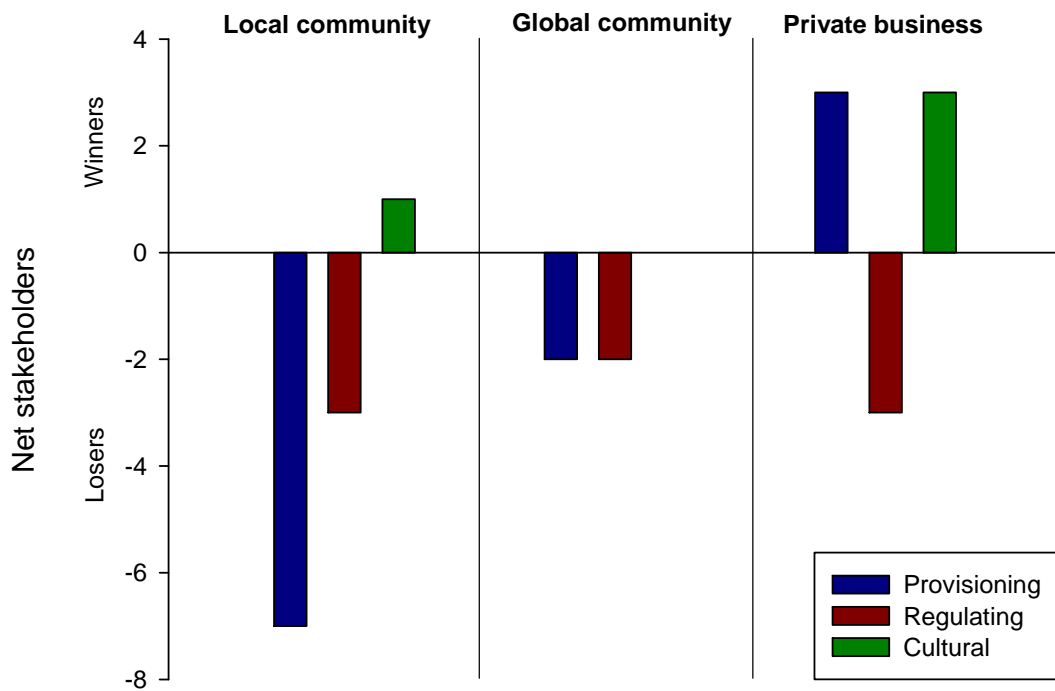


**Figure 14.** The average scores given by the four groups for the current trend in condition of the ecosystem services mapped. Small dots on each ecosystem service's radial spoke represent the highest and lowest scores recorded.

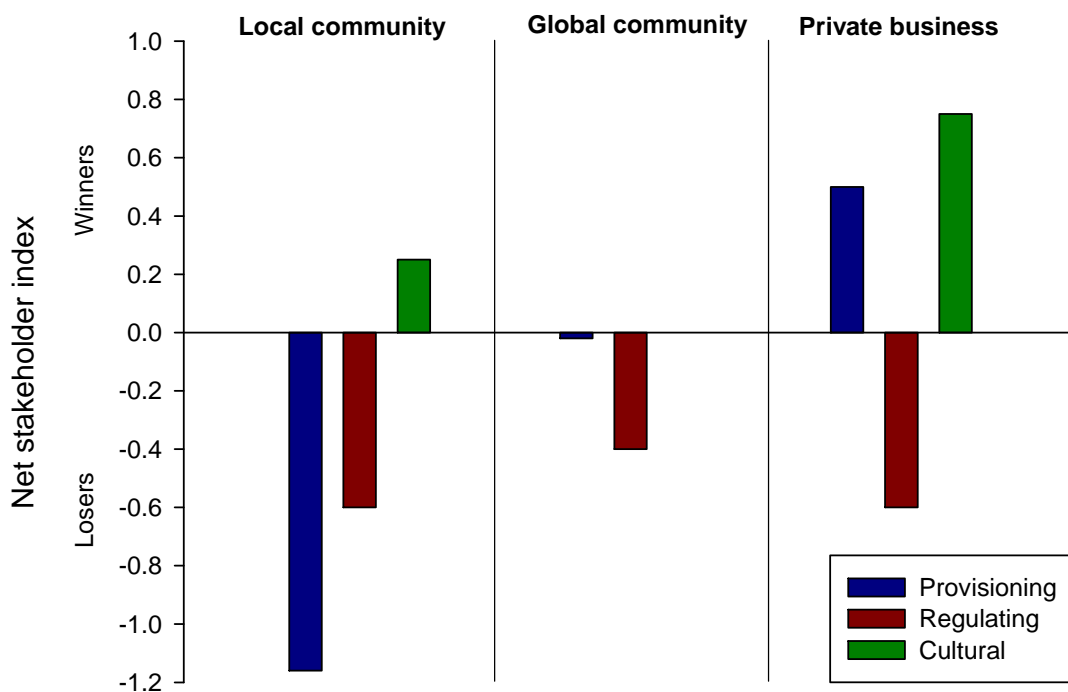
**c) What are the trade-offs between ecosystem services, and who are the stakeholders who win or lose?**

There was discussion about possible trade-offs among the ecosystem services, and links between their trends in condition. Of concern was the condition of freshwater for drinking, which all groups agreed was declining, and parallels with declining water quality regulation (Figure 14). It was agreed that this could be linked to erosion regulation (within catchments), which groups also agreed was decreasing. The causes of these linked trends was considered to be population pressure, linked removal of vegetation in catchments, and possibly the impact of oil palm run-off on water courses. There was also concern about the declining condition of gardening and hunting, and therefore traditional knowledge of subsistence food provision. The cause of this was considered to be urban migration of people and their increased involvement in the formal cash economy including the oil palm industry.

Participants identified three groups of stakeholders (local community, global community and private business), and judged them as either 'winners' or 'losers' as a result of the current condition of ecosystem services. When the net winners and losers were counted, local communities were the greatest losers from provisioning services. They were also losing from regulating services, but gaining slightly from cultural services (Figure 15). Private business was gaining from provisioning services (largely oil palm and timber production). Local communities, global community and private business were losing from provisioning services. When these counts were standardised for the number of ecosystem services in each category, the results were similar (Figure 16).



**Figure 15.** The net counts (i.e. total counts of winners minus total counts of losers) of each stakeholder group identified as winners or losers as a result of the current condition of provisioning, regulating and cultural ecosystem services in Upper Milne Bay.



**Figure 16.** The net index for each stakeholder group identified as winners or losers as a result of the current condition of provisioning, regulating and cultural ecosystem services in Upper Milne Bay. Counts have been corrected by the number of ecosystem

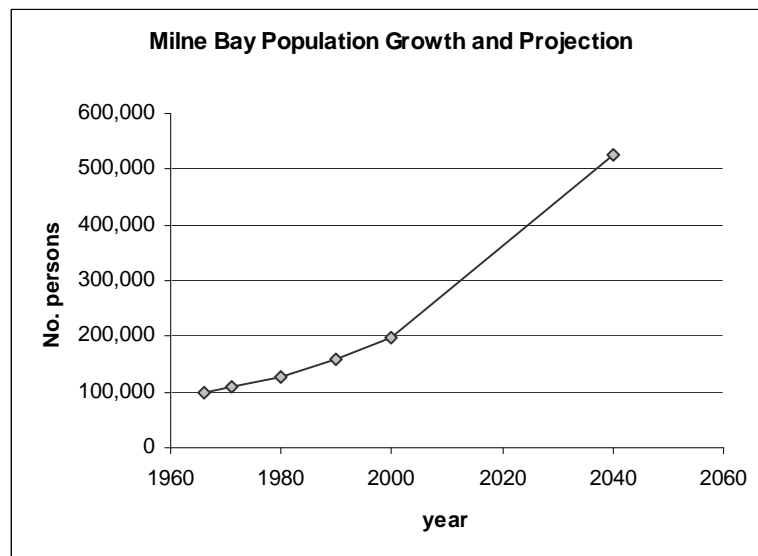
services for provisioning (6), regulating (5) and cultural (4) categories to form the index.

**d) What are the current drivers of ecosystem service use and condition, and how are they likely to change in the future?**

On Day 2 of the workshop participants with particular expertise presented a summary of the current drivers of ecosystem service use and condition in Milne Bay Province, and potential future changes in these drivers. These were human population growth, climate change, fisheries, timber industry, oil palm, tourism, mining and biodiversity conservation.

**Human population (Richard Dawana , Coordinator Rural Health Services, Health Division):**

- The Milne Bay Province population is currently 230,000, living on 14,600 km<sup>2</sup> of land at an average density of 16 per km<sup>2</sup>.
- The rate of population increase is 2.7% p.a. At this rate the population will double to 420,000 by 2040 (Figure 17).
- 80% of people live on the islands, and the greatest pressures on land and food security occurs in these areas. The Trobriand Islands has the highest population density of 84/km<sup>2</sup>, and soil fertility is decreasing, threatening food security. Malnutrition is evident in the Esa'ala District.
- Families have between 4 – 12 children each, but family planning awareness is increasing. There are 86 health centres in the province.
- Approximately 2.5% of the population are HIV positive, and escalation will affect the most productive cohort of the population.
- The average cash income is K780 per annum, which is below the international poverty line.



**Figure 17.** Current and projected human population growth in Milne Bay Province from the National Census 2000, with projections made using the population growth rate.

*Climate change (Tim Skewes, CSIRO):*

- Global air temperatures are likely to increase by 2 – 6 °C by 2100. For Milne Bay Province the downscaling of climate models is ongoing, and there is considerable uncertainty about potential effects. However, current predictions are that the increase in Milne Bay will be at the lower end of this scale.
- In the marine environment, increased sea temperatures will result in changes in species growth and distribution, and coral bleaching when temperatures exceed 30.5 °C. Bleaching events have already occurred in 1996, 1998, 2000 and 2006. There may be annual bleaching by 2030, resulting in a switch from coral to algae-dominated reefs and associated changes to fish and invertebrate communities, including lowered species richness.
- Globally, sea levels may rise from 9 – 88 cm by 2100. A decadal sea level rise of 8 – 10 mm p.a. has been observed on the east coast of PNG, three times the global average. This will result in inundation of low-lying areas, particularly during storm surges. Small changes in sea level coupled with changes in local current patterns can also cause erosion of sand islands.
- Mangrove forests can play an important role in protecting coasts from erosion caused by rising seas. Recent research has shown that mangroves can accumulate sediments to keep up with sea level rise, or migrate inshore, but only if there are no impediments to inshore migration (e.g. roads).
- Precipitation trends are very difficult to predict, however winters are likely to become dryer and summers wetter. Weather patterns are likely to become more erratic, with perhaps more El Nino conditions and associated droughts. Cyclones may become less common but more intense.
- Ocean acidification is likely to damage calcifying organisms and cause reef erosion by 2030.
- Water currents patterns will also be affected by regional factors which in turn will cause changes to the strength and timing of upwelling events, particularly along the northern PNG coastline. This will also have unpredictable impacts on larval delivery pathways with potential detrimental effects on fishery populations.
- Most impacts will result in a loss of production from marine systems. Food production on land may also be affected by droughts and temperature increases. Temperature-sensitive species will become more restricted in their ranges, and some may become extinct as climate refugia contract.

*Fisheries (Tim Skewes, CSIRO):*

- Milne Bay Province is the largest producer of beche-de-mer in PNG, with over 30% of the national catch in 2000. Beche-de-mer is the largest source of foreign exchange in Milne Bay, and the catch peaked in 2001 when 209 tonnes worth over US\$2 million was exported.
- A survey in 2001 showed that many of the high value species were overfished. Recommendations were made to close the sandfish and black teatfish fishery, strictly enforce the current total allowable catch of 140 tonnes, and restrict the catch of premium value species to 10 tonnes, medium species to 26 tonnes and low value species to 104 tonnes.
- In 2009 the National Fisheries Authority will enforce a closure of the beche-de-mer fishery for three years. This is likely to have a major impact on the livelihoods of many communities in the outer islands.
- The 2001 survey also found that giant clam populations were at low levels, perhaps also due to overexploitation.
- Fisheries for shark fin are also important sources of foreign exchange for the province, and many fishermen may transfer effort from the beche-de-mer fishery to sharks. Shark fisheries in other parts of Asia and the South Pacific have been shown to be very vulnerable to overexploitation. Any dramatic increase in effort will likely also see this fishery over-fished.

***Timber industry (Noel Dibela, Provincial Forest Officer):***

- There are a series of logging concessions within the province. There is currently one selective logging project in the province, at Sagarai (Timber Authority) Gadaisu (Timber Permit). Other timber areas at Gara-Modewa, West Gurney, West Woodlark Island, Sideia on Normanby Islands have expired whilst East Fergusson is still current but un-allocated.
- There are limited suitable areas for future selective logging in Milne Bay. There is now a focus on reforestation for future commercial use. There are two proposed forest management areas for East Collingwood Bay where landowners prefer to leave their forest, and also in East/West Suau.
- Incoming foreign forestry companies are banned, and landowner logging is also declining. There are no round log exports from Milne Bay, and only milled timber is exported. This is driven by the declining price of timber, and the reduced availability of high value rosewood *Pterocarpus indicus* and kwila *Intsia bijuga*.
- A Logging Code of Practice (1996) exists, which recommends minimum buffer zone widths on rivers, settlement ponds and other environmental management practices.

***Oil palm industry (Chris Terupo, Cargill-CTP):***

- Cargill is committed to the Roundtable on Sustainable Palm Oil (RSPO), which is promoting self regulation of the oil palm industry, verified through independent audit. Issues considered under the RSPO include the amelioration of environmental and social impacts.
- The Oil Palm Industry Cooperation (OPIC), which supports small-holder oil palm producers, may have difficulty implementing the RSPO guidelines.
- Cargill provides crucial services to their work force and families such as health care.
- RSPO limits the expansion of oil palm into high value, undisturbed conservation forest. However, there may be some growth in smallholder production into un-forested and disturbed areas, resulting in a potential increase of 9,000 ha (50%) in oil palm area in Milne Bay Province. There may also be an intensification of production on existing areas if world prices increase.

***Tourism industry (Maxine Nadile, Milne Bay Tourism Bureau):***

- The Milne Bay Tourism Bureau has been promoting village-based eco-tourism in the province, with support from CI. Current government funding is inadequate to support this fully. There is a need for greater infrastructure, accommodation and training of tourism providers if village operators are to realise eco-tourism's full potential. Prices charged and the quality of the tourism experience is currently mis-matched.
- Proposals are continuing to open Alotau (Gurney) airport as an international airport, which would increase the accessibility of the province to overseas visitors. It is intended that Milne Bay should also become a major cruise ship destination.
- Security concerns are a potential constraint to the attractiveness of the province, and social unrest due to collapses in other cash sectors (e.g. beche-de-mer fisheries) could further deter international visitors.
- SCUBA dive fee payments to villages are operating well in some areas, but not in others, eroding the incentives to local communities to conserve marine assets.
- If the province's natural assets are degraded there will be little to base a viable eco-tourism industry on. Major future needs are the conservation of these assets, plus cultural identity (e.g. the canoe festival) through awareness-raising.

***Mining industry (Judah Dickson, Mines Liaison Officer, Milne Bay Administration, Commerce and Mines Division):***

- The mining industry in Milne Bay is controlled by the PNG Government's Department of Mines, and the Minister can over-rule community and other provincial-scale decisions.

- There are currently potential gold mines on Normanby Island, at Mwatebu/Imwauna, Weioko, Woodlark Island, Fergusson Island at Gameta, Wofolu, and in the Owen Stanley Range. Nautilus Ltd. has exploration tenements over the seabed between Misima and Woodlark Islands.
- The major environmental issue is disposal of tailings from gold mines. Revegetation of closed mines (e.g. Misima) should use native species, but this so far is not common practice.

***Biodiversity conservation (Dr. Robert Johns, BRIT, and David Mitchell, CI):***

- The high degree of endemism of flora and fauna in Milne Bay makes the province one of the world's biodiversity hotspots. However, a lack of funding is limiting the recording of floral biodiversity, and consequently Environmental Impact Assessments for mining and other developments can not adequately protect threatened species. There is likely to be high rate of extinction of unknown species as a result.
- Based on the IUCN Red List of Threatened Species (e.g. critically endangered, endangered, vulnerable), CI is completing a process of identifying Key Biodiversity Areas. Many of these areas could in part be protected by sacred sites, but as local custom is eroded by development these sites are being neglected, reducing the opportunity to combine cultural and biodiversity conservation.
- With growing global efforts to reduce carbon emissions to mitigate climate change, it is possible that threatened areas of forest habitat could become eligible for the United Nations' Reducing Emissions from Deforestation and Forest Degradation (REDD) payments. There may also be a premium for forest areas with high biodiversity values. However, REDD will be under discussion in Copenhagen in December 2009 and if accepted would not be in place until after 2012.

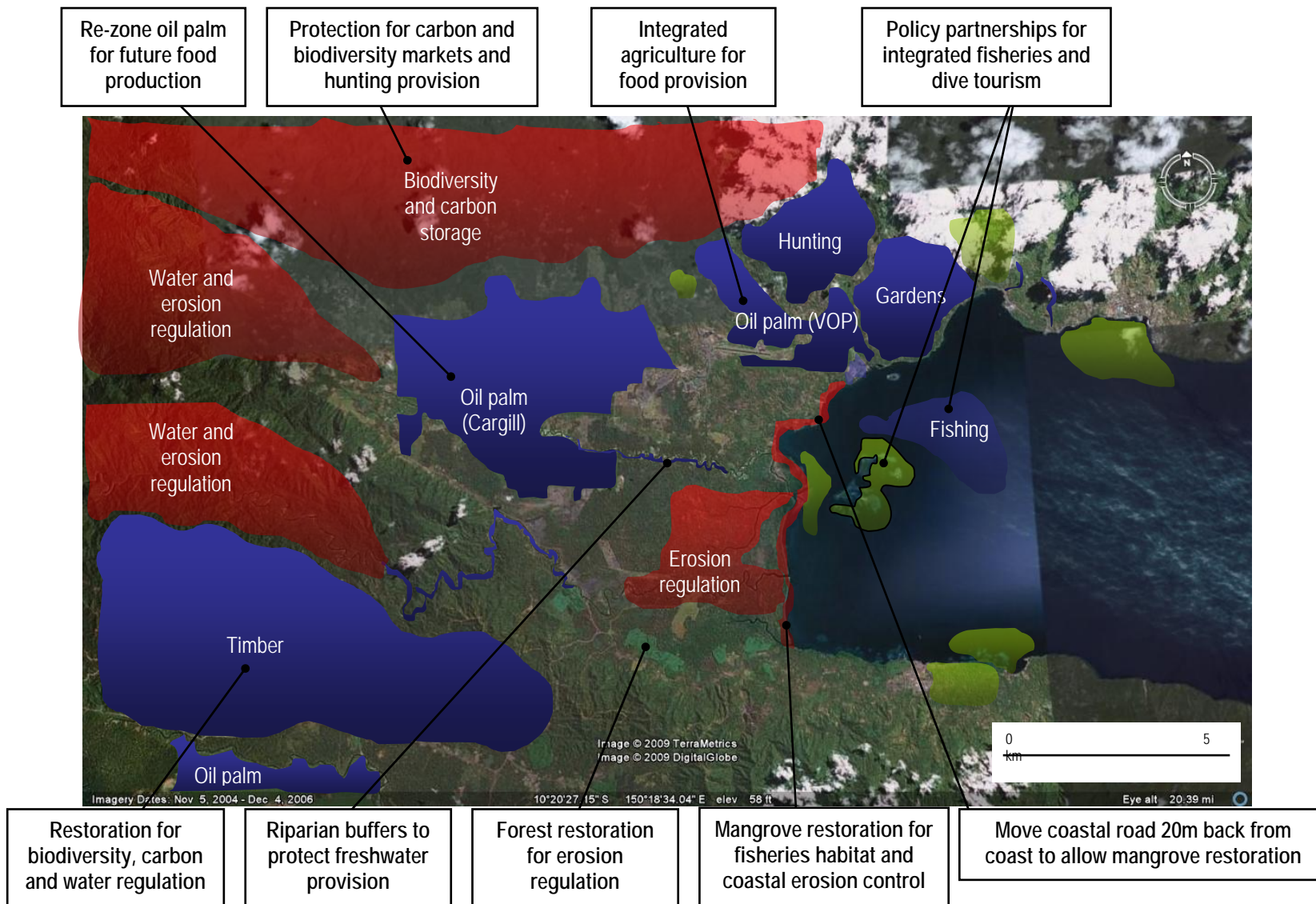
***e) How should Upper Milne Bay be managed to account for these future drivers and achieve sustainable development?***

Having considered these drivers and their possible future trends, the groups considered the management strategies required to sustainably manage the ecosystem services in the Upper Milne Bay study area. They mapped these onto new Google Earth maps, and the results are illustrated in Figures 18 to 21. Taking into consideration the current trend in condition of the ecosystem services the groups presented various strategies, with some commonalities:

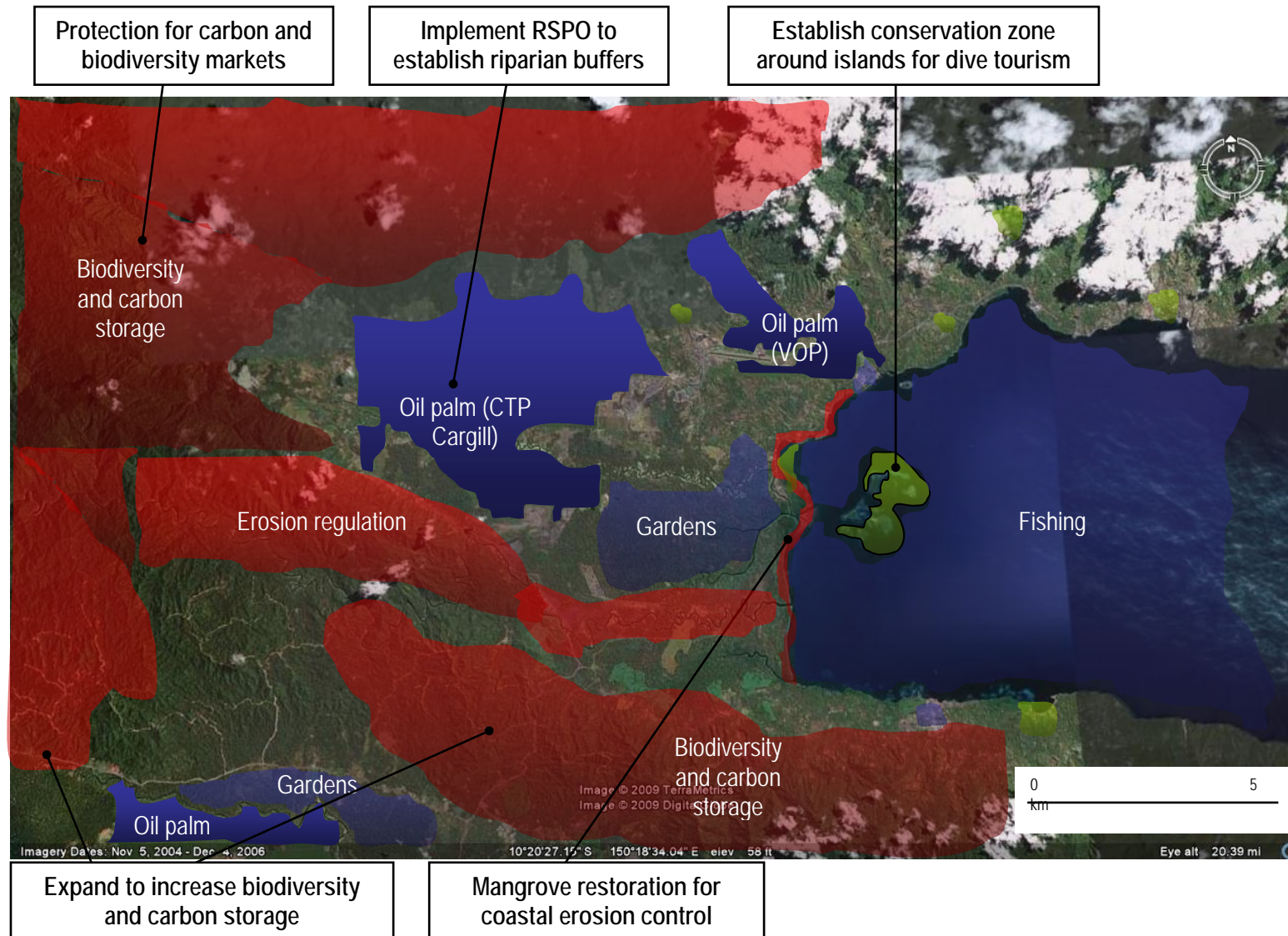
- *Provisioning services:* Due to the pressure of human population growth and the potentially declining availability of subsistence food, one group suggested the re-zoning of the Cargill-CTP oil palm plantation for gardens, and integrated agriculture in the VOP areas. Another also highlighted the need for improved food production from existing garden areas. For oil palm, two groups recommended no expansion of existing oil palm areas, and the implementation of RSPO standards to create buffer zones and improve water quality and freshwater provision, and similar strategies for

water were suggested by other groups. For timber, it was suggested that existing timber mills should be closed due to declining supply, while reforestation with high value species should be introduced in some areas to provide alternative incomes for landholders, and to promote erosion regulation. Hunting areas could also be enhanced by the protection of biodiversity and forest in upper catchment areas. Fisheries would be enhanced by community partnerships with SCUBA dive tourism to establish management zoning (e.g. Marine Protected Areas; MPAs) for fisheries and the banning of destructive fishing practices.

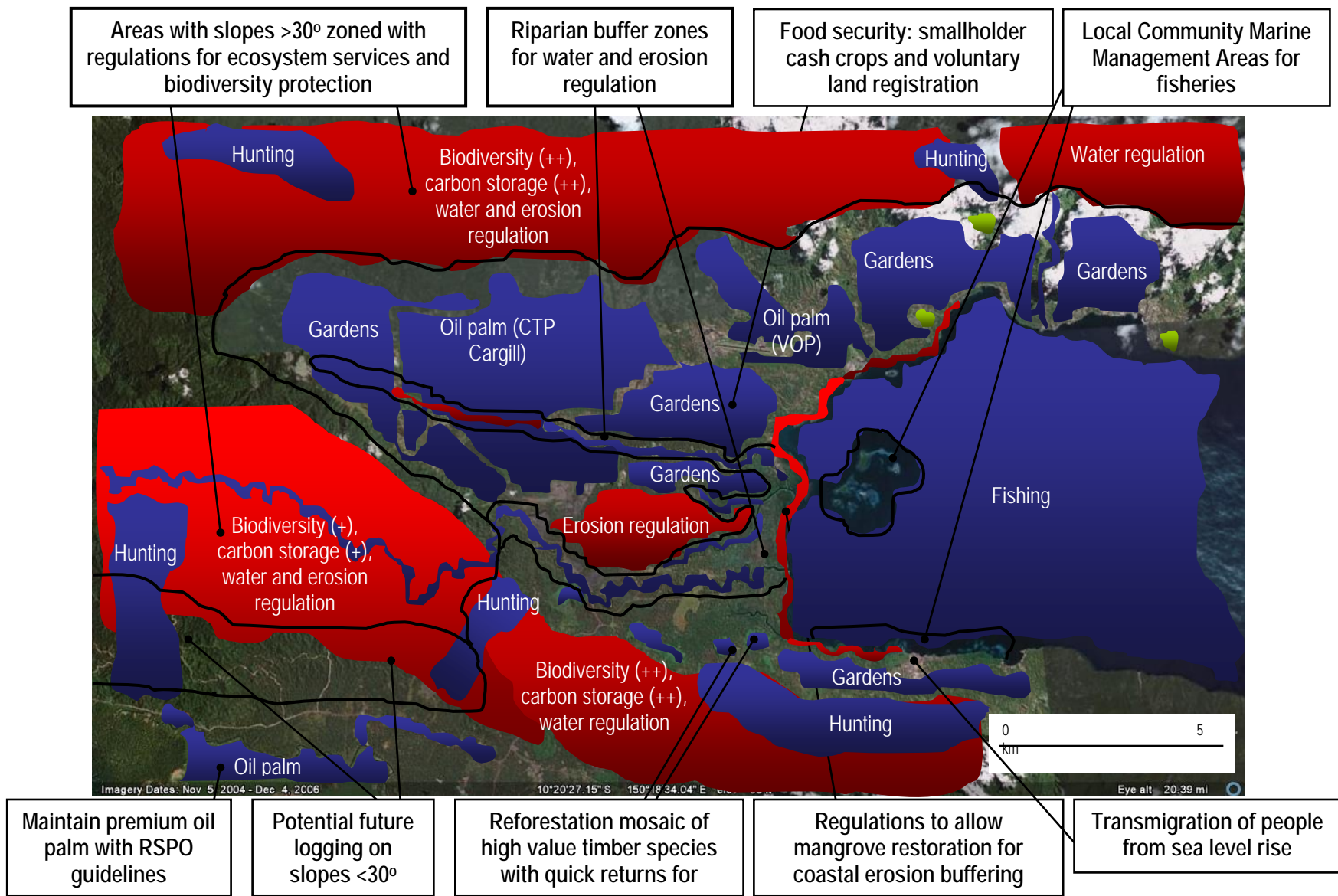
- *Regulating services*: Three groups recognised the need to protect upper catchment areas for both biodiversity conservation and carbon storage in anticipation of potential REDD and biodiversity markets. One group suggested that areas with slopes of  $>30^{\circ}$  should be maintained for biodiversity and carbon, while slopes  $<30^{\circ}$  could be available for future logging, and another group considered that similar areas could be logged in the absence of REDD payments. Groups also recognised the need to protect watersheds to improve water and erosion regulation. Three groups suggested the protection of mangroves to enhance coastal erosion regulation in the face of sea level rise threats, and one suggested the moving of the coastal road to allow for mangrove restoration. One group suggested the transmigration of coastal communities in anticipation of sea level rise.
- *Cultural services*: Three groups suggested some form of integrated management system with fisheries to protect reefs where SCUBA dive tourism operates. One group suggested the diversification of eco-tourism to increase the attractions available to international tourists.



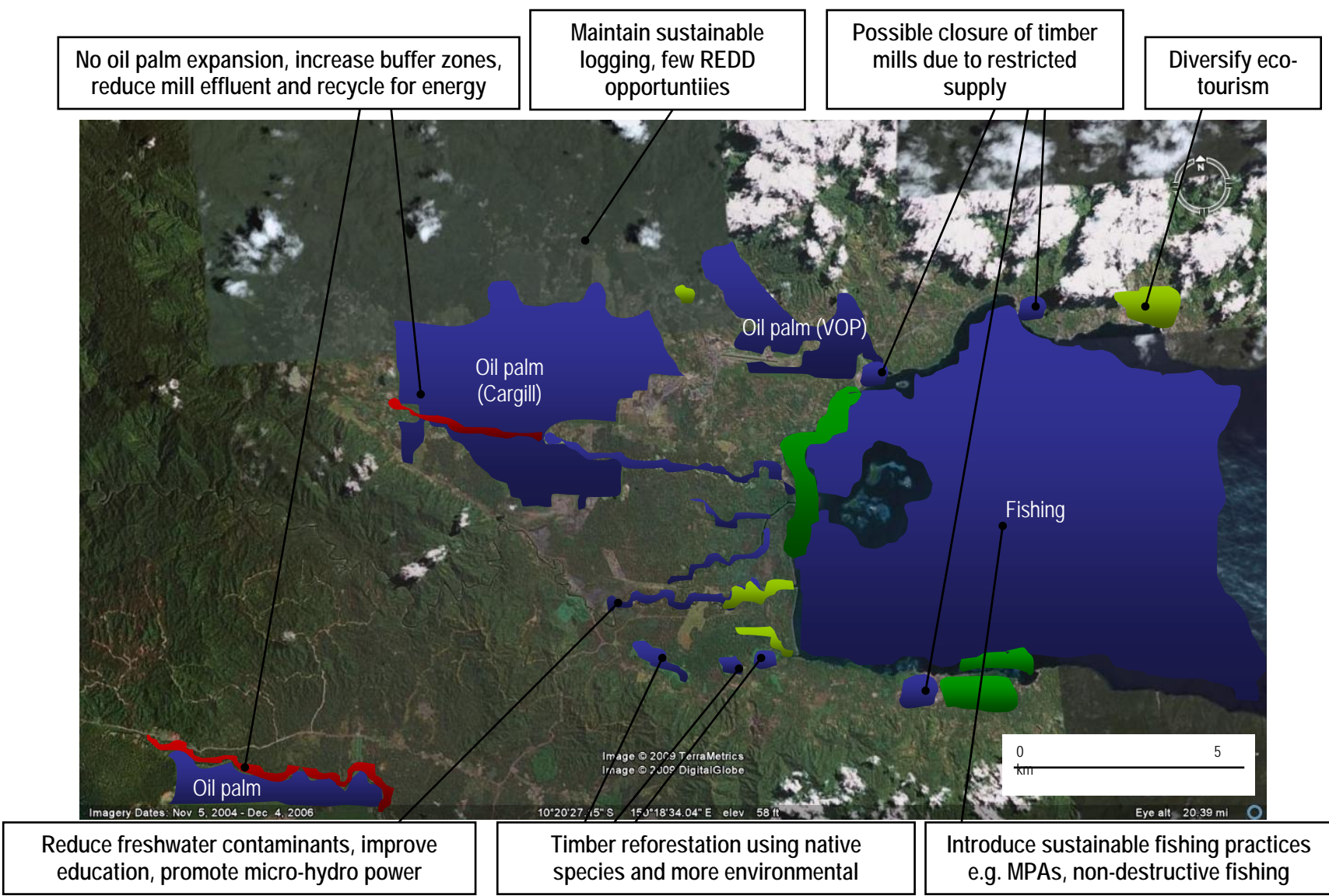
**Figure 18.** Group 1’s strategies for managing ecosystem services in the Upper Milne Bay study area for sustainable development. Blue represents provisioning services, red regulating services and green cultural services.



30 **Figure 19.** Group 2’s strategies for managing ecosystem services in the Upper Milne Bay study area for sustainable development. Blue represents provisioning services, red regulating services and green cultural services.



**Figure 20.** Group 3's strategies for managing ecosystem services in the Upper Milne Bay study area for sustainable development. Blue represents provisioning services, red regulating services and green cultural services.



**Figure 21.** Group 4’s strategies for managing ecosystem services in the Upper Milne Bay study area for sustainable development. Blue represents provisioning services, red regulating services and green cultural services.

## 4. DISCUSSION OF RESULTS

Due to the limited time it was not possible to complete all steps of the CSIRO-CI approach, but the preliminary integrated planning exercise did reveal some interesting perspectives from the stakeholders about sustainable development and livelihoods issues in Upper Milne Bay. The results can be summarised relative to the steps taken:

- a) *What are the current ecosystem services in the Upper Milne Bay area, and where do they occur in the land and seascape?* Groups provided a wide range of ecosystem services, with general similarities around the location of provisioning services (e.g. oil palm, freshwater provision, timber, gardens and fisheries) and regulating services (e.g. biodiversity, carbon storage, water and erosion regulation). However, there was a great deal of variation in the numbers and locations of cultural services such as canoe festivals, caves, waterfalls, tourist lodges, WWII history and SCUBA diving. In future exercises it may be useful to combine all groups' ecosystem services locations into one summary map.
- b) *What are the current trends in condition of the ecosystem services?* The radial diagrams suggested that there were some differences of opinion about the trends in condition of ecosystem services in Upper Milne Bay. The summary diagram (Figure 14), which averaged the trends from the groups, showed that fisheries, timber, oil palm, water quantity and quality regulation and biodiversity had the most variation, with some groups believing that their condition was improving, while others believed they were declining. Some of this variation may have been caused by confusion between the trends in human use (which we did not consider) and the trend in condition. However, there was general agreement that there were declines in freshwater, gardens, hunting, carbon storage and erosion regulation. Also, there was agreement that the condition of tourism was improving, although this may also have been confused with increasing trends in tourism activity. This exercise highlighted the difficulty of distinguishing between ecosystem service use and condition, and pointed to the need to define these differences carefully in any future planning processes.
- c) *What are the trade-offs between ecosystem services, and who are the stakeholders who win or lose?* It was difficult to clearly demonstrate trade-offs between ecosystem services. However, the summary of the groups' net counts of 'winners' and 'losers' for each ecosystem service category was useful, showing that of all stakeholders local communities were losing the most. This was the result of the current condition of provisioning services, due to the decreasing condition of gardens, freshwater and hunting. Local communities also were losing from the condition of regulating services, but gaining slightly from cultural services, due to the increasing condition of tourism. The greatest winners were private business, particularly from cultural services (i.e. tourism). It is debatable if our definitions of stakeholder groups (local and global communities and private business) were distinct enough, since there is probably overlap between local communities and local private business, and it may be worth revisiting these in future planning exercises with the input of workshop participants.

- d) *What are the current drivers of ecosystem service use and condition, and how are they likely to change in the future?* The summary of current and future drivers by both local and international workshop participants was useful, and allowed everyone to discuss potential future scenarios, although this was not carried out in a structured way. In future planning exercises with more time it should be possible to bring more detailed knowledge, information and tools for discussion, such as the products from CSIRO's AusAID-funded *Melanesian Marine Ecosystem Assets* project, which will identify potential climate change impacts on the Milne Bay marine ecosystem. However, for this exercise the most important drivers appeared to be human population growth, resulting in pressure on food security, climate change and sea level rise, and the over-exploitation of fisheries and beche-de-mer in particular. REDD may present an opportunity for protecting ecosystem services including biodiversity while providing income for landholders, but it is still unclear how and when this mechanism will be implemented in Milne Bay.
- e) *How should Upper Milne Bay be managed to account for these future drivers and achieve sustainable development?* Based on these drivers, the groups provided interesting strategies to protect and enhance ecosystem services and livelihoods. For example some bold measures were considered, such as the transmigration of communities to adapt to sea level rise, the re-zoning of oil palm for local food production, the protection of mangroves to buffer coastal erosion from sea level rise, and the relocation of a coastal road. One group also provided detailed guidelines for the protection of forest on slopes  $>30^{\circ}$  for potential biodiversity and carbon storage payments, while zoning areas  $<30^{\circ}$  for future sustainable logging. Innovative suggestions were also made to establish integrated planning (e.g. MPAs) of fisheries and SCUBA diving tourism.

These questions covered only steps 1-8 of the CSIRO-CI approach, and even then only considered a few of the issues in each step. For example, we did not explicitly evaluate trends in human use of ecosystem services and links to human well-being and livelihoods (Step 2), the values of ecosystem services and possible thresholds (Step 3), future scenarios of the drivers (Step 5), their impacts on human well-being and trade-offs (Step 6) or the monitoring of drivers, ecosystem services and well-being (Step 9). In any future integrated planning exercise it is suggested that all of these issues should be addressed in a series of stakeholder-driven workshops, supported by expert opinion and tools.

In spite of this the Upper Milne Bay preliminary planning exercise did achieve several important steps. First, it brought together a wide range of provincial government departments, industry and community representatives, and representatives of an international development agency (AusAID). This provided an excellent opportunity to combine knowledge of the full range of ecosystem services and drivers, and to undertake a deliberative process where values and opinions were shared with equal weight. Second, the Upper Milne Bay study area illustrated that this is a useful scale (approximately 375 km<sup>2</sup>) for undertaking such a planning process, allowing the consideration of land and seascape (e.g. carbon storage, biodiversity and fisheries) and site (e.g. sacred sites) scale ecosystem services, and appropriate and realistic management strategies (e.g. protection of coastal mangroves, MPAs for specific reefs). This is relevant because it is at this local scale that most linkages between ecosystem

services and human well-being occur, and management interventions are most effective (MA, 2005).

## 5. NEXT STEPS

On the afternoon of Day 2 of the workshop the participants considered the next steps for the *Sustainable Futures for Milne Bay* project. It was highlighted that there are currently four levels of planning in Milne Bay Province:

- Provincial Development Plan
- District Plan
- Local Level Government Plans
- Ward Development Plans

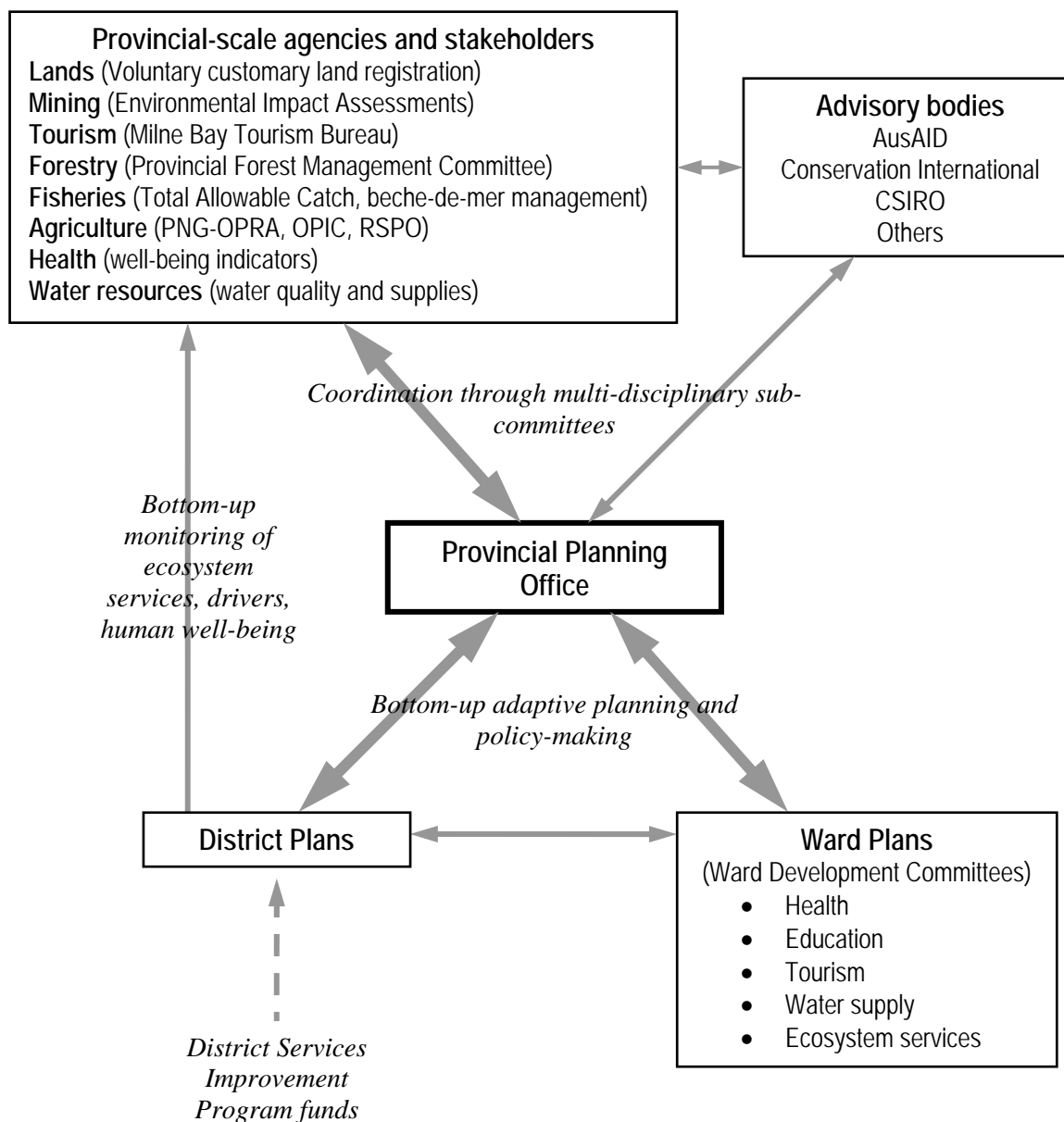
The Administration would like to present examples of bottom-up, multi-stakeholder planning to the national government. It was suggested that the integrated assessment undertaken for Upper Milne Bay would be best applied to assist District Plans, since districts are currently the focus of the national and provincial governments' investment. Currently the focus of District Plans is the District Services Improvement Program, which distributes national government funding to capital works, rather than natural resource management. The Provincial Planning Office is coordinating sustainability projects through the Voluntary Customary Land Registration Act 2009, and this office would be the appropriate facilitator of any future integrated assessment planning. At the provincial level the recently established Provincial Coordination and Monitoring Committee would be the best forum for continuing the multi-stakeholder approach to natural resource management established at the workshop.

One group also suggested a planning framework to implement this model (Figure 22). In this framework the Provincial Planning Office would coordinate the input of province-scale agencies and stakeholders and advisors (e.g. AusAID, CSIRO, CI) through multi-disciplinary sub-committees. The Planning Office would then facilitate bottom-up planning and policy-making through District and Ward Plans. Monitoring of ecosystem services, drivers and human well-being (i.e. Step 9 of the CSIRO-CI approach in Figure 4) would then be carried out at the district level and reported back to the agency and stakeholder sub-committees.

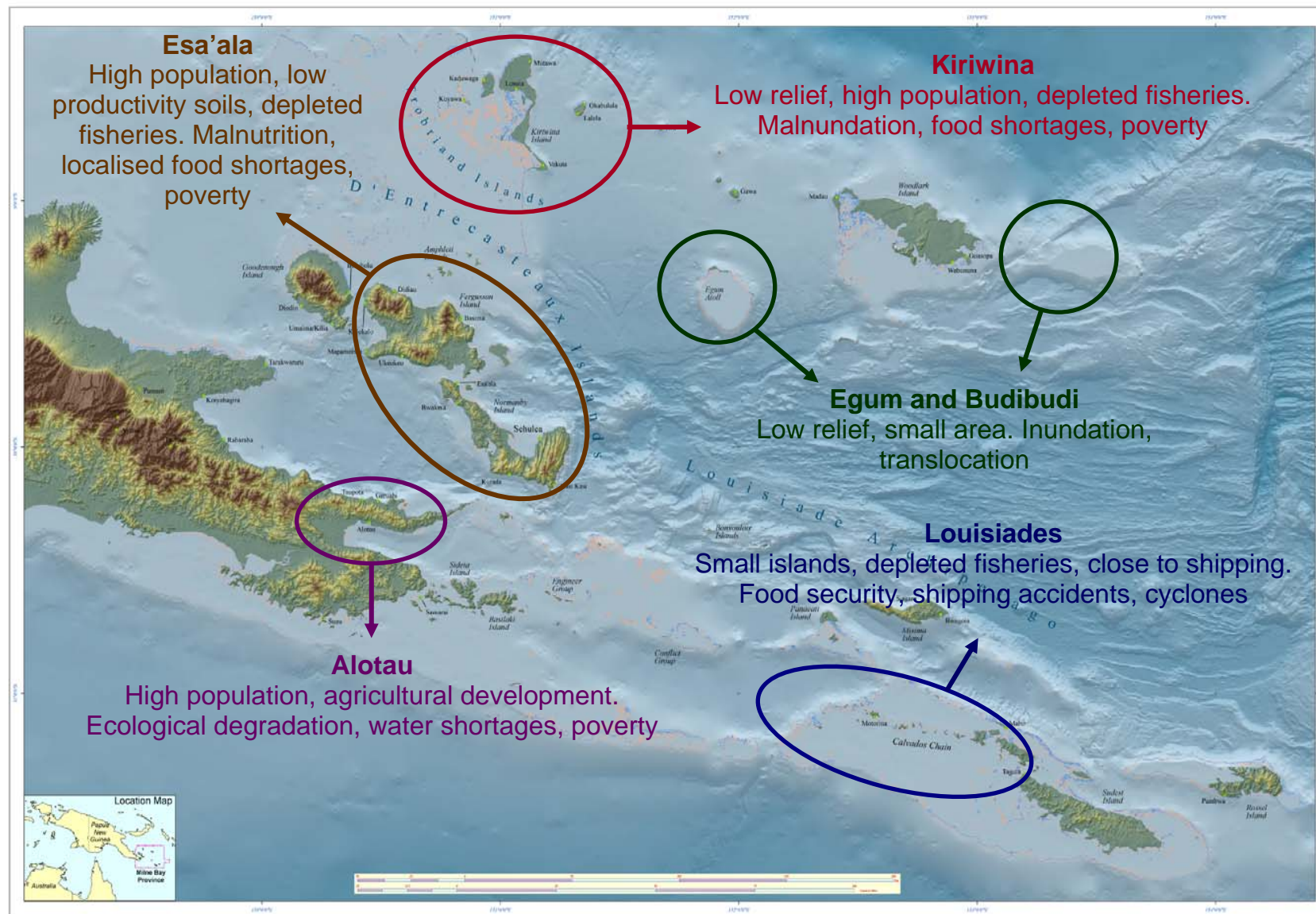
It was also noted that any future integrated planning is consistent with the work of AusAID in the province. AusAID, through its *Sub-national Strategy* and its broader aid program, is assisting the Milne Bay Administration to address the challenges of delivering basic services such as health, education, agriculture and fisheries extension services and transport infrastructure maintenance. Given the significant impacts on the livelihoods of people in the province resulting from climate change and unsustainable natural resource use, and the resulting challenges this creates for service delivery, AusAID's representatives in Milne Bay are very supportive of these issues being addressed in planning processes, particularly at the ward and village level and would be available to support any future work.

Subsequent to the workshop AusAID, CSIRO and CI participants considered which areas of Milne Bay Province were under greatest pressure from the drivers of human population growth, food security, fisheries collapse and sea level rise. It was suggested that Esa'ala, Kiriwina Islands, Louisiades Islands, Egum and Budibudi atolls, and the Alotau area were priority areas which could benefit from detailed integrated assessments for sustainable development planning (Figure 23).

However, further funding will be required for CSIRO and CI to continue assisting any planning exercises after June 2009, and this is now the primary objective for the project team.



**Figure 22.** A suggested structure for implementing integrated assessments and planning of natural resources and ecosystem services in Milne Bay Province. The weights of the arrows imply greater or lesser strengths of links.



**Figure 23.** Regions in Milne Bay Province where drivers are significantly impacting human well-being and ecosystem services, and integrated assessments could assist planning for sustainable development.

## 6. REFERENCES

Carpenter, S.R., Mooney, H.A., Agard, J., Capistrano, D., DeFries, R.S., Díaz, S., Dietz, T., Duraiappah, A.K., Oteng-Yeboah, A., Pereira, E.M., Perrings, C., Reid, W.V., Sarukhan, J., Scholes, R.J., Whyte, A. 2009. Science for managing ecosystem services: beyond the Millennium Ecosystem Assessment. *Proceedings of the National Academy of Sciences* 106: 1305–1312.

de Groot, R. 2006. Function-analysis and valuation as a tool to assess land use conflicts in planning for sustainable, multi-functional landscapes. *Landscape and Urban Planning* 75:175–186.

Millennium Ecosystem Assessment 2005. *Ecosystems and Human Well-Being: Synthesis*. Island Press, Washington, DC.

Scoones, I. 1998. Sustainable Rural Livelihoods: a Framework for Analysis. Institute of Development Studies Working Paper 72.

## **APPENDIX I**

### **Workshop attendees**

Mr. Henry Bailasi (Milne Bay Administrator)  
Mombi Onesimo (D'Entrecasteaux Island Nature Tours)  
Judah Dickson (Mines Liaison Officer, Milne Bay Administration, Commerce and Mines Division)  
Noel Dibela (Provincial Forest Office)  
Dr. James Butler (CSIRO Sustainable Ecosystems)  
Tim Skewes (CSIRO Marine and Atmospheric Research)  
Dr. Erin Bohensky (CSIRO Sustainable Ecosystems)  
David Mitchell (CI Melanesia Program)  
Clyde Hamilton (AusAID)  
Dr. Robert Johns (Botanical Research Institute of Texas)  
Chris Terupo (Environment Officer, Cargill-CTP)  
Harm van Rees (PNG Oil Palm Research Organisation)  
Maxine Nadile (Milne Bay Tourism Bureau)  
Richard Dawana (Coordinator, Rural Health Services, Health Division)  
Ofara Petilani (Project Coordinator, Milne Bay Church Development Fund Association)  
Perry Dotaona (Samarai Tourism Authority)  
Paul Madlai (EMTV)

## APPENDIX II

# Sustainable Futures for Milne Bay: Stakeholder Workshop to Plan Project Monday 27<sup>th</sup> – Tuesday 28<sup>th</sup> April 2009, Alotau AGENDA

### DAY 1 Monday 27<sup>th</sup> April

**9.00** Welcome, introductions

**9.15** Introduction to CSIRO Sustainable Futures research project (James Butler, CSIRO)

**9.30** Future development pathway for Milne Bay (Dave Mitchell, Conservation International)

**9.45** Terminology: ecosystem services, trade-offs and human well-being (Erin Bohensky, CSIRO)

**10.15** Planning exercise (James Butler, Erin Bohensky, Dave Mitchell)

**10.30** *Morning tea*

**11.00 – 13.00**

#### **PLANNING EXERCISE**

- Field trip to Upper Milne Bay introduce concepts – small groups to work together

**13.00** *Lunch*

**14.00 – 15.30**

#### **PLANNING EXERCISE continued**

- Mapping of Upper Milne Bay ecosystem services and other important landmarks in groups
- Short presentations by groups

**15.30** *Afternoon tea*

**16.00 – 17.00**

#### **PLANNING EXERCISE continued**

- Categorise Upper Milne Bay ecosystem services identified in mapping exercise
- Assess condition, trends and trade-offs
- Identify associated 'winners' and 'losers'
- Short presentations by groups

## **DAY 2 Tuesday 28<sup>th</sup> April:**

**9.00 – 10.30**

### **FUTURE ISSUES**

Presentations and discussions on future issues

- Climate change and marine assets (Tim Skewes, CSIRO)
- Biodiversity (Conservation International)
- Population growth
- Oil palm
- Subsistence agriculture and food security
- Mining
- Fisheries

**10.30** *Morning tea*

**11.00 – 13.00**

### **FUTURE LANDSCAPES**

- Re-mapping of Upper Milne Bay to account for future issues
- Short presentations by groups
- Other steps we are missing (e.g. benefits/values, trade-off analyses)

**13.00** *Lunch*

**14.00 – 15.00**

### **FUTURE LANDSCAPES continued**

- Discussion: consideration of potential policies and management required to attain a sustainable development pathway for Milne Bay

**15.00 – 15.45**

### **NEXT STEPS**

- Design of project?
- How much detail?
- Stakeholder reference group?
- Next steps
- Close

**15.45** *Afternoon tea*



