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Ridges to Reefs Conservation Plan
for Isabel Province, Solomon Islands

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Foreword

Isabel Province has a rich cultural and ecological diversity and a unique governance structure that formally recognises the roles of the Isabel Council of Chiefs, the Diocese of Ysabel and the Provincial Government. Our province has a long and proud history of engaging with environmental organisations and development partners to protect the remarkable biodiversity of our island of Isabel. The first community based marine protected areas to be established in the South Pacific was the Arnavon Community Marine Conservation Area (ACMCA) which is located in Isabel. The ACMCA was formally established in 1995 to protect the largest remaining nesting beaches of the critically endangered hawksbill turtles in the South Pacific. Its establishment represented a partnership between the Kia Community, the Wagina and Katapika communities in Choiseul, The Nature Conservancy (TNC) and the National Government.

In the early years of the ACMCA the Isabel Provincial Government assisted in developing and passing the Wildlife Sanctuary Ordinance, which gives legal recognition to the ACMCA. The ACMCA is now in its 17th year of existence, it is internationally acclaimed, the hawksbill turtle populations are recovering and the communities that own this area are seeing benefits in the form of tourism – conservation is at work. In more recent years we have also seen ongoing marine conservation efforts in the Kia and Maringe districts with support from WorldFish and UNDP.

But these efforts are not enough. A decade of unstainable logging, the prospect of large scale nickel mining, population growth and climate change means that it is time to accelerate our efforts to protect the ecological and cultural features that define our province. Today more than ever, we must make informed decisions about how to conserve and sustainably develop our natural environment, to ensure that our children can enjoy the cultural, social and economic treasures that have defined our people for a millennium.

This is not an insurmountable challenge, andthe stakeholder driven ridges to reefs conservation planning process that is documented in this report represents the first comprehensive attempt to pull together all of our available knowledge, both scientific and local, on the biodiversity and cultural heritage of Isabel, and the threats they face.

On behalf of the Isabel Provincial Government and the people of Isabel province, I thank you all of those who were involved in data and information gathering, scientific and local knowledge and those that complete this report. I therefore urge us all to utilise our unique tripod governance structure to provide full support for this Isabel ridges to reefs conservation plan, and it is my sincere hope that we use this plan to galvanise interest and support for implementing a ridges to reefs Isabel Protected Area Network.

Honourable James Habu

Premier, Isabel Province

ACKNOWLEDGEMENTS

This report represents a synthesis of the expertise, knowledge and views of Isabel's church leaders, chiefs, provincial government departments, scientific experts, development industries and NGO's. TNC facilitators wish to thank the 118 individuals who participated in the planning workshops without whose contribution; this assessment would not have been possible. Special thanks also go to Ivan Rotu, Frazer Kavali and Henry Marau for their assistance in organising the stakeholder workshops. We also thank Eddie Game for reviewing this report and providing advice on running the Marxan models, Aya Mizumura for also reviewing a draft of this report, Ayisha Boaden for assistance with digitising, Jeanine Almany for assistance with formatting the final report and Jeff Kinch for providing relevant literature. Funding for developing this Isabel Ridges to Reefs Conservation Plan was provided by the John D. and Catherine T. MacArthur Foundation and The David and Lucile Packard Foundation.

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Richard Hamilton	TNC	Marine Scientist	Brisbane	Yes	Yes	Yes
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Roderick Hebala	Kia ward rep	Leader	Kia Village	Yes	Yes	Yes
Mary Joyce	Koviloko Village	Mothers Union	Koviloko	Yes	Yes	Yes
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John Pita	TNC	Isa Coordinator	Buala	Yes	Yes	Yes
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Name	Organisation	Position	Location	First workshop	Second workshop	Third workshop
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Esther Ghausa	Mothers Union	Kolopakisa	Kolopakisa	Yes	-	-
Erick Gnokro	Chief	Village Leader	Maglau	Yes	-	-
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Seno Mauli	TNC	Marine Scientist	Honiara	Yes	-	-
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Aley Nindi	Buala Village	Leader	Buala	Yes	-	-
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Clement Rogumana	Elder	Kubulota	Kubulota	Yes	-	-
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Lionel Thono	Chairman		Tithiro	Yes	-	-
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Derald Daniel	ACMCA	Board member	Ritamala	-	Yes	
Grace Delight	Mothers Union	Sec/Treasurer	Buala	-	Yes	-
Adson Dohi	Talise		Talise	-	Yes	-
Nelson Eleme	Youth	Ward Coordinator	Kia	-	Yes	-
John Gamutu	Samasodu	Chief	Samasodu	-	Yes	-
Merilyn Gedi	Kia		Kia	-	Yes	-
Fr. Eric Kafa	Kia		Kia	-	Yes	-
Christina Maezama	Zabana	Leader - Barora	Kai Zaquto	-	Yes	-
Simon Mamupio	Chief of Kia	Chief	Kia	-	Yes	-
John Neso	Farmer	Leader	Jejevo	-	Yes	-
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Sue Smith	TDA	Volunteer	Terepare	-	Yes	-
Fr. Daniel Talu	DOY	Kia DP	Kia	-	Yes	-
John Tanisapa	Leader	Church Rep	Babahairo	-	Yes	-
Joel Zeagini	E. H. Chief	Chief	Kia	-	Yes	-

Name	Organisation	Position	Location	First workshop	Second workshop	Third workshop
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Ruth Konia	TNC	Communications	PNG	-	-	Yes
Brenda Manedika	IPG	Tourism	Buala	-	-	Yes
Jaylyn Meson	Huali	Youth	Huali	-	-	Yes
Clarissa Miomilo	Mothers Union	Leader	Nagolau	-	-	Yes
Alex Nindi	Buala	Leader	Buala	-	-	Yes
Donald Raka	ADB		Honiara	-	-	Yes
Fr. Charles Rubaha	Garanga	Priest	Garanga	-	-	Yes
Allan Sade	Hovikoilo	Chief	Hovikoilo	-	-	Yes
Myknee Sirikolo	Ministry Forestry	Research	Honiara	-	-	Yes
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Masie Tete	Goveo	Chief	Goveo	-	-	Yes
Cecil Togamae	Maringe	Chief	Sogolego	-	-	Yes
Hon. Wilson Tohidi		Minister, Natural Resources	Buala			Yes

ACRONYMS

ACMCA	Arnavon Community Marine Conservation Area
ADB	Asian Development Bank
CITES	Convention on the International Trade of Endangered Species
CBD	Convention for Biological Diversity
DbD	Development by Design
DOY	Diocese of Ysabel (The Anglican Church of Melanesia)
EIS	Environmental Impact Statement
GIS	Geographic Information System
IUCN	International Union for Conservation of Nature
IMRS	Institute for Marine Remote Sensing
ICC	Isabel Council of Chiefs
IIC	Isabel Investment Cooperation
IPG	Isabel Provincial Government
IPAN	Isabel Protected Area Network
KDMRMC	Kia District Marine Resource Management Committee
LLCTC	Lauru Land Conference of Tribal Communities
LPAN	Lauru Protected Area Network
MECDM	Ministry of Environment, Climate change, Disaster and Meteorology
MFMR	Ministry of Fisheries and Marine Resources
MMCA	Maringe Lagoon Marine Conservation Area
MPA	Marine Protected Area
NBSAP	National Biodiversity Strategy and Action Plan
NGO	Non-Governmental Organization
PoWPA	Program of Work on Protected Areas
SMM	Sumitomo Metal Mining
TDA	Tetepare Descendants Association
TNC	The Nature Conservancy
UNDP	United Nations Development Program
USP	University of the South Pacific
WFC	World Fish Center
WWF	Worldwide Fund for Nature/ World Wildlife Fund

EXECUTIVE SUMMARY

The Isabel Ridges to Reefs Conservation Plan can be used to guide future conservation and development activities throughout Isabel. The plan allows stakeholders to visualise the location of conservation priorities for Isabel Province, the threats that the biodiversity of Isabel faces and what a successfully implemented protected area network across Isabel could look like under several different scenarios. It provides an important step towards establishing an Isabel Ridges to Reefs Protected Area Network (IPAN), which would support future food and freshwater security, preserve the islands remarkable biodiversity and reduce the stress on terrestrial and marine environments, hereby increasing the resilience of natural systems to external shocks such as climate change.

The process of developing the plan was locally driven and involved a range of stakeholders. The planning process included an initial stakeholder planning workshop in Buala in February 2012, a second stakeholder planning workshop in Kia in April 2012 and a final workshop in Buala in June 2012. These workshops brought together community members from every district of Isabel, along with representatives from provincial and national government, NGOs and development industries. The workshops began with presentations from church leaders, government officials, chiefs and scientists on the status of Isabel's environment and the need to protect it for the future prosperity of the people of Isabel. Workshop facilitators then presented the best available national scale data on the various marine and forest types of Isabel, and described some of the threats these different types of habitats face.

To document fine scale information and make the planning process relevant, stakeholders used participatory mapping to identify local features within their customarily owned lands and seas that are of high conservation value to them. These features represent important biological and cultural resources that would benefit from protection or management, such as sources of freshwater, cultural heritage sites, turtle nesting beaches, fish spawning aggregations and megapode nesting areas. Participatory mapping was also used to identify threats to biodiversity (e.g. logging, mining and areas susceptible to climate change) and to map areas of conservation opportunity, such as sites that are proposed but not yet managed. These local conservation features were digitised and put into a Geographic Information System (GIS) format. Conservation targets (how much of each feature should be protected across Isabel) were set at a minimum of 17% for all terrestrial and 10% for all marine conservation features that were identified from national scale data, that being in line the Convention of Biological Diversity (CBD) targets which Solomon Islands is a signatory to. Stakeholders wanted higher levels of protection for the locally identified conservation features, so minimum and maximum levels of protection were used for these features. All this information was then analysed with the software Marxan to produce three different conservation priority maps for Isabel Province.

As well as providing background and guidance for conservation and development across Isabel province, this report provides constructive progress regarding Solomon Islands commitment to the Convention on Biodiversity (CBD) and the identification of terrestrial and marine priorities as part of the Program of Work on Protected Areas (PoWPA). This report also makes progress towards implementing the Solomon Islands National Biodiversity Strategy and Action Plan (NBSAP) which all of the Premiers of the Solomon Islands signed in 2009. Specifically it addresses Themes 2 and 3 of the NBSAP, which concern species conservation and protected area systems.

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1.0 Introduction

Developing a conservation plan involves firstly understanding the biodiversity of an area and then comparing the distribution of biodiversity with the current distribution of protected areas. This shows where particular species and ecosystems are left either, unprotected or, under protected. To address this systematically a protected area system can be outlined that represents or samples, the full variety of biodiversity across all the freshwater, marine and terrestrial habitats or ecoregions. This is called ecological representation (Noss, 1995). To be effective, conservation planning also needs to involve a wide range of stakeholders and include information on locally significant features. Stakeholder involvement builds understanding about the values of conservation planning and allows stakeholders to drive the outcomes, since they can use their local knowledge to identify areas on their customarily owned lands and seas that are of high conservation value to them.

This report outlines the process of developing the Isabel Ridges to Reefs Conservation Plan. The process was led by local stakeholders and facilitated and compiled by The Nature Conservancy in partnership with the Isabel Provincial Government. Section 2 provides an overview of the physical, cultural, economic, biodiversity and policy framework for conservation in Solomon Islands. Section 3 provides a similar overview for Isabel Province and describes the three stakeholder workshops held in 2012. These workshops were undertaken to build support for this plan and to document local knowledge of features that are of conservation value to the people of Isabel Province. Section 4 describes the methods and results of the modelling process using a tool called Marxan, to develop priority conservation area maps across Isabel Province. Section 5 discusses the results and Section 6 provides recommendations and next steps.

This conservation plan provides a tool for guiding future conservation and development efforts throughout Isabel. It is hoped that it will enable the leaders of Isabel to gain local, provincial, national and international support for implementing an Isabel Ridges to Reefs Protected Area Network (IPAN). Implementing a protected area networks in Isabel will ensure future food and freshwater security and reduce the stress on terrestrial and marine environments, herby increasing the resilience of natural systems to climate change. Finally, this report provides constructive progress regarding Solomon Islands commitment to the Convention on Biodiversity (CBD) and the completion of the identification of terrestrial and marine priorities as part of the Program of Work on Protected Areas (PoWPA).

2.0 Solomon Islands

2.1 Physical and Cultural

Solomon Islands form an arc of deep water oceanic islands within the Solomon Sea (Figure 1). One of the larger South Pacific nations, Solomon Islands extends for over 1,700 kilometres between Bougainville in the north-west and Vanuatu in the south-east, with the main islands lying between latitudes 5-12^{o} S and longitudes 152-163^{o} E. The Solomon Islands archipelago is located within the Pacific's Ring of Fire. Volcanic activity and major folding and faulting between the Pacific, Australian and Asian tectonic plates have created a country of unusual and spectacular landscapes (Hunnam et al., 2001). Fluctuating sea levels and these periods of highly localised tectonic uplifting and folding events stabilised around 6,000 years before present (Nunn, 1994; 1998), leaving a diversity of island formations, with

dormant and active volcanoes, raised limestone reefs, lagoons and atolls, all dominant features of Solomon Islands. The six major islands of the Solomon nation are Guadalcanal, New Georgia, Malaita, Isabel, Choiseul and Makira (Figure 1). All are elongate steeply rising islands, with peaks of up to 2,400 m. They are rugged, naturally forested and surrounded by fringing coral reefs and lagoon systems.

About 35,000 years ago the first wave of migration occurred when people from Papua New Guinea moved to the northern islands in the Bismarck Archipelago. Midden deposits on New Ireland provide the earliest evidence of human colonisation of oceanic islands, and some of the earliest evidence of marine fishing technologies (Allen et al., 1989). A second wave of human migration occurred approximately 5,000 years ago, when Austronesian speaking people moved throughout the entire Bismarck archipelago and Solomon Islands. The Austronesian people, famous for their decorated Lapita pottery, were expert seafarers and fishers and rapidly colonised the Melanesian islands, before moving east of Fiji to colonise Tonga and Samoa and become the first settlers and ancestors of present day Polynesia (Kirch, 2000).

This rapid second phase of colonisation was made possible by the geological stabilisation of this area, with newly formed lateral erosion plains and river basins providing suitable areas for agricultural developments, and extensive lagoon systems providing rich supplies of marine resources. Today Solomon Islands supports a great diversity of cultures, with over 87 Austronesian and non-Austronesian languages spoken by its 515,000 inhabitants. The majority of Solomon Islanders live in more than 5000 villages located throughout the country, where they retain customary ownership of their land and coastal resources. Most of these communities are located on the coast, and rely heavily on the ecosystem services provided by their reefs and forests to meet their basic needs.

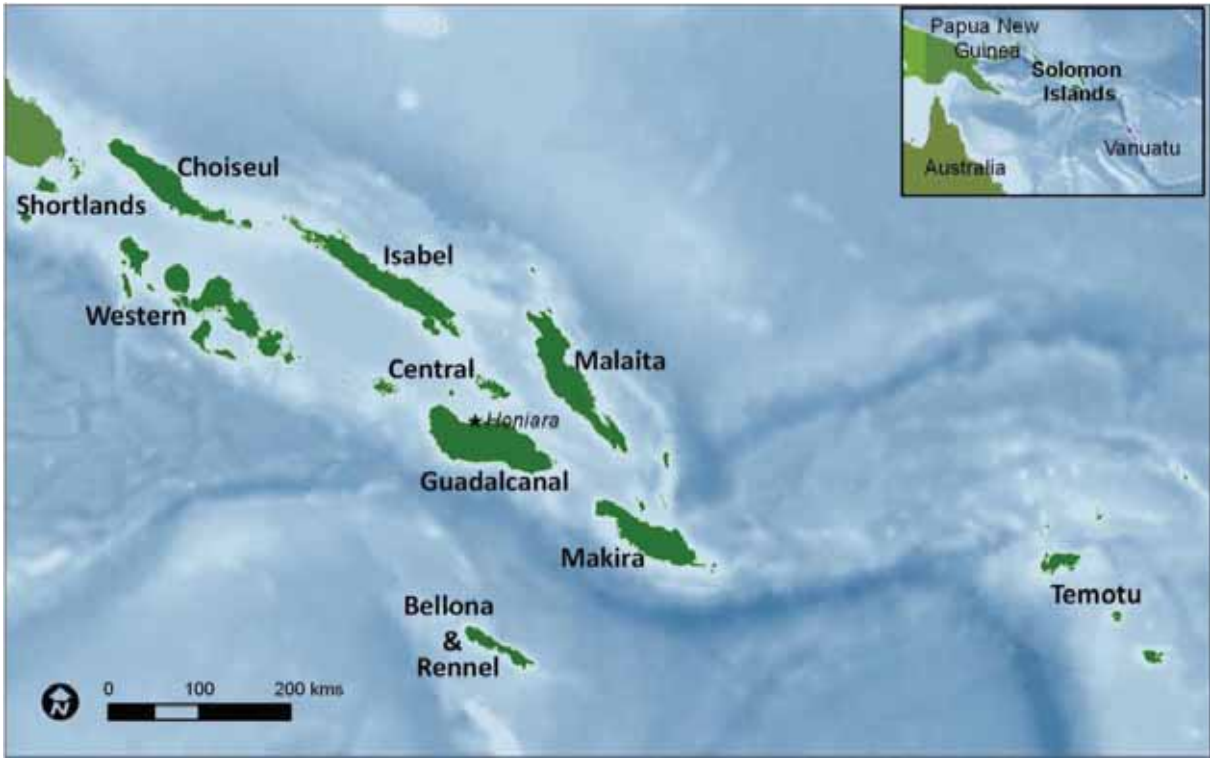

Figure 1. Provinces of Solomon Islands.

2.2 Economy

Eighty seven percent of Solomon Islanders live a subsistence based lifestyle, with the national economy heavily dependent on local production. The subsistence sector is the backbone of the domestic economy, supplying the basic livelihood needs such as food and housing materials for the majority of the rural population and a significant proportion of the urban population. Although the value of the subsistence sector has not been well quantified, it is estimated to far exceed all other sectors (Roughan and Wara 2010). Overseas exports from the smallholder sector are made up of dried copra and cacao along with non–perishable marine products such as bech-de-mer (currently banned), shark fin and trochus. The commercial harvest of bech-de-mer dates back to the mid 1800's (Bennett, 1987).

The macro economy is dominated by overseas aid and exports of primary products such as logs, tuna, gold and palm oil, while fuel, food and equipment dominate imports (Roughan and Wara, 2010). Logging has been a significant component of foreign earnings in the past two decades, but in the last ten years rates of logging have grossly exceeded sustainable levels and are now at a crisis level. Denton Rarawa, the governor of the central bank of the Solomon Islands described the logging industry as a 'sunset industry'[1].

With the imminent exhaustion of loggable forests there is an increasing focus on developing the minerals and mining sector. The Gold Ridge mine in Guadalcanal became operational in 2011 after a decade of closure due to the 1999-2003 political instability. In addition, considerable deposits of gold, copper, nickel and bauxite have been identified in locations across the country. In 2008, the Ministry of Mines and Energy issued 56 prospecting licences, including considerable seabed areas in the New Georgia group of islands in the Western Province (Roughan and Wara, 2010). This has immense implications for conservation planning across the nation including Isabel Province, as many areas of high biodiversity and local significance will be potentially impacted by this increase in mining activity.

There is also renewed interest in fisheries policy reforms that will ensure that that country gains a greater percentage of revenue from its pelagic tuna stocks. Solomon Islands also has significant potential for ecotourism, yet a lack of infrastructure and low investment by government means that this sector currently provides less than 4% of Gross Domestic Product (GDP), a figure that is far lower than neighbouring countries such as Vanuatu, and not expected to change significantly in the next decade (Peguvaka, 2011).

2.3 Biodiversity

Solomon Islands has the second highest terrestrial biodiversity of anywhere in the Pacific, surpassed only by Papua New Guinea (Morrison et al., 2007). Solomon Islands supports approximately 4,500 plant species, with Solomon Islands rain forest ranked in the Global 200 list of the most biologically valuable ecoregions (Olson and Dinerstein, 1998). The Solomon Group Endemic Bird Area (which excludes Rennell and Bellona and the Santa Cruz islands but includes Bougainville) has 94 restricted range species, which is a greater number than any other place on earth by area (Stattersfield, A.J., et al. (1997) cited in Kool et al. 2010). Many endemic bird species found in the Solomon Islands are restricted to specific islands or provinces, highlighting the need to consider the scale at which conservation plans are conducted (Kool et al. 2010). Kool et al. (2010) report that: "20 species of birds in Solomon Islands are classified as threatened and two are believed to be extinct. There are 53 known mammal species in Solomon Islands, 19 of which are endemic, and 20 of which are

[1] Solomon Star, June 2012.

threatened. The 53 species comprise 41 bats, three of which are critically endangered and 8 giant rats, three of which are endangered. Three mammal species are thought to be extinct".

Solomon Islands occupies the eastern portion of the global centre of marine diversity, known as the Coral Triangle, which includes all or part of the Philippines, Indonesia, Malaysia, Timor Leste, Papua New Guinea and Solomon Islands (Figure 2). The Coral Triangle comprises 76% of the world's corals and 37% of the world's coral reef fish species in an area that covers less than 2% of the planet's oceans (Veron et al., 2009). The Solomon Islands marine environment presents numerous opportunities for marine conservation, as throughout the nation marine biodiversity is high, marine habitats are in good condition and current levels of threats are low relative to other areas in the western Coral Triangle (Green et al., 2006).

Figure 2. The Coral Triangle.

2.4 Threats

Less that 1% of Solomon Islands land and sea areas are currently protected. Most of the existing protected areas are marine and are managed by local communities with support from non-government organisations (NGOs) and or government. Major threats to Solomon Islands biodiversity include logging, mining, oil palm and other industrial agriculture. Forest cover in Solomon Islands has decreased dramatically from 80% in the 1990s to less than 60% today, indicating a significant loss in biodiversity. The need to protect remaining intact forests is imperative to ensure that biodiversity of Solomon Islands is maintained. Mining activity has the potential to damage ecosystems through direct land clearing, infrastructure development, and contamination of freshwater and marine systems.

Unsustainable fishing practices also pose a threat to biodiversity and livelihoods. In many regions of Solomon Islands valuable macro- invertebrates are severely overexploited, while large vulnerable reef fishes are in serious decline in some provinces (Ramohia, 2006; Hamilton, 2003). Valuable marine invertebrates such as pearl oysters and green snails have

been overfished to the point of commercial extinction, with national export bans typically implemented after the fisheries are in serious decline. The most recent casualty is the bech-de-mer fishery. This fishery has provided very significant levels of income for coastal communities in the Solomon Islands over the past 30 years (e.g. Christensen, 2011) but a national ban on this fishery was first implemented in late 2005 in recognition of the dire state of the fishery (Nash and Ramofafia 2006). Unfortunately these 'bottom of the cliff' management strategies do not always prove successful (Friedman et al, 2011; Hawes et al., 2011). As an example, the pearl oyster fishery in Solomon Islands showed no signs of recovery 15 years after a complete ban on harvesting pearls was put in place in 1993 (Hawes et al., 2011).

All of these threats are further compounded by a rapidly expanding human population. The growth rate in the Solomon Islands is 2.3% per annum (Solomon Islands Census 2009). The impacts of climate change are increasingly being felt across the islands and include sea level rise and increased frequency of storms. Severe problems with sea level rise are apparent for many of the northern atolls such as Ontong Java, where significant beach front erosion has occurred and for almost a decade subsistence gardens have been failing due to saltwater intrusion (Roughan and Wara 2010). In many low lying coastal communities in the Solomon Islands inundation of villages and drinking wells is now common during king tides (Figure 3). Mass coral bleaching events (which occur as a consequence of warming seas) can result in the death of entire reef systems, however coral bleaching has not been widely documented in the Solomon Islands to date. Nevertheless, mass coral mortality was observed around Lata in Temotu Province in 2011 (Figure 3), likely as a result of a coral bleaching event several years earlier (R. Hamilton, personal observations 2011). It is envisaged that implementing protected area networks will reduce the stress on the environment and therefore increase the resilience of natural systems to climate change.

Figure 3. Left: Coastal village in the Reef Islands inundated with saltwater during a king tide in 2012 (Photo P. Ramohia). Right: Extensive dead reef around Lata, Temotu Province 2011 (Photo R. Hamilton).

2.5 National policy framework for conservation

In 1995 the Solomon Islands ratified the United Nations Convention on Biodiversity (CBD) which provides a national framework for conservation across the country. Furthermore, in 2010, Parties to the CBD adopted the Strategic Plan for Biodiversity 2011–2020, a ten-year framework for action by all countries and stakeholders to safeguard biodiversity and the benefits it provides to people. One of the new targets (Target 11) of this strategic plan requires that all countries ensure that by 2020, at least 17% of their terrestrial and inland water and 10% of coastal and marine areas are conserved through ecologically representative and well-connected systems of protected areas. In 2009, to support the CBD commitments, the Solomon Islands Ministry of Environment, Climate change, Disaster and Meteorology (MECDM) produced a National Biodiversity Strategy and Action Plan (NBSAP) and supported a desktop GAP analysis to identify conservation priority areas across the entire country (Kool et al. 2010). In addition, in 2008, a National Adaptation Plan of Action (NAPA) for the country was produced for climate change, as stipulated under United Nations Framework of the Convention on Climate Change (UNFCCC).

While identifying conservation and climate change priority areas at a national scale is an important step, conservation success in the Solomon Islands only occurs when local communities support the initiatives, as access and utilization of land and near shore areas is linked to traditional tenure systems. Therefore, in order for provincial wide conservation planning to be meaningful, it is critical to work with landowners and provincial governments to identify their conservation priorities. To date the only province to take this stakeholder driven approach is Choiseul Province, who worked with The Nature Conservancy to develop a ridges to reefs conservation plan for Choiseul Province in 2010 (Lipsett-Moore et al. 2010).

2.5.1 The Protected Area Act (2010)

Solomon Islands has several National Acts of Parliament associated with natural resource management, with the most recent piece of legislation, the *Protected Areas Act* (2010), being particularly relevant for conservation planning. The *Protected Areas Act* (2010) was passed in 2011 and its regulations were gazetted by the Minister of MECDM on 27th February 2012. It is important to highlight the following points for landowners and communities:

- The Act devolves responsibility to communities and provides a mechanism for community-based management efforts to be recognised under national legislation.
- However, areas of customary land and sea can only be formally protected if landowners agree to it, and the establishment of a protected area does not affect land ownership.
- For an area to be designated under the *Protected Areas Act* a management committee needs to be established, and a management plan developed that sets out the rules of the protected area.
- Once a protected area is established, it does not mean that communities are prevented from using that area to support their livelihoods (i.e. collecting food or building materials).

Although the specific rules for how a protected area can be used will be outlined in the management plan, some activities that are particularly damaging to land and sea, such as large-scale logging and mining are prohibited inside all protected areas established under the 2010 Act. With the advent of more extractive industries like large scale mining, it is imperative existing protected areas have management plans and committees, and have these areas recognised under the protected area act. The process that customary owners of land or

sea need to follow if they wish to formally establish a legally recognised protected area are outlined in Figure 4, which was taken from the Protected Area Fact sheet for Communities, developed by the Landowners' Advocacy and Legal Support Unit Public Solicitor's Office[2].

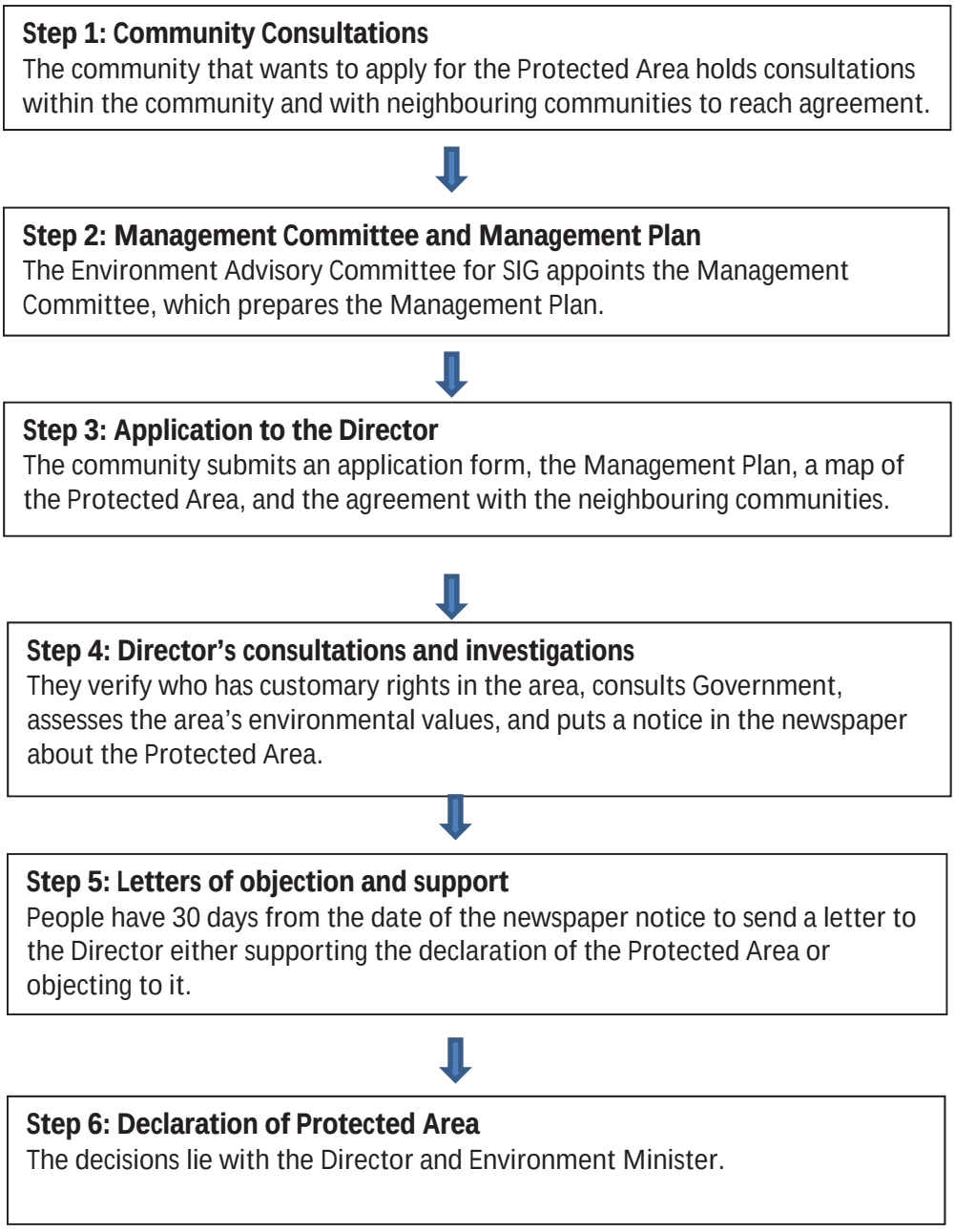

Figure 4. Process for establishing a legally recognised protected area in Solomon Islands.

[2] http://www.pso.gov.sb/index.php/lalsu-resources

3.0 Isabel Province

3.1 Physical and Cultural

Isabel, or Ysabel as it is often spelt locally, has a total land area of 4,221 km^2 (Figure 5). About 26% of the land in Isabel is held by the province as alienated land (government owned), with the remainder held under customary land and sea tenure, which is based on matrilineal inheritance (Santa Isabel Provincial Development Plan 2011-2014). The island has a mountainous terrain and experiences very high annual rainfall. The highest human population densities are located in the south eastern end of the island, and this is the only region of Isabel where inland communities still occur. Six indigenous languages are spoken in Isabel, with the three main languages being Bugotu, Cheke Holo and Zabana (Santa Isabel Provincial Development Plan 2011-2014). Solomon Islands Pijin is also widely spoken. More than 95% of the people in Isabel are Anglican, belonging to the Diocese of Ysabel.

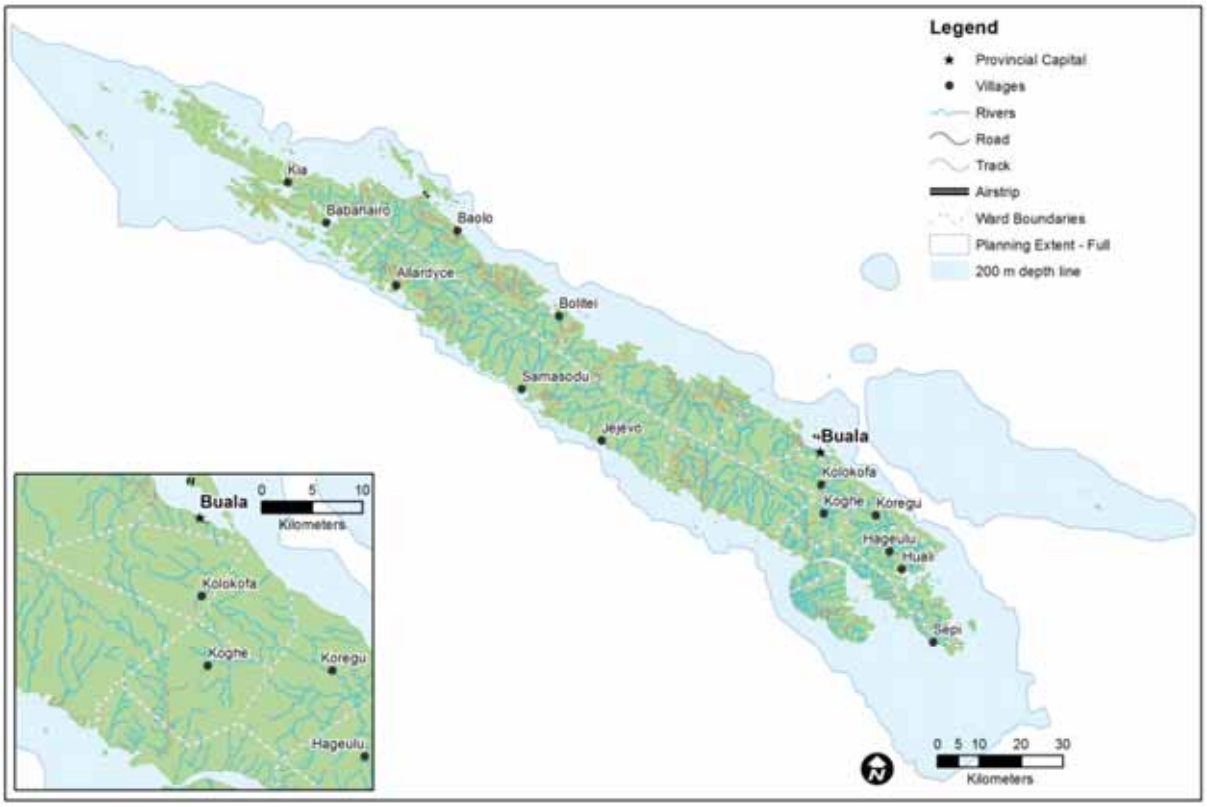

Figure 5. Isabel Province reference map.

Like other areas of the Solomon Islands, Isabel has experienced a rapid population growth, with the total population tripling between 1970 and 2009. In 2009 Isabel had an annual population growth rate of 2.5% and a total population of 26,158, with 49% of the population under 20 years of age (Figure 6). Despite this Isabel Province remains one of the least densely populated provinces, having a population density of 6 people per km^2.

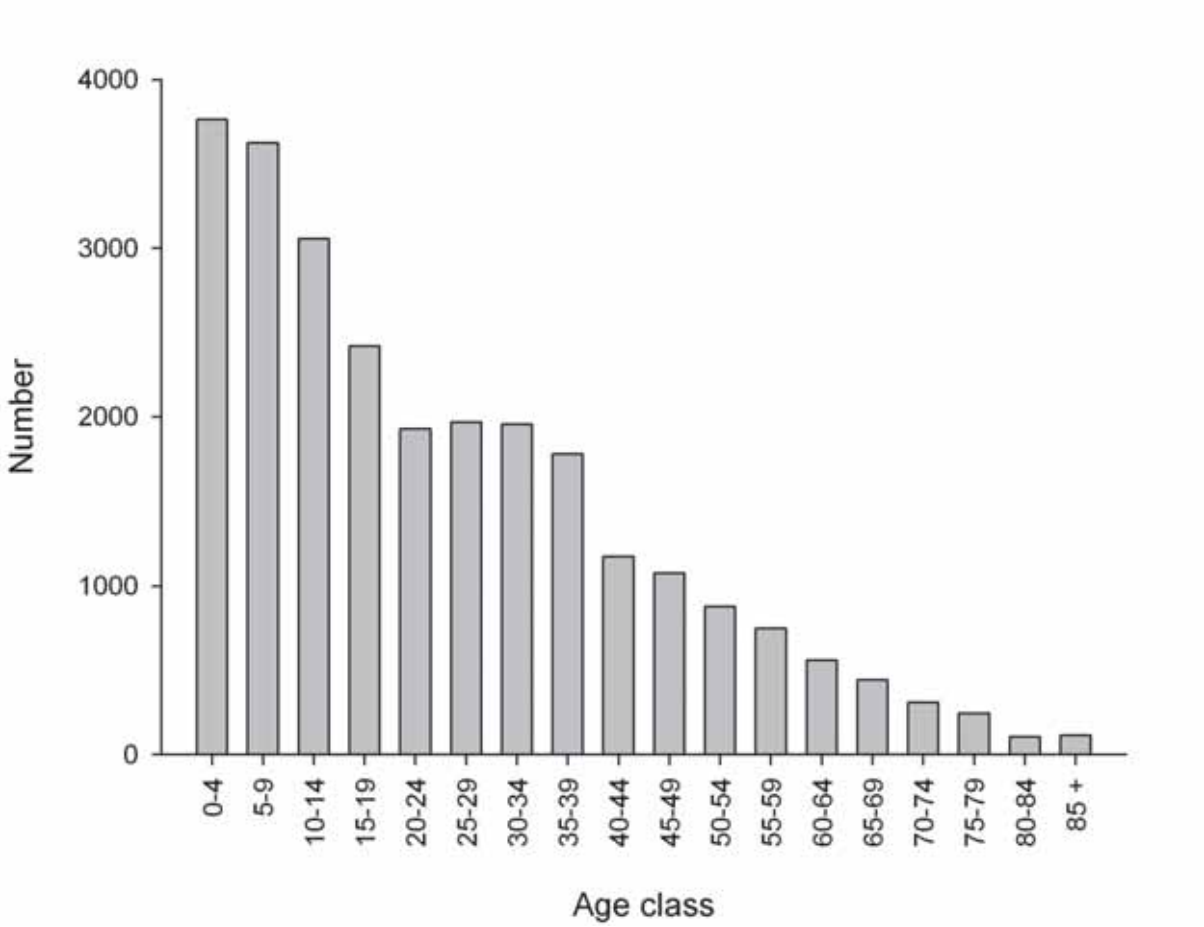

Figure 6. Population structure of Isabel Province by 5 year age groups[3]

The vast majority of the Isabel population remains heavily dependent on their natural resources for survival, with the 2009 census providing many insights into people's reliance on ecosystem services. For example, 94% of all houses in Isabel had walls and floors made out of materials sourced locally from the forests (traditional materials and locally cut timber) and 95% of households use wood and coconut shells sourced from the nearby bush as their main source of cooking energy. The population is also heavily reliant on natural sources of freshwater, with 64% of households having communal standpipes as the main source of drinking water (with nearby rivers being the source) and 24% having rainwater tanks as their main source of drinking water.

The Isabel provincial government has a long history of supporting environmental management and conservation agendas, and this is reflected in the Santa Isabel Provincial Development Plan 2011-2014, where two out of the five goals relate to the environment:

Goal 2. Facilitate provincial economic development by managing natural resources in a sustainable manner and as a way to lead to human and social development.

Goal 4: Ensure sustainable provincial development which is economically, socially, culturally and environmentally balanced and reduces natural disaster risk.

[3] Graph computed based on Solomon Islands 2009 Census Data (SIG Statistical Bulletin 06/2011).

3.2 Economy

Like many of the provinces Isabel has a limited basic infrastructure such as roads, wharfs, shipping and banking facilities, and only 26% of the adult population is engaged in any form of paid employment (SIG Statistical Bulletin 06/2011). Most of the population generate income through a combination of small scale agriculture and fishing. Some of the main crops sold are: coconut, copra and vegetables. Other significant forms of revenue for the provincial government come from national government and through programs such as the Provincial Governance Strengthening Program (PGSP), which is funded by the United Nations, the European Union and the Regional Assistance Mission to Solomon Islands (RAMSI) (Santa Isabel Provincial Development Plan 2011-2014).

In recent decades significant revenue for land owners and government has been generated from logging. Isabel Province supports the second highest number of current logging operations in Solomon Islands. The province has 71,600 hectares of loggable area with approximately 32,000 hectares already logged. In 2008 alone Isabel Province exported more than 300,000m³ of round logs, with an estimated value at SBD$153,736,654 of which 15% (SBD$ 23,100,000) was paid to land owners as royalty payments and 25% (SBD$ 38,400,000) was paid to the Government of Solomon Islands as export duty (Santa Isabel Provincial Development Plan 2011-2014). Currently more than 60% of the Provincial budget is supported by the logging industry. However, with this industry about to exhaust loggable areas and the government looking to place a moratorium on the export of round logs from 2015, the province needs to look elsewhere for sources of revenue.

Isabel has significant deposits of nickel within the ultramafic soils where Tubi (ironwood) also occur, and it is likely that mining will proceed in the future. Sumitomo Metal Mining (SMM) has been issued the rights to investigate the feasibility of conducting mining in the eastern end of Isabel, and at the time of writing this report SMM had submitted an Environmental Impact Statement (EIS) for tenements D and E to MECDM. If SMM does proceed with nickel mining, operation is likely to continue for 30 years, and this may involve the construction of a large plant for processing low grade ore mined from Isabel and Choiseul, with submarine tailing disposal being proposed as one option for tailing treatment (SMM presentation, conservation planning Workshop 1, Buala, February 2012). While such an operation would generate significant revenue for the national and provincial government, this needs to be balanced against the numerous social, cultural and environmental problems that the mine would also bring with it.

The large amount of land that is held by the Province as alienated land is seen as a key opportunity for the province to establish infrastructure and to conduct economic activities, since it can be leased and is not open to land disputes, hence more likely to attract foreign investment. As an example, in recent years a successful surf tourism industry has been established on Papaturu Island, which is alienated land. Other smaller community based surf tourism destinations such as Kakadu (North of Kia) have also been established recently.

Non-perishable marine products such as beche-de-mer, trochus and shark fin are important commodities for the rural population, and when the beche der-mer fishery is open it provides a very important source of income (Kinch, 2004: Ramofafia et al., 2007). Over the past two decades fisheries centres have been established at Kia (Bahana) and in Buala under international aid projects. When operational these centres provide an important source of revenue to local fishers, but it has been shown that due to the difficulties in getting fish to markets and the costs of maintaining equipment, the majority of rural fisheries centres in the

Solomon Islands are not economically viable without ongoing investment from aid agencies (Unnamed, 2007). At the time of writing this report the Buala fisheries centre was not operational and the Bahana fisheries centre was operating sporadically. However a successful private operation has been operating out of Babahiro in the Kia region for approximately six months, and several private fishing ventures operate out of Buala, primarily targeting deep reefs to the north of Buala (Brewer, 2011).

3.3 Biodiversity

The forests of Isabel support a high biodiversity of animals, birds and plants (Lees et al., 1991), including the endemic ironwood species (*Xanthostemon melanoxylon*), known locally as Tubi. Tubi is found in southern Isabel and on the island of San Jorge. The only other location where this species is found is in southeast Choiseul, near Boeboe, Bebalama and Robroy Island (Wilson and Pitisopa, 2007). Given its extremely limited global distribution, current rate of harvest for commercial logging (particularly from San Jorge) and proposed mining activity in the areas it occurs, it would almost certainly qualify for both IUCN RED List and CITES status if it was to be assessed. Isabel province has 22 distinct frog species, the highest diversity of anywhere in the Solomon Islands, with most of these species being endemic (Pikacha et al. 2008). Apart from Choiseul, Isabel also has more species of palms and orchids than any other province in the country (Myknee Sirikolo, personal communications, 2012).

Lees et al., (1991) proposed that the outstanding archipelago of forested high islands, reefs and smaller islands that flank and extend the north-western peninsula of Isabel should be protected, and Green et al., (2006) came to the same conclusion, stating that the well flushed sheltered reef habitats and extensive mangrove environments (Pillai and Sirikolo, 2001) around the north-western area surrounding Kia were of high conservation importance, along with the fjord-like coastline on southern Isabel. The reefs around Isabel appear to remain unaffected by coral bleaching events and crown of thorn starfish outbreaks which have detrimentally affected nearby regions such as the Autonomous Region of Bougainville over the past decade (Hamilton et al. 2010).

Isabel Province also has many very important turtle nesting beaches. The Arnavon Islands support the largest remaining nesting population of the critically endangered hawksbill turtle population in the South Pacific. The critically endangered western Pacific leatherback turtle (known locally as Babaru) also nests around Isabel between December – March, and the Litogharhira and Sasakolo nesting beaches that are located in the south west of Isabel being the largest leatherback nesting beaches in the country (Pita et al. 2007).

3.4 Threats

The main threats to biodiversity and the ecosystems upon which the people of Isabel depend are logging, mining, overfishing, and climate change. All of these factors are compounded by rapid population growth which increasingly burdens the island ecosystems. Logging rates are currently at crisis levels, and island mining will have many ecological consequences that need to be carefully considered if it is allowed to go ahead. Some of the potential ecological impacts of mining include:

1. The risk of acid mine drainage and movement of metals into streams and the marine ecosystems.

2. Impacts of mining on freshwater and food security.

3. Loss of the endemic, culturally important Tubi tree that only occurs on soils that have high levels of nickel (Wilson and Pitisopa, 2007).

In the marine environment overfishing has occurred for many valuable species such as bech-de-mer and pearl oyster, and fin fish stocks are also greatly depleted in some areas such as Maringe Lagoon, which is in close proximity to the provincial capital Buala (Ramohia et al, 2009). Widespread overfishing of coral reefs is a concern because overfished and stressed reefs have less ability to bounce back from other shocks such as coral bleaching or storm damage. Climate induced sea level rise is having an impact through the province, and the provincial government is taking steps to adapt to these impacts. For example, two of the development projects being undertaken by the provincial government concern adaption to climate change, that being the construction of a 70 m seawall along the shoreline of Buala headquarters to safe guard the administration building from encroaching seas and wave damage, and the relocation of the Tataba clinic building to higher ground to ensure it is safe from sea level rise (Santa Isabel Provincial Development Plan 2011-2014).

3.5 Provincial policy framework for conservation

Solomon Islands provincial governments are empowered to make ordinances over the management and protection of their natural resources. Isabel has passed three such ordinances addressing the environment: *Isabel Province Marine and Freshwater Areas Ordinance 1993 (IPMFAO); Isabel Province Conservation Areas Ordinance 1993 (IPCAO)* and*; Isabel Province Wildlife Sanctuary Ordinance 1995 (IPWSO).* In 2006, the Isabel Provincial Executive endorsed a new ordinance to consolidate the three statutes dealing with land, marine and wildlife conservation areas, known as the *Isabel Province Resource Management and Environmental Protection Ordinance 2006* (McDonald, 2006). The 2006 ordinance seeks to provide a mechanism for communities and the province to enforce management rules they considered important. It also made provision for the establishment of protected areas on alienated land, and for the creation of areas with a predominantly conservation (rather than resource management) focus. The latter provisions were aimed at safeguarding the special status of the Arnavons Community Marine Conservation Area (ACMCA).

It is noteworthy that even in cases where communities have developed a detailed management plan for a conservation area and have the support of NGOs and provincial government, prosecuting offenders can prove difficult. The ACMCA is a good example. It has had a management plan and management committee since 1994, and its protected area status is supported by the *Isabel Province Wildlife Sanctuary Ordinance 1995*. In the past decade ACMCA conservation officers have intercepted poachers within the ACMCA on a number of occasions, and have notified Isabel police officers, who have subsequently confiscated their fishing gear and opened cases against the poachers. However, because a magistrate did not visit Isabel Province for many years, the cases have never gone to court. Furthermore, after more than a decade of high inflation, the penalties for poaching are now very low and so are a limited deterrent to poaching (Hamilton et al., 2008).

3.6 Conservation and resource management in Isabel

Isabel has a long history of managing its resources at a community level. The continuity of customary tenure over most of the province enables chiefs to place management measures on natural resources in order for them to recover. As with nearby Choiseul, a common form of customary management is for communities to ban the harvest of trochus and beche-de-mer on a reef for a period of months or years. Closures are declared by the chiefs and church leaders, and once closed reefs are considered tambu (sacred or off limits) until reopened by the leaders.

In the past two decades several international environmental non-government organisations (NGOs) have worked in Isabel Province. The first such organisation was The Nature Conservancy (TNC). TNC began working in Solomon Islands in 1992, initially to facilitate the establishment of the ACMCA. The ACMCA consists of 15,800 hectares of protected islands and sea, located between Choiseul and Isabel Province. It supports one of the largest remaining hawksbill turtle rookeries in the South Pacific. The ACMCA was established in 1995 in partnership with the Katupika and Wagina communities (Choiseul Province), Kia community (Isabel Province), Choiseul and Isabel provincial government and the national government of Solomon Islands.

Since its establishment the number of nesting hawksbill turtles within the ACMCA have improved dramatically. In addition, an endowment has been established to fund the ongoing operational costs of the ACMCA and communities are beginning to receive some direct financial benefits, particularly from fees paid from international cruise ships that visit the area. In 2011, TNC formally passed all management responsibilities to the ACMCA Management Committee Trust Board, who will lead from here on, as TNC phases out. From 2006, TNC also began a conservation and monitoring program with the Kia community at the Sasakolo leatherback nesting beach, although at the time of writing this report the conservation work had halted there due to land ownership disputes. In 2012, TNC and Isabel Provincial Government (IPG) established and staffed an environmental office in Buala, to assist the IPG and communities with conservation work in the province.

In 2005, WorldFish worked with Kia and surrounding communities to develop management plans for beche-de-mer. WorldFish has maintained a presence in the Kia District since 2005, providing technical and financial support, and in May 2008 the Kia District launched the Kia District Marine Resource Management Plan. This plan covers a sea area of 450 km^2 and outlines a variety of community-based management measures, such as periodic closures of 6-12 months on selected tambu reefs, and restrictions on destructive fishing practices on open reefs (Kia District Marine Resource Management Plan, not dated; Schwarz et al., 2009). In 2010, UNDP and local resource owners also established three marine protected areas (MPAs) within the heavily overfished Maringe Lagoon (Ramohia et al. 2009; Maringe Lagoon Management Plan, not dated).

3.6.1 The need for Province wide conservation planning

Although considerable conservation work has taken place in Isabel Province, this is the first time stakeholders have undertaken a process to systematically identify conservation priority areas across the entire province. With multiple pressures including a growing population, mining and climate change, the need to have a provincial conservation plan has never been more critical. This plan can be used to help make informed decisions about where

development and conservation activates should take place, and where limited funding for conservation work should be allocated.

The plan will also have other benefits, as demonstrated in Choiseul province, when in 2010 stakeholders developed a conservation plan using the same process as Isabel (Lipsett-Moore et al, 2010). The benefits of developing a ridges to reefs conservation plan for Choiseul included:

1. Building awareness of the need for establishing protected area networks and as a result, Lauru Land Conference of Tribal Communities (LLCTC) and Choiseul Provincial Government endorsed the establishment of a Ridges to Reefs Lauru Protected Area Network (LPAN), that seeks to establish a mosaic of protected areas to conserve biodiversity, secure livelihoods and buffer against climate change. This was the first such commitment in the country.

2. The Choiseul Ridges to Reefs Plan and the ongoing efforts of the LLCTC and partners to establish a LPAN continue to attract other donors to the province keen to support resource management and sustainability.

3. Providing an independent/community led assessment of conservation priorities across Choiseul, which is of considerable value when assessing what impacts major extractive developments such as mining will have in the province.

3.7 Stakeholders conservation planning workshops

To initiate the process of developing a conservation plan for Isabel, TNC and the Isabel Provincial Government held three stakeholder conservation planning workshops in 2012. The first workshop was held in Buala from the 2nd-4th of February 2012, the second workshop was held in Kia from the 25th-27th of April 2012 and the final workshop was held again in Buala from 25-26th June 2012. 118 stakeholders attended these workshops, including chiefs, church leaders, women and youth from every district in Isabel. Local organisations represented at the workshops included the Arnavon Community Marine Conservation Area (ACMCA), Buala FM, Diocese of Ysabel (DOY), Isabel Council of Chiefs (ICC), Isabel Investment Cooperation (IIC), Mothers Union, Papaturu Resort and the Provincial Departments of Commerce, Education, Fisheries, Lands, Planning, Police and Tourism. The Ministry of Environment, Climate Change, Disaster and Meteorology (MECDM), the Ministry of Fisheries and Marine Resources (MFMR) and the Ministry of Forestry were also represented at the workshops. Other organisations from outside of Isabel who were represented at these workshops included the Asian Development Bank (ADB), Lauru Land Conference of Tribal Communities (LLCTC), Pacific Horizons, Sumitomo Metal Mining (SMM), Tetepare Descendants Association (TDA), University of the South Pacific, WorldFish, WWF, and TNC staff with expertise in conservation planning and ecology.

3.7.1 First Workshop, Buala, 2-4 February 2012

The workshop was opened by a speech from the Deputy Premier for Isabel Province, after which the facilitators outlined the need for conservation planning and the types of information that are required for this process. The Mothers Union then gave a presentation on importance of the natural environment for the women of Isabel, followed by a presentation by DOY on the importance of the environment from a spiritual perspective. In the afternoon

there was a presentation by the ACMCA, Pacific Horizons and IIC. The last presentation of the day was by SMM on the proposed mining activities in Isabel.

On the second day participatory mapping of the marine and terrestrial biodiversity in Isabel was conducted. This initially involved workshop participants identifying numerous local features that were of high conservation value to them, including existing and proposed managed areas and cultural heritage sites. Following this, stakeholders mapped where these features occurred within their customary lands and seas (Figure 7). The meeting was divided into three groups, covering the western, middle and eastern section of Isabel. Large format colour base maps illustrating existing terrestrial (vegetation) and reef data, rivers, roads and major communities at 1:70,000 scale were provided to each group and conservation features were delineated and labelled by the community leaders using participatory mapping.

In the afternoon the same process was used to identify threats to biodiversity (i.e. mining activities, proposed or past logging areas and sea level rise) and these threats were identified through participatory mapping. On the final day each of the three geographical groups provided feedback on the participatory mapping process and there were breakout discussions on the proposed nickel mining and what this meant for the people of Isabel.

3.7.2 Digitizing local features identified through participatory mapping

After the first workshop the base maps were returned to Brisbane and all line features digitized to create GIS files for the community based features. This resulted in the mapping of 87 categories (conservation features, threats, and opportunities) (Figure 8). Thirty three of these categories were deemed suitable for inclusion in the analysis as well as threats (Appendix 1). Categories that were too general (e.g. corals, bush rope, bamboo) were not used.

Figure 7. Participatory mapping of local conservation features and threats at the Buala and Kia workshops.

3.7.3 Second workshop, 25-27 April 2012

The second workshop was opened by the Minister of Natural Resources for Isabel Province, after which the facilitators outlined the conservation planning process. The ICC then gave a presentation on the importance of the natural environment from a chief's perspective, and the DOY gave a talk on the importance of the environment from a spiritual perspective. An overview of the environmental work that has been occurring in the Kia region was then given by the Mothers Union and WorldFish. Papatura Resort then gave a presentation on ecotourism is Isabel Province. Following this workshop facilitators presented draft maps of what the conservation priorities for Isabel looked like, and explained the Marxan modelling process that had been used to produce these maps (see Section 4.2.1 of this report for detail on the Marxan modelling process).

The afternoon of the first day was spent re-examining the local conservation features and threats identified in the first workshop, and facilitators explained which ones had been used in the preliminary analysis and how they had been grouped and selected. Some new conservation features were added by stakeholders and some considered to be too general were removed. The group then determined the percentage of each conservation feature they would like to see conserved. For most features, a low and high value was assigned (Appendix 1), which reflects the range of views held by the participants. For some features such as cultural heritage sites, there was a consensus among the group that the conservation target needed to be set at 100%. On the second day, workshop participants broke into three geographical groups and cross checked the local features they had marked on maps in Workshop 1. They also added additional conservation features and threats to the maps. The day ended with a presentation by the LLCTC on their Lauru Protected Area Network, and a discussion on whether Isabel Province should implement a ridges to reefs protected area network of their own. On the final day of the workshop participants travelled to the Arnavon Islands to witness the conservation work there.

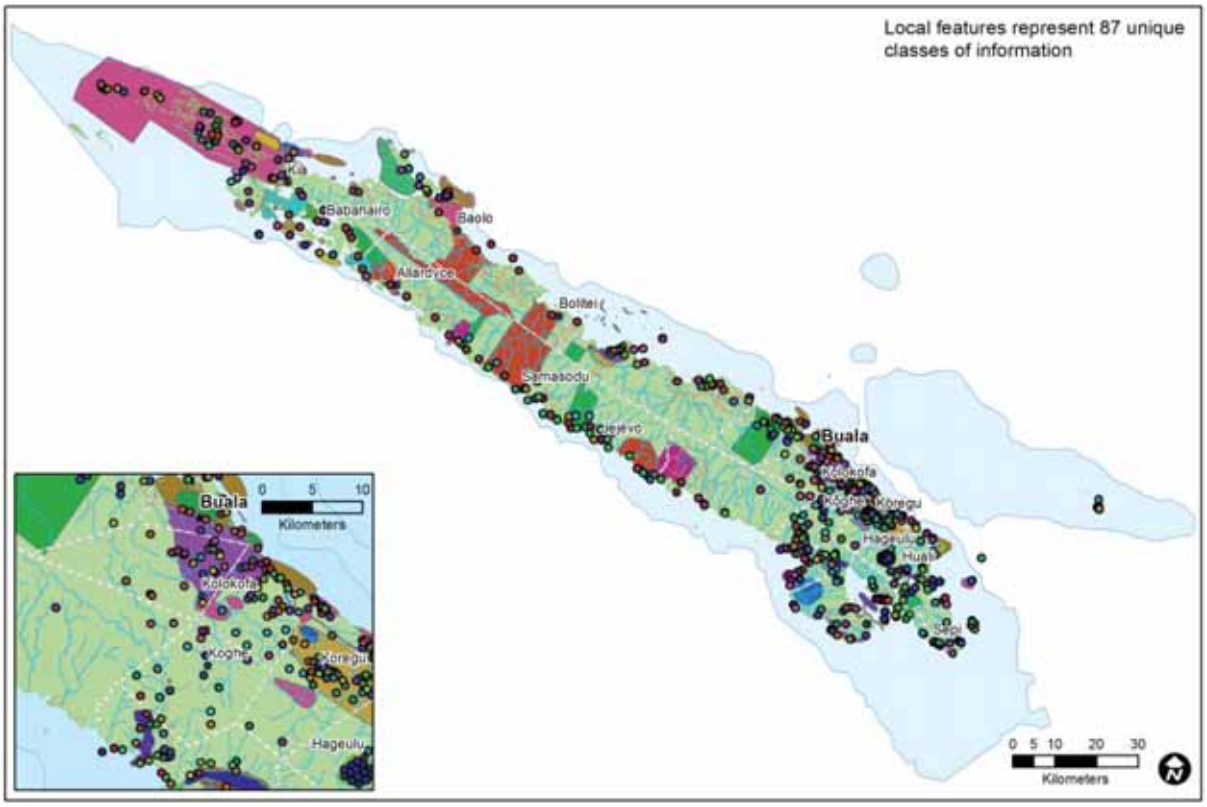

Figure 8. Map of Isabel Province showing spatial distribution of the 87 Local conservation features and threats identified by participants at the first two stakeholder planning workshops.

3.7.4. Third workshop, 26-27 June 2012

The third workshop enabled stakeholders to view and comment on the draft Isabel Ridges to Reefs Conservation Plan and develop strategies for rolling the plan out across Isabel. It was opened by the Isabel Premier Hon. James Habu who endorsed the plan and congratulated the workshop participants on their efforts. Agnetha Vave-Karamui, Chief Conservation Officer from MECDM then spoke on how this type of work fits with international, national and provincial commitments to preserve the environment. This was followed by a presentation by MyKnee Sirikolo from the Ministry of Forestry on the status of terrestrial biodiversity in Isabel. Workshop facilitators then overviewed all of the information that went into developing the Isabel Ridges to Reefs Conservation Plan and presented the conservation priority maps for Isabel. In the afternoon Jimmy Kereseka (LLCTC) gave a presentation on how Choiseul is using its conservation plan. This was followed by a presentation from an Isabel Provincial Government representative on the provincial frameworks that exist to support conservation work in Isabel Province. The day ended with a presentation from Peter Kenilorea from MFMR on the recent national bech-de-mer survey, and a presentation from Tingo Leve from WWF, who talked about his perspective on the value of Isabel conservation planning process.

The second day of the workshop began with a presentation by Peter Ramohia on ADBs program of work in Isabel, and this was followed by a presentation by Ruth Konia on her

experiences on the positive and negative impacts of mining in PNG. Peter Blanche from Papatura Resort than talked about the relevance of the Isabel Ridges to Reefs Conservation Plan and protected areas for sustainable developments such as ecotourism. For the rest of the morning the workshop participants broke into groups and discussed the next steps needed to roll out the Isabel Ridges to Reefs Conservation Plan. It was decided the roll out process throughout Isabel would be coordinated by the Mothers Union. In the afternoon all of the workshop participants participated in the public display of the SMM Environmental Impact Statement (EIS) of tenants D and E which was facilitated by MECDM staff, with numerous concerns raised by workshop participants.

4.0 Conservation Planning

The Solomon Islands is a signatory to the Convention on Biodiversity (CBD) which requires that at least 17 per cent of their terrestrial and inland water and 10 percent of coastal and marine areas are conserved through ecologically representative and well-connected systems of protected area networks. Solomon Islands have no formal criteria for designing protected areas networks, so here we adopt the criteria Lippsett-Moore et al. (2010) used when developing a ridges to reefs conservation plan for Choiseul Province.

4.1 Criteria used for developing the Isabel conservation plan

1) A minimum of 17 percent of their terrestrial and inland water and 10 percent of coastal and marine areas are conserved through ecologically representative and well-connected systems of protected area networks.

2) Local stakeholders determine the level of protection necessary for each locally identified conservation feature.

3) Protected areas should be replicated across the geographic range of the ecosystem to decrease the likelihood that chance events such as disease or coral bleaching will cause the ecosystem to decline.

4) The protected area network should seek to maximize the area of high quality habitat for all known elements of biodiversity wherever practicable, but with particular reference to areas of high species diversity, natural refugia for flora and fauna and centres of endemism.

5) Conservation targets should be elevated above CBD targets for highly vulnerable life stages of important food species (e.g. reef fish spawning aggregations).

6) Conservation targets should be elevated above CBD targets for conservation features most vulnerable to the impacts of climate change (e.g. turtle nesting beaches).

7) Adopt a ridges to reefs approach that protects connected terrestrial and marine areas. Such an approach recognizes that what we do on the land has a profound effect on our rivers and near shore areas and seeks to minimize these impacts.

4.2 Basis of the Analysis

The following ridges to reefs conservation assessment and products, represents a synthesis of the best available spatial and locally derived data. This information is then used to inform a gap analysis which compares the distribution of biodiversity with the distribution of protected areas, highlighting where species and ecosystems are left unprotected or under protected (Dudley and Parrish, 2006). To address these gaps in a systematic way, the concept of ecological representation was developed. This refers to the need for protected areas to represent, or sample, the full variety of biodiversity of different biological realms (freshwater, marine and terrestrial through all the ecoregions) and biological scales (ecosystems, species and within-species variation) (Noss, 1995). So based on the best available data and the identified gaps, options can be developed for protected area systems that represent the full range of ecosystems across the province.

Conservation planning aims to develop options for the effective representation of many different conservation features, all with very different spatial distributions. This also requires the consideration of many threats and opportunities for the protection and effective management of those conservation features. In order to prioritise areas to protect, a fundamental unit of choice, or planning unit needs to be allocated. For this study we selected a 50 ha hexagon as our planning unit. The entire planning unit layer for Isabel Province consisted of 23,745 x 50 ha hexagons (Figure 9 and refer to Section 4.3.1 for detail on this process). This allowed us to compare one area with another across Isabel to determine those areas that provide the best ecological representation. Determining conservation priority areas that efficiently represent the biodiversity of Isabel requires identifying planning units that best satisfy a number of ecological criteria (outlined above in section 4.1).

4.2.1 Marxan decision support

We used the software Marxan to assist with the many decisions required to determine the most important areas to protect and manage in order to meet the CBD and local targets (section 4.1). Marxan is a decision support tool developed specifically to assist with complex conservation planning problems (Ball and Possingham 2000, Possingham et al. 2000). Specifically, we used Zonae Cogito a user friendly interface for Marxan (Watts et al. 2010). Marxan and its variants have been used to assist with hundreds of conservation planning initiatives around the world. It is designed to help synthesize large amounts of data and support decisions by exploring a range of conservation scenarios. In order to deal with often conflicting biodiversity, threat and opportunity data we need to have well defined targets. The targets for Isabel were identified using the best available ecological data for the province and through the stakeholder workshops. In addition to the overall objectives identified in Section 4.1, specific conservation targets are detailed in Appendix1. These conservation targets are then sought in a way that the resulting conservation actions would result in minimal impact on community interests. Conservation priorities are preferentially selected in areas where communities have expressed an interest in conservation through either the stakeholder workshops or other processes.

The key inputs used in the Marxan runs were:

- Planning Units: 23,745 50 ha hexagons (Figure 9)
- Stratification of Marine Targets (Figure 10)
- Terrestrial Conservation Features: 20 (refer to Appendix 1)
- Marine Conservation Features: 52 (refer to Appendix 1)
- Local Conservation Features: 33 (refer to Appendix 1)
- Conservation Targets: CBD targets (17% terrestrial and 10% marine) with rare and vulnerable features to 50% or 100%, and a minimum and maximum target for each local feature (Section 4.1 and Appendix 1).
- Cost surface based on boundary length
- 100 runs
- Number of iterations/run: 10,000,000
- Boundary Length Modifier: 4
- Penalty Cost: 5 (Set equally across all conservation targets which means all targets were weighted equally)
- Temperature decreases: 10,000
- Adaptive annealing “on”
- Using simulated annealing

A more detailed description of the key inputs is detailed in the following section. For a complete description on the use of Marxan see Game and Grantham (2008).

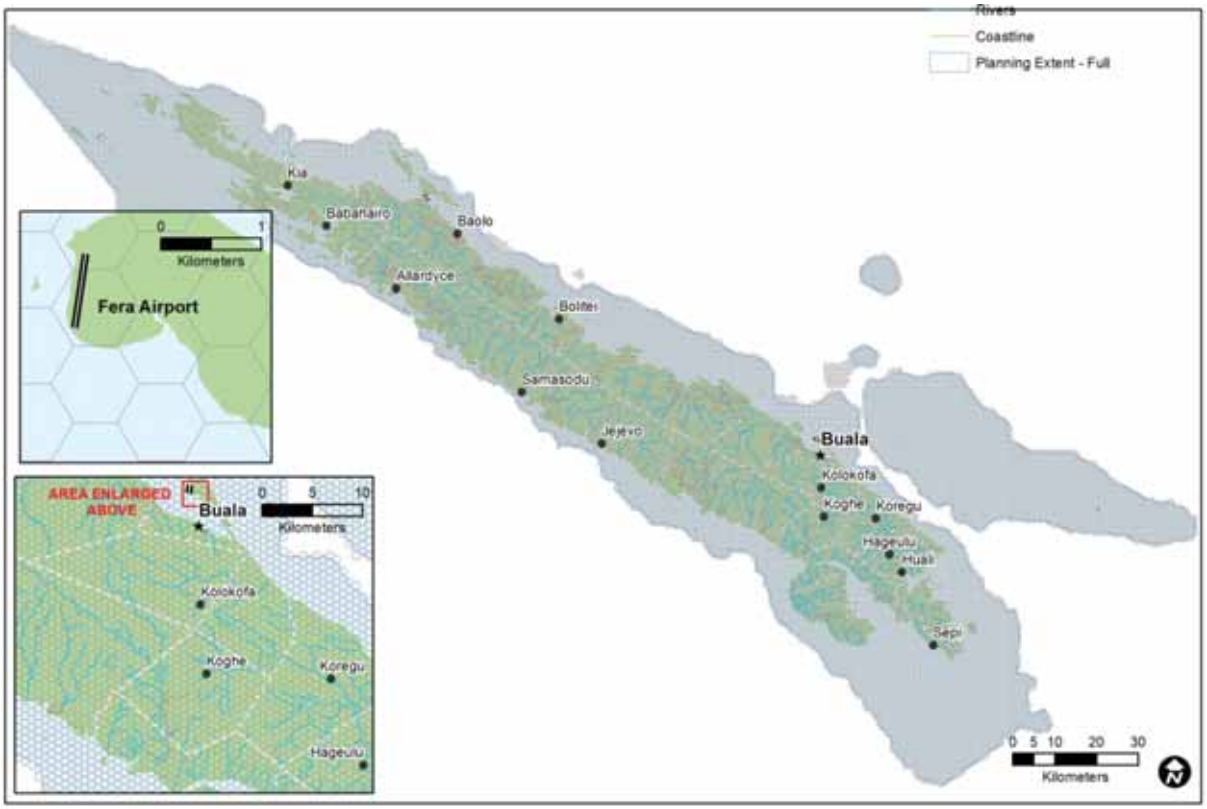

Figure 9. Map of Isabel Province showing the 50 ha Planning Units (hexagons) across the entire ridges to reef planning area

4.3 Methods

4.3.1 Planning Area, stratification, planning units

The planning area includes all the islands of Isabel Province and all near shore, reef and shelf waters out to the 200m depth contour (derived from GEBCO bathymetry data)[4]. Planning units provide the individual unit of choice for selection for conservation. We generated a planning unit layer that consisted of 23,745 x 50 ha hexagons across the entire study area (Figure 9). The 50 ha size is approximately the size of the smallest protected areas in Isabel. It is also a fine enough scale to allow the development of refined areas while simultaneously keeping the number of planning units constrained to a number where the processing time in Marxan was manageable.

The stratification provides the overarching template within which each target is sought. This ensures that representation, geographic spread and replication are effectively incorporated in the analyses. The marine areas were stratified into seven regions (Figure 10) to capture the variation in reef structure, currents and seasonal variation in prevailing winds (based on expert opinion R. Hamilton and A. Green pers. comm.). Terrestrial area was not stratified as, with the exception of the ironwood, it forms one largely homogenous unit.

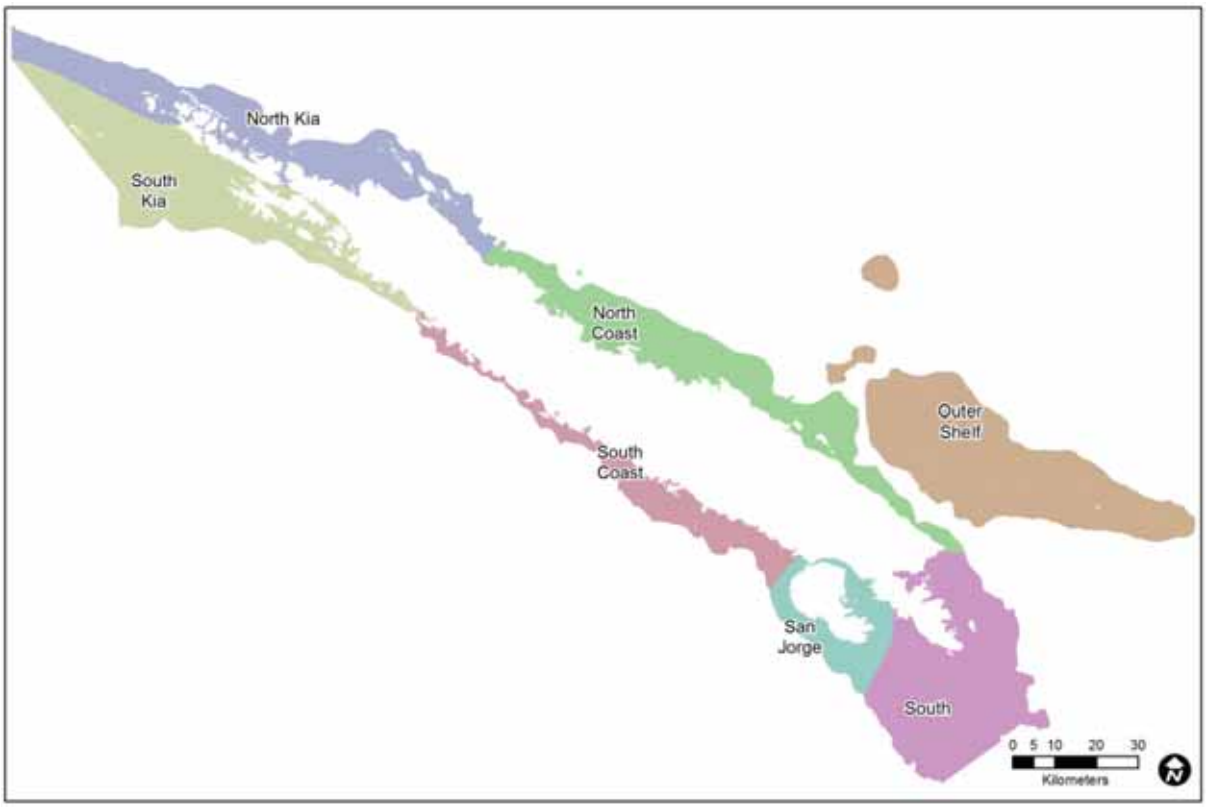

Figure 10. Marine Stratification.

4.3.2 Conservation Features

We compiled the best available spatial data sets for Isabel Province to represent marine and terrestrial features, as well as data on threats (e.g. logging and mining). Terrestrial conservation features were sourced from a vegetation classification supplied by the Solomon Islands Ministry of Forestry. Additional spatial data illustrating, roads, rivers, ward

[4] http://www.gebco.net/

boundaries, and village locations was supplied by the Solomon Islands Ministry of Lands in early 2009. The proposed mining footprint for tenement D and E in southern Isabel was obtained from the EIS report submitted by SMM to the national government (SMM Solomon Limited, 2012) and supporting GIS data that was provided by SMM. The stakeholder workshops also verified these data sets as well as adding extra significant conservation information to a base maps. A full list of conservation features is detailed in Appendix 1.

4.3.2.1 Marine Conservation Features

Baseline information for marine conservation features was obtained from the Millennium Coral Reef Mapping Project data set where a total of 47 marine conservation features were detailed (Andréfouët et al., 2005), including coastal shelf, reef and bay complexes (Figure 11, Appendix 1). The Millennium Coral Reef Mapping Project reef classification is derived from remotely sensed satellite data and processed by Serge Andrefouët and his team at the Institute for Marine Remote Sensing (IMRS), University of South Florida. These data are freely available and offer the most detailed and complete reef classification for Isabel.

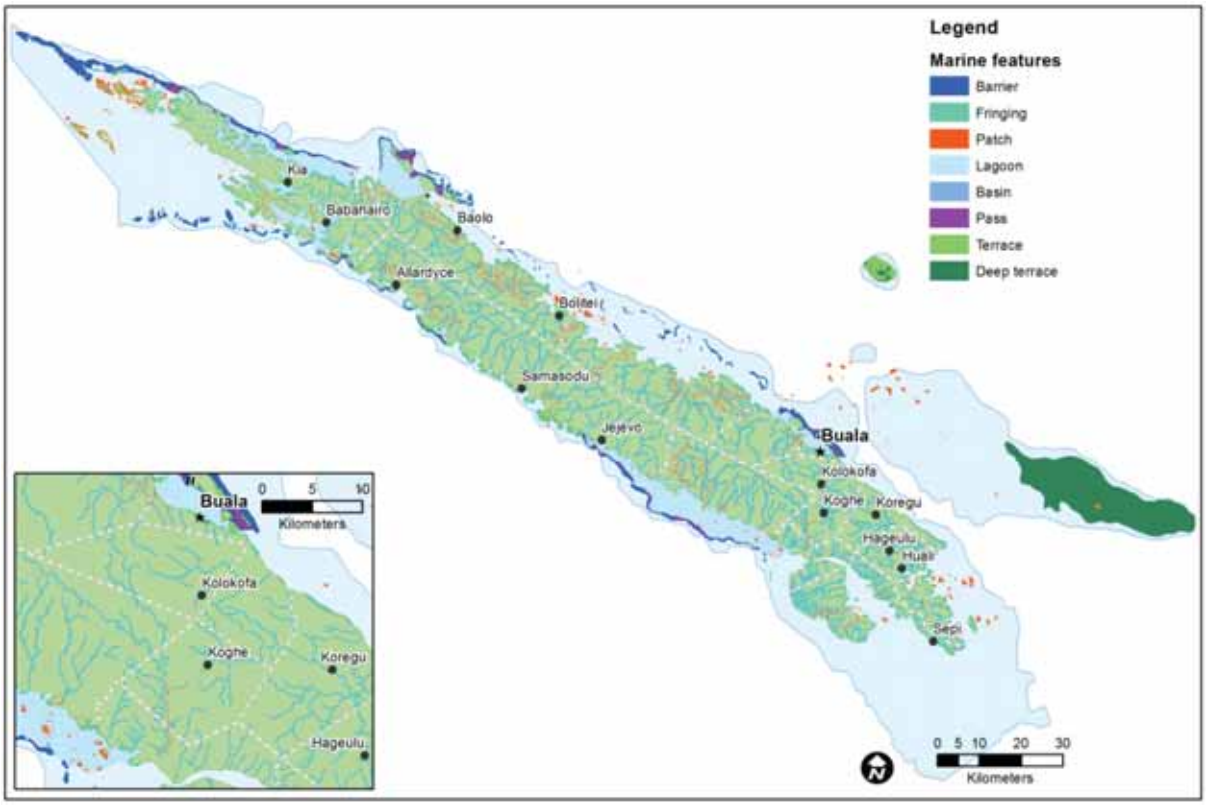

Figure 11. Map of Isabel Province showing a general classification of marine features[5].

4.3.2.2 Turtle Nesting Beaches

Isabel Province has more turtle nesting beaches than anywhere else in the country, with the three most important areas being the ACMCA, Sasakolo and Litogahira. The ACMCA supports the largest population of nesting Hawksbill turtles in the South Pacific, and Sasakolo and Litogahira support the largest nesting populations of Leatherback turtles in the Solomon

[5] Full classification includes 47 reef types (Appendix 1).

Islands. Both of these species are classified as critically endangered. Collectively the province has over 70 kms of turtle beaches (Figure 12). While not all beaches have equal levels of nesting activity, they are still all of high conservation value given that turtles are globally threatened.

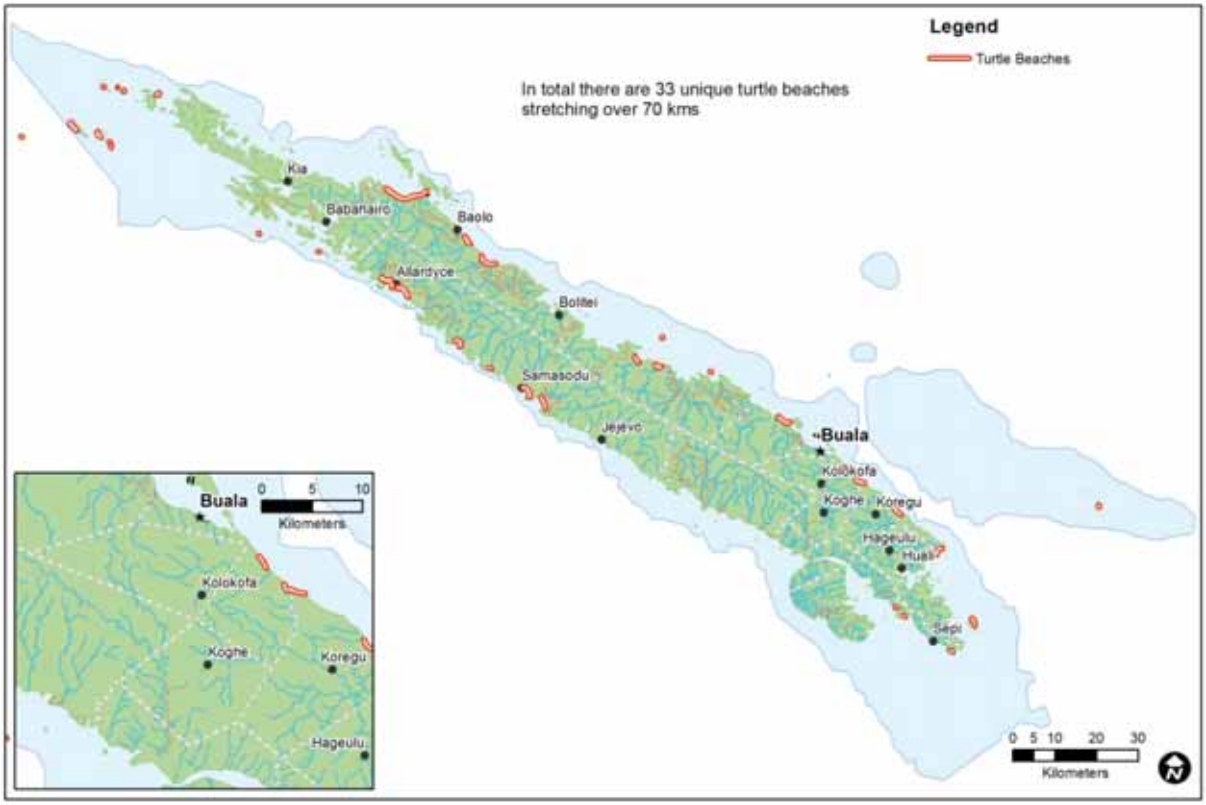

Figure 12. Map of Isabel Province showing turtle nesting beaches.

4.3.2.3 Terrestrial Conservation Features

Seven broad natural vegetation types in the Solomon Islands have been outlined including: coastal strand vegetation, mangrove forests, freshwater swamp forests, two types of lowland rain forests, seasonally dry forest and grassland (only on Guadalcanal), and montane rain forest (Mueller-Dombois and Fosberg 1998). The vegetation map used in this analysis was based on available forestry mapping. Based on the 7 general vegetation types a total of 24 vegetation types and three non-vegetation types were further delineated within the mapping including: fresh water mixed forests, iron wood (*Xanthostemon melanoxylon*) forest, hill mixed forest, upper montane forest, and various classes of degraded forest (Figure 13 and 14).

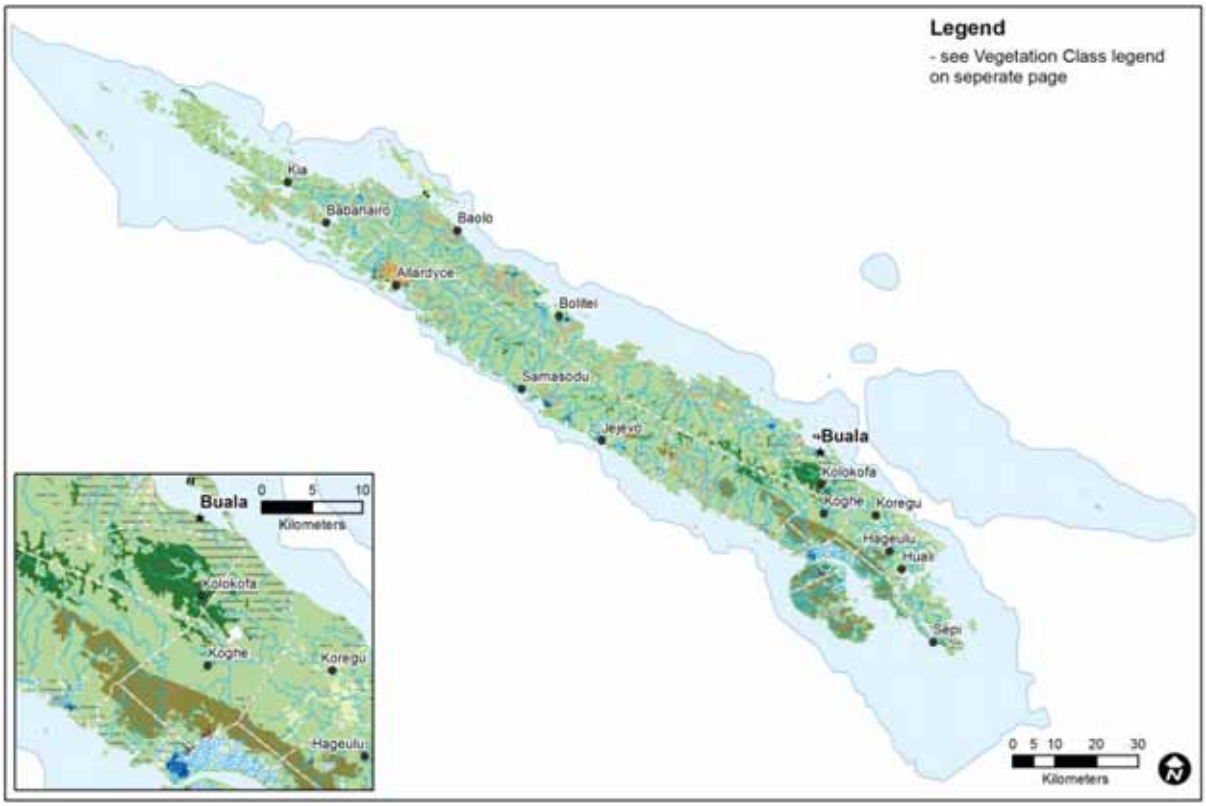

Figure 13. Map of Isabel Province showing cover for 24 vegetation classes (refer to Figure 14 for map legend).

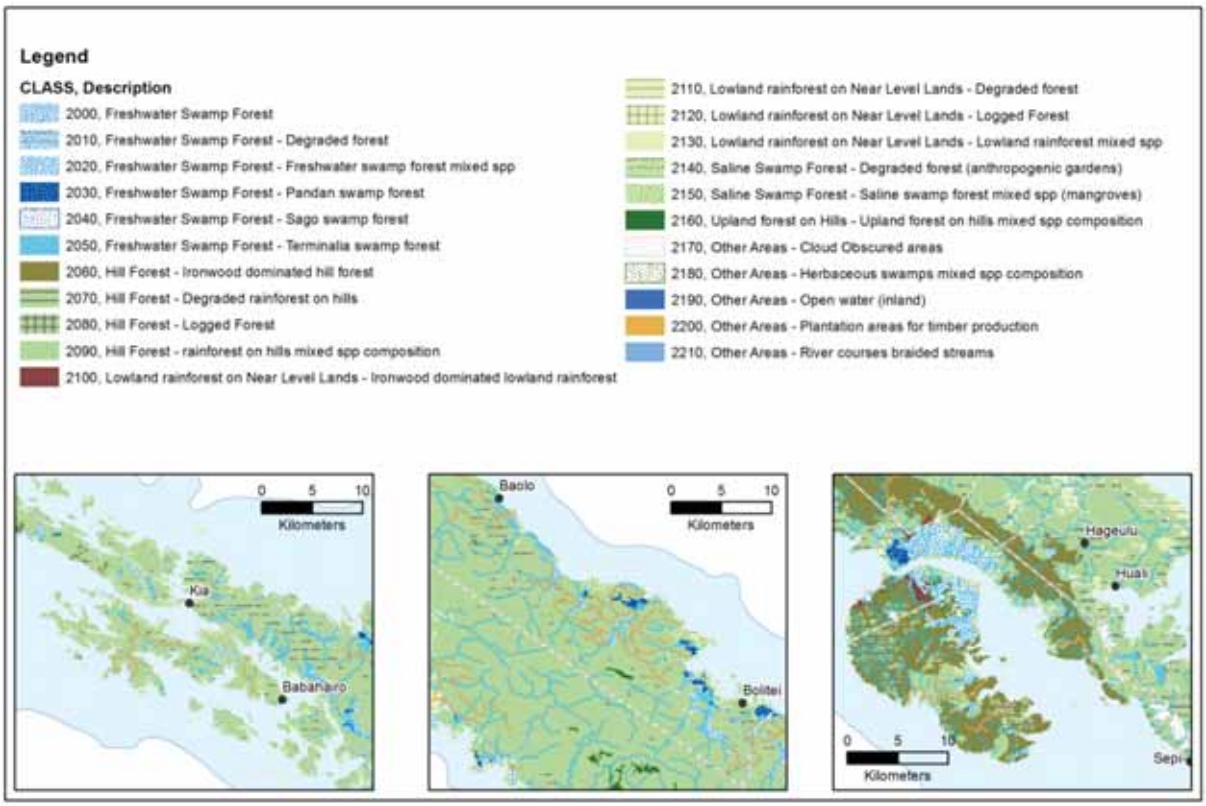

Figure 14. Vegetation class legend for Isabel Province (refer to Figure 13 for map).

4.3.2.4 Discounting

Discounting is a method used to rank and compare the contribution of forest areas towards meeting conservation targets relative to their overall quality/condition for biodiversity (eg logged versus unlogged forest). Discounting is calculated based on the following assumptions about the contribution of different forest types to biodiversity:

- Intact forests provide the highest quality habitat for supporting biodiversity
- Logged forests provide less suitable habitat for biodiversity, and
- Plantation forests provide the least suitable habitat for biodiversity.

The aim was to approximate current forest condition to provide a gradient from undisturbed forest to disturbed forests and to then clearly differentiate areas unsuitable for protection from those more suitable. Within the existing scheme we assigned the following discounting (Figure 15) for forests based on logging activity and mining tenements. Logging areas illustrated below are based on available logging history data and modified based on local qualitative knowledge on relative condition of each area.

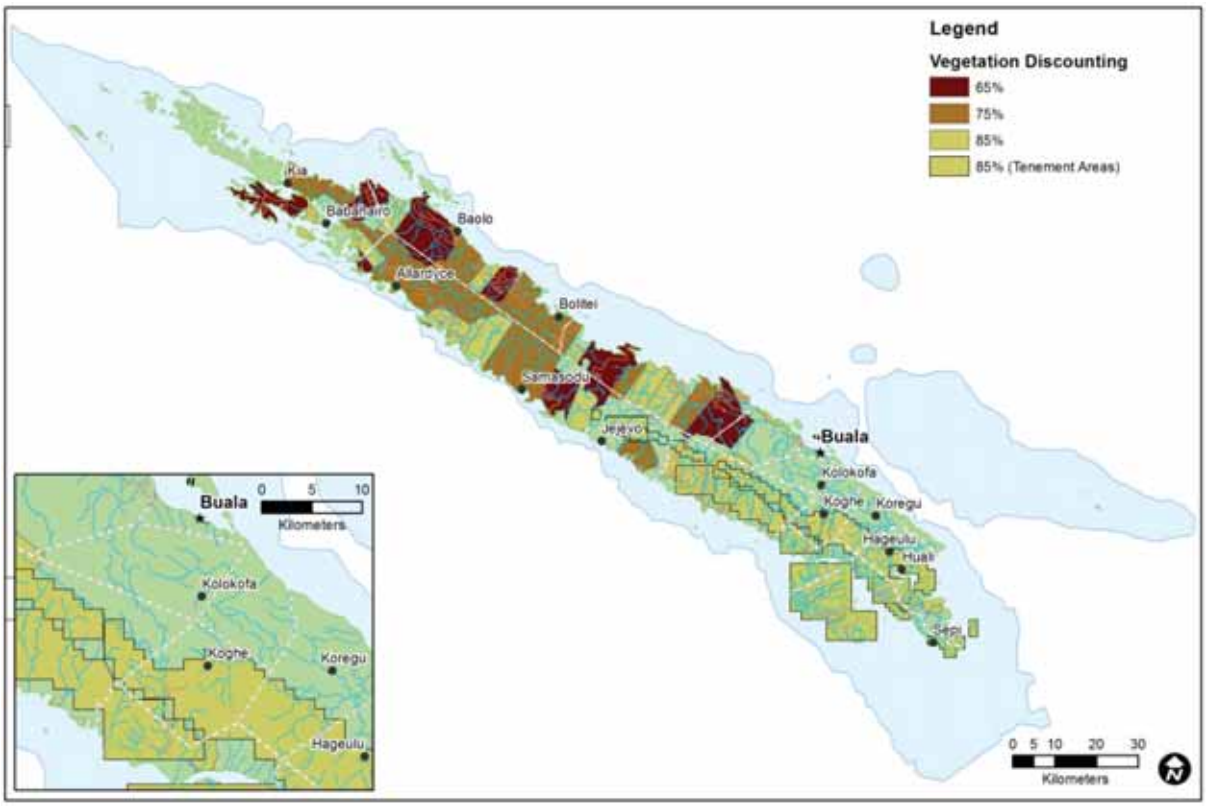

Figure 15. Map of Isabel Province showing the relative discount rate for each vegetation type. Note that degraded forest was not discounted, but rather was not given a target in the Marxan analysis.

4.3.3 Existing Protected Areas

One percent of Isabel's land and sea is currently under some form of protection or management (Figure 16). The largest and best known area is the ACMCA. Sasakolo Locally Managed Marine Area (LMMA) captures a critical leatherback turtle nesting beach on the south-west coast. There are six managed or protected areas on land, and 27 locally identified

managed or protected marine areas. This totals to 29,237 ha of protected or managed areas or 1% of the study area.

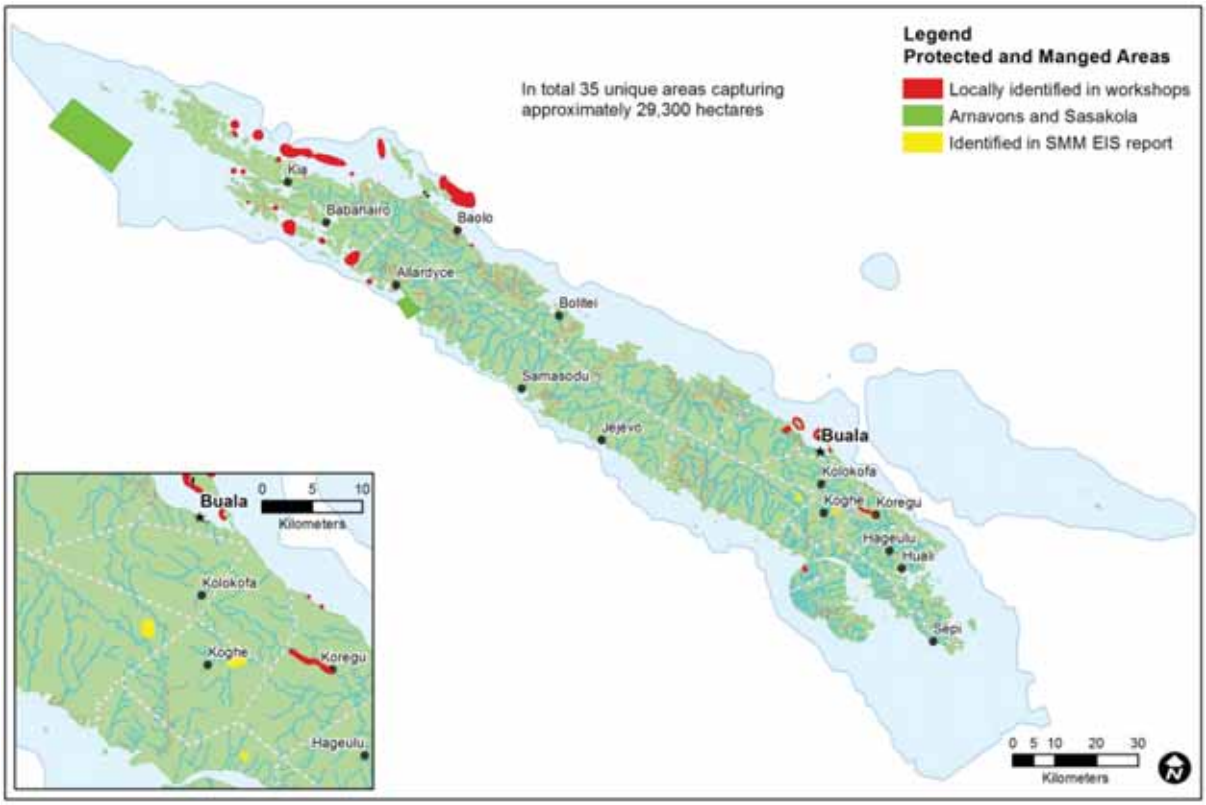

Figure 16. Map of Isabel Province showing existing marine and terrestrial protected and locally managed areas

4.3.4 Calculating conservation targets

Conservation targets (how much of each feature should be protected across Isabel) were set at a minimum of 17% for all terrestrial and 10% for all marine biodiversity in accordance with the Convention of Biological Diversity (CBD) targets. Stakeholders wanted higher levels of protection for locally identified conservation features, so minimum and maximum levels of protection were developed for these features. Broadly delineated community features such as dolphins or sharks, and non-conservation features such as degraded forests and non-forested areas were not used as targets (Appendix 1).

4.3.5 Calculating "cost" of planning units for conservation

The cost of including each planning unit in the protected area network was determined simply by the area of each planning unit in hectares. Where participants at the workshops identified areas of interest for conservation activities, the "cost" of the planning units that covered these areas was reduced (Figure 17). These include sites that are proposed but not yet gazetted protected areas, sites already managed by communities for natural resources, and sites where communities have previously indicated their support for the establishment of a protected area. Sites already formally declared protected areas were considered a non-negotiable part of the Isabel Protected Areas Network.

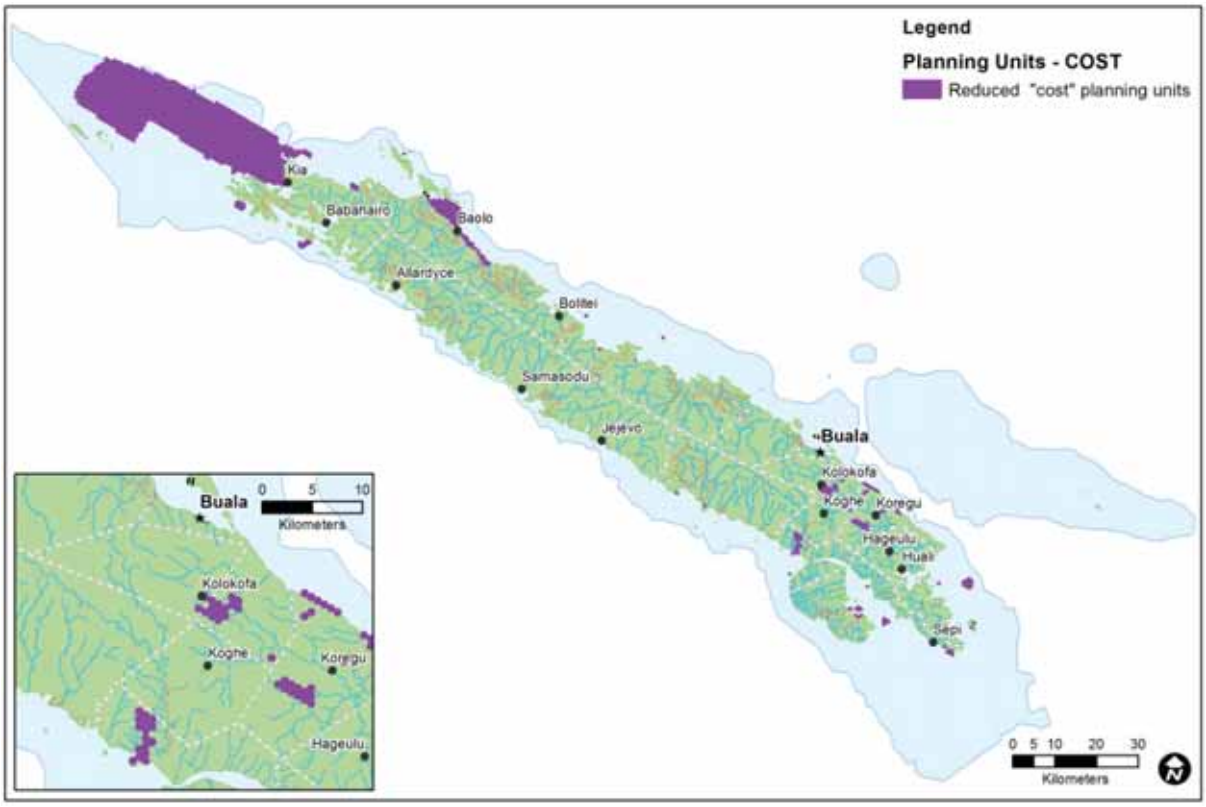

Figure 17. Map of Isabel Province showing reduced "cost" planning units (areas of biodiversity/conservation value that are already locally targeted or managed for conservation).

4.4 Results

The results of this mapping and planning exercise informed the development of three different scenarios for conservation across Isabel province using Marxan to model the data, and based on various combinations of local and international biodiversity conservation priorities:

4.4.1 Scenario A: Conservation priorities map for Isabel without any local features

Based on the relative values of different areas as detailed above we developed a CBD option (17% terrestrial and 10% marine) for Isabel Province. We omitted locally defined conservation features from this scenario to demonstrate a protected areas network for Isabel without considering past community conservation efforts and the numerous other local features identified by stakeholders (Figure 18). This scenario used Marxan to develop a representation of 100 different but equally valid scenarios to meet the CBD goal. It identifies priority areas for protection and management based on the CBD targets for all marine and terrestrial conservation features. The different colours provide a gradient from those areas most required in order to meet the CBD representation target (blue), to those areas least required to meet a CBD representation target (yellow).

Therefore:

- Blue Areas represent the core areas that are critical for a comprehensive and representative protected area network (i.e. little flexibility). These areas occur in 90 out of 100 different scenarios.

- Red areas represent important areas, but there is some flexibility in terms of which areas to choose. These areas occur in 60 out of 100 different scenarios.
- Yellow areas are still important, but there is greatest flexibility and choice around which planning units to include in a protected area network. These areas might occur in 10-20 out of 100 different scenarios.

4.4.2 Scenario B: Conservation priorities map with local features (minimum).

Scenario B (Figure 19) identifies priority areas for protection and management when all available features in the analysis are incorporated (from local information to national level mapping and international CBD targets). For conservation targets identified from national scale data (i.e. marine and vegetation types) the CBD targets of 17% for all terrestrial and 10% for all marine were used. For locally important conservation features the **minimum** acceptable level of protection as identified at the stakeholder workshops was used.

4.4.3 Scenario C: Conservation priorities map with local features (maximum).

Scenario C (Figure 20) identifies priority areas for protection and management by utilising all available features in the analysis. For conservation targets that were identified from national scale data (i.e. marine and vegetation types) the CBD targets of 17% for all terrestrial and 10% for all marine were used. However, the difference with Scenario B is that this scenario considers the **maximum** acceptable level of protection for local conservation features as identified at the stakeholder workshops.

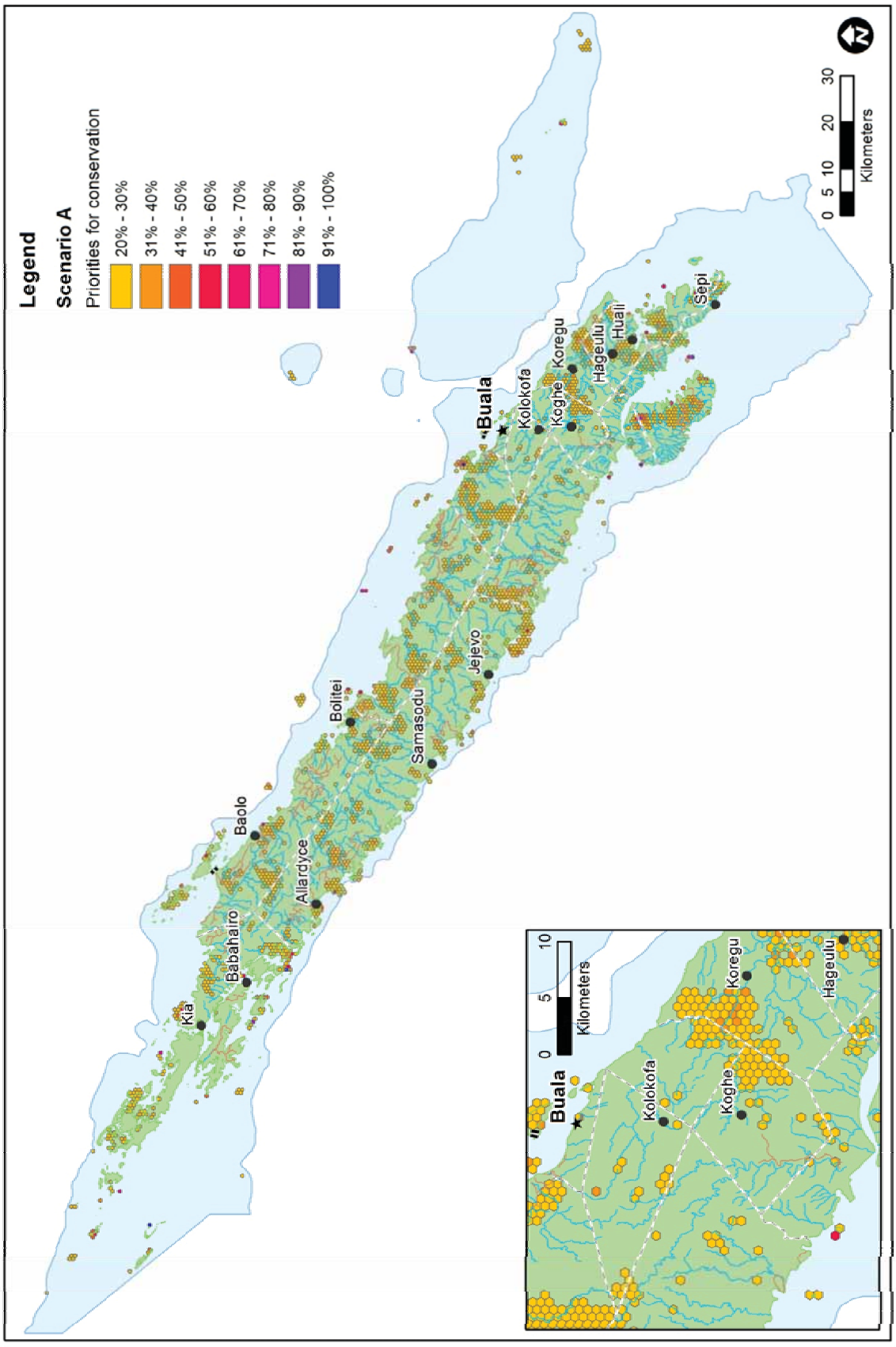

Figure 18. Scenario A: Conservation priorities for Isabel Province without considering any locally identified features.

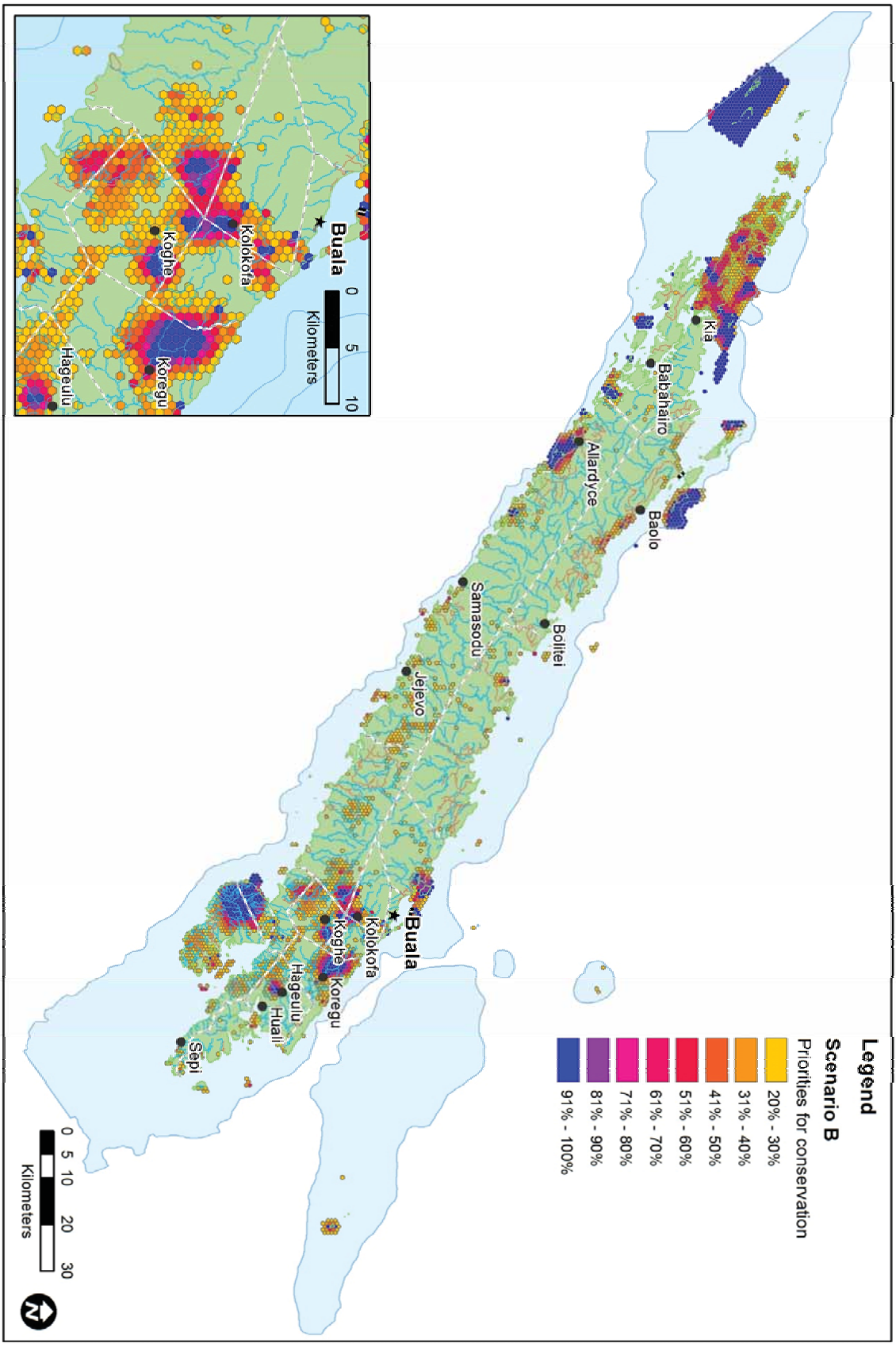

Figure 19. Scenario B: Conservation priorities for Isabel Province with local features considered (minimum level of protection).

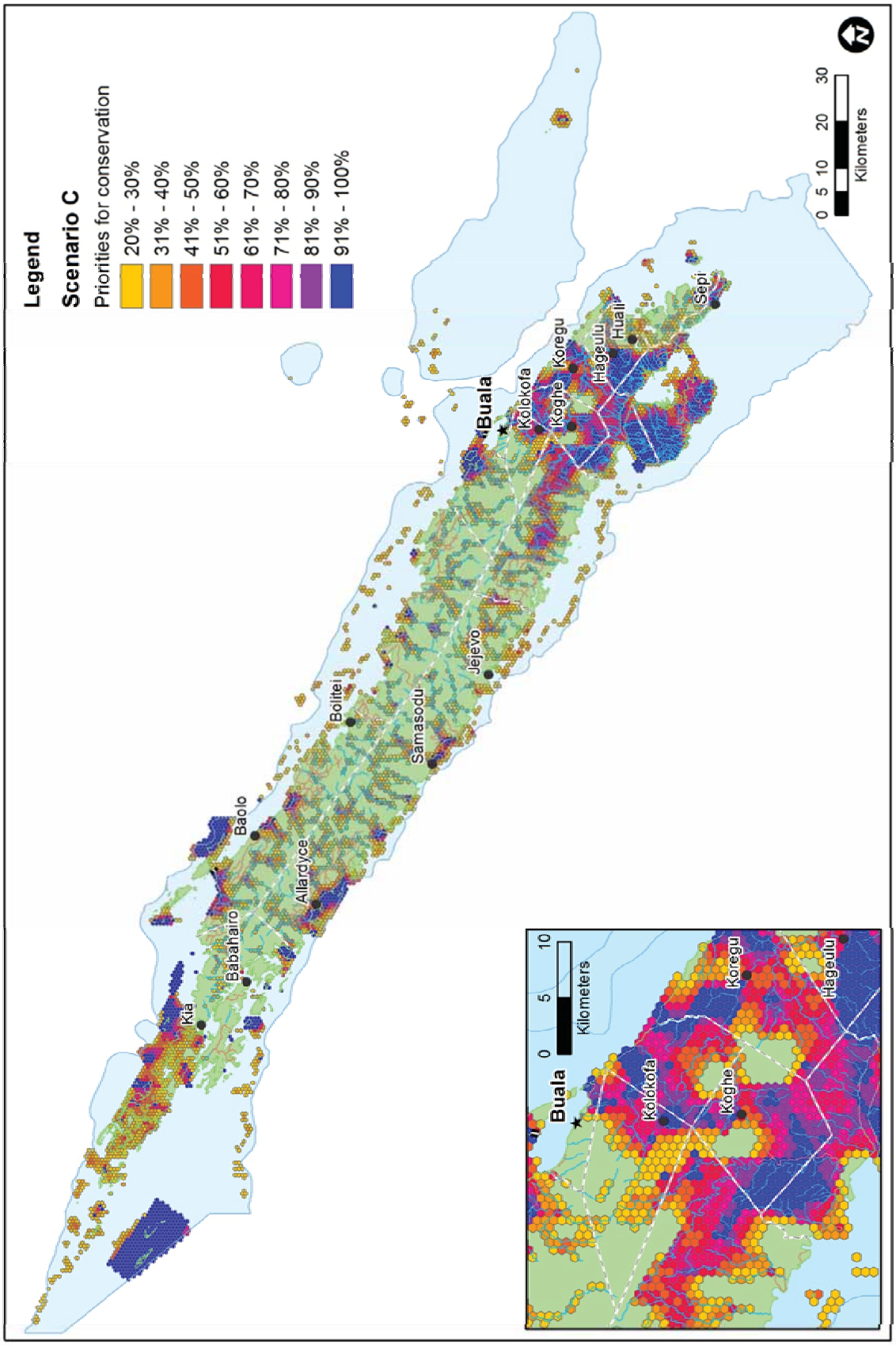

Figure 20. Scenario C: Conservation priorities for Isabel Province with local features considered (maximum level of protection)

.4.4 Threat considerations

Threats to the ecological systems identified by participants are illustrated in Figure 21 and include terrestrial threats such as logging and agriculture and marine threats such as over-fishing and sedimentation. The impending nickel mining across the province is considered separately as a critical issue. The overlap between the proposed SMM mining and road sites for tenements D and E[6] and the conservation priority areas for this region are shown in Figure 22. This map of threats is presented here to determine where potential conflicts areas exist between threats and conservation priority areas identified in Scenario B and C. For example, the mapping clearly identifies overlap between the proposed nickel mining and areas of very high conservation priority in the southern part of the province (refer to Figure 22).

[6] This information was obtained from the SMM EIS report for Isabel Province when it was submitted to the government in the final stages of completing this report (SMM Solomon Limited, 2012).

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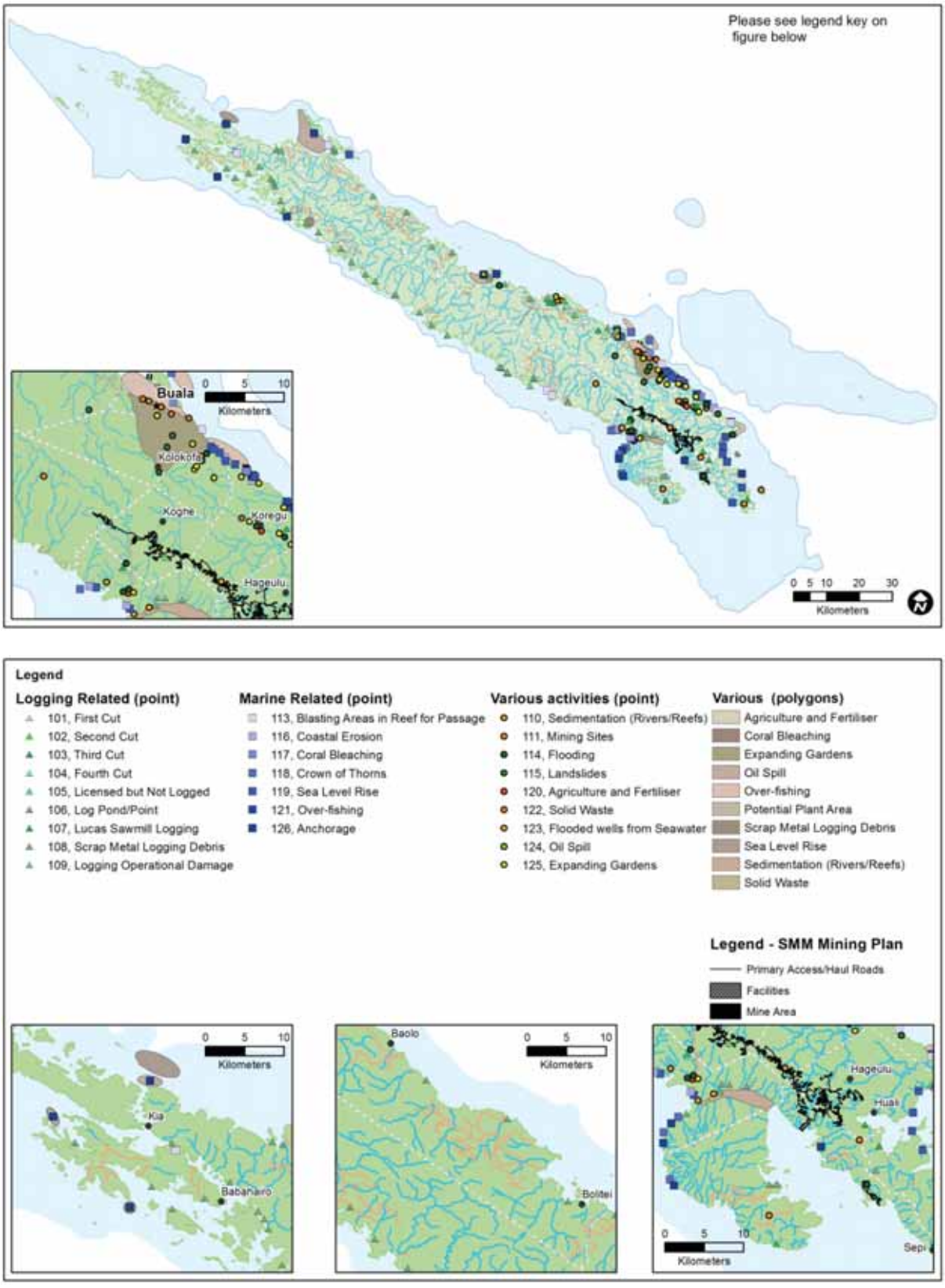

Figure 21. Map of Isabel Province showing threat features across the province (these threats were not used to develop the three conservation scenarios using Marxan)

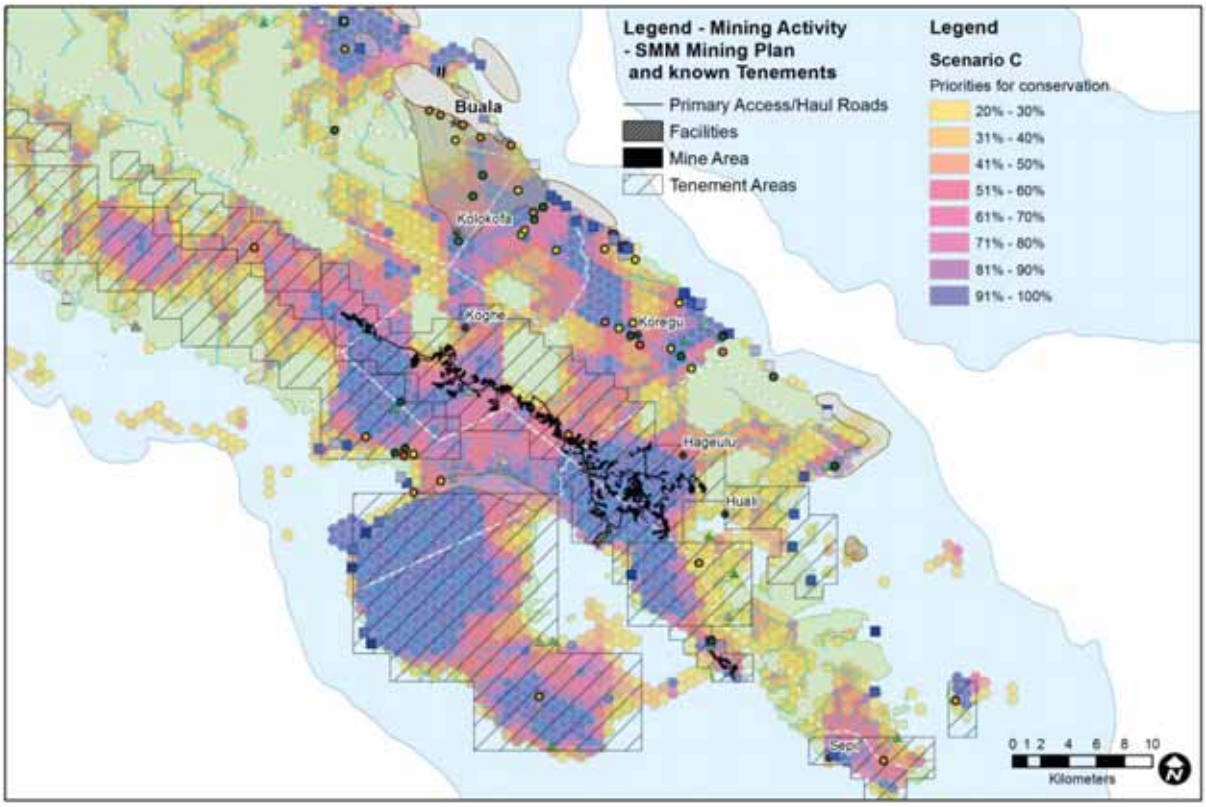

Figure 22. Map of the southern part of Isabel Province demonstrating the overlap between the proposed SMM nickel mining sites in Tenement D and E and the conservation priority areas.

5.0 Discussion

The completion of the Isabel Ridges to Reefs Conservation Plan allows stakeholders to visualise the locations of conservation priorities for Isabel Province, the threats that the biodiversity of Isabel faces and what a successfully implemented protected area network across Isabel could look like under several different scenarios. This planning process utilised the best available national scale data on terrestrial and marine features and the local knowledge of multiple stakeholders. All of this information was then put into a GIS format and analysed with Marxan software to produce three different conservation priority maps for Isabel Province. For conservation targets that were identified from national scale data (i.e. marine and vegetation types) the CBD targets of 17% for all terrestrial and 10% for all marine were used. For local conservation features minimum and maximum levels of protection were determined by the stakeholders involved in this planning process.

Scenario A shows a conservation priorities map for Isabel when no local features are considered, and conservation targets are set using the CBD targets. Scenarios B and C show the conservation priorities for Isabel when local features are included. Unquestionably scenarios B and C are the most relevant when considering conservation priorities for Isabel, as they encompass the geographies and conservation features of highest conservation priority to local stakeholders. In the Melanesian context, where the success or failure of site based conservation initiatives ultimately resides with customary land and sea owners, the importance of incorporating local knowledge into a conservation planning processes cannot be understated. Indeed, it is intuitive that the likelihood of successfully implementing scenario A, which has no local inputs, is low.

It is noteworthy that the targets for local conservation features often exceed CBD targets. Locally defined targets for the endemic Tubi tree (ironwood) provide one such example. Since rich nickel deposits are only found in the same ultramafic soils that Tubi grow on, there is a significant overlap between the conservation priorities identified in this plan and proposed mining activities in the province. Because of these overlaps, we would highly recommend that if mining is to go ahead, SMM adopts a Development by Design (DbD) approach to their mine design and operations. A DbD approach would seek to ensure that important biodiversity and ecosystem services are carefully considered and protected at a landscape level in the design and implementation of any future mining projects, and that a net positive impact is achieved for biodiversity and ecosystem services in Isabel Province. There are many steps in developing a DbD approach, but essentially it can be achieved by first focusing on avoiding mining in areas of high biodiversity or cultural value, mitigating (minimising) the impacts that cannot be avoided and offsetting for areas that are damaged or destroyed.

It is important to note that there were limitations of these analyses presented here, and these include:

- The best available vegetation data sets were still coarse
- Not all local features (threats and opportunities) could be included into the Marxan analyses
- Impacts and severity of future threats such as climate change are unknown
- Not all relevant local knowledge was documented
- SMM mining footprints were not used in this analysis

Although such data can be improved and refined as it becomes available, it should not detract from the need to act now.

A unique aspect of this planning process was that workshop participants identified cultural heritage sites as a critical local feature that needed to be integrated into the conservation plan. Furthermore, cultural heritage sites were the only local feature where there was unanimous agreement that the conservation target needed to be set at a minimum of 100%. Thus, both scenarios B and C capture all of the cultural heritage sites identified through participatory mapping. Walter (2011) states that: “All Solomon Islands landscapes have a cultural and historical dimension that is extremely powerful in determining human action and choice”. The obvious strategy therefore is to prioritise conservation areas that incorporate both the valued cultural heritage sites and the biodiversity targets. Such areas will provide the highest likelihood of achieving effective management outcomes.

Finally, it is important to recognise that this conservation plan and the conservation priority maps presented here should be viewed as a tool that can help guide the establishment of marine and terrestrial protected areas in Isabel. The conservation priority areas identified in the Marxan scenarios should not be viewed as the only options for conservation; rather they represent the targets that, if conserved and managed, would most rapidly protect the biodiversity and cultural heritage of Isabel Province. Perhaps the most valuable contribution of this plan is that it provides a starting point for discussion with community leaders, provincial and national governments, development agencies, industries and donors about the conservation priorities and aspirations of the Isabel people.

6.0 Recommendations and Next Steps

The people and government of Isabel has a long history of engaging with conservation efforts, and appear well placed to utilise this Ridges to Reefs Conservation Plan to implement a Isabel Protected Area Network (IPAN), that will safeguard the biodiversity, cultural heritage and livelihoods of Isabel population. In order for this to become a reality the following steps are recommended:

1. There is a need to roll out the Isabel Ridges to Reefs Conservation Plan to communities in Isabel, in a way that explains the needs for, and benefits of, a provincial wide protected areas network. Awareness also needs to be raised on the existing national and provincial policy that can be utilised to support the development of community based conservation and management efforts. It is important that this roll out is done by local stakeholders who have been involved in the planning process and can explain the products in their own languages. The following steps are planned:

    - TNC has committed to hold a 'train the trainers' workshop in the second half of 2012, where some of the local participants who attended the workshops (from each of the eight districts) are provided with the materials needed (i.e. information on the value of protected areas and large laminated maps of conservation priority) to explain the conservation planning process.

    - After this 'train the trainers' workshop, support the Mothers Union to oversee efforts to raise awareness on this conservation plan throughout Isabel.

2. Many of the areas identified as protected areas in this report are not fully effective. Thus, improving the effective conservation of managed or protected areas already designated through earlier efforts is as important as implementing new conservation areas.

3. Because of the spiritual and cultural sensitivities of cultural heritage work, there is an urgent need to build the capacity of local communities to design, run and implement their own cultural heritage management programs. Efforts to build this capacity have already commenced in Isabel, with a cultural heritage training workshop being held in the Arnavons in 2011 (Walter, 2011). Future such efforts should be encouraged and could be coordinated through the Isabel Provincal Government and Isabel Council of Chiefs and should involve the Solomon Islands National Museum.

4. If widespread support for this conservation plan is achieved in Isabel, then there should be a formal political commitment made to implement an Isabel Ridges to Reefs Protected Area Network (IPAN). For this to be successful the concept of an IPAN must have the full support of the tripod governance system (ICC, IPG and DOY). It is important to acknowledge that neither the IPG, NGOs nor the local communities alone will be able to resource the implementation and maintenance of a IPAN. It will require the collective effort of communities, DOY, ICC, IPG, national government, development industries, donors and regional environmental organisations to ensure that the IPAN can become a reality.

5. Existing protected areas in Isabel that already have a management plan and management committee in place should go through the formal steps of having their protected areas registered under the Solomon Islands Protected Areas Act. The ACMCA is an obvious example, as are the MPAs established in Maringe Lagoon. Another key area of high conservation importance that has been identified in this conservation plan is Barora Faa Island and the many small forested high islands and reefs that flank it. The marine environments of this area already have some management measures in place, with WorldFish assisting with the development of The Kia District Marine Management Plan in 2008, and in April 2012, landowners from Kia dismissed the seventh timber right hearing for Barora Faa Island. Placing this region under the Protected Area Act would give it protection from future destructive activities such as logging and mining.

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8.0 Appendices

Appendix 1

Class	Scenario A	Scenario B	Scenario C	Reef Simple	Class Description	Use in models
1	0%	50%	100%		Turtle Beach	TARGET
2	0%	50%	50%		Megapode Nest	TARGET
3	na	na	na		Crocodile Nest	OUT
4	0%	100%	100%		Tambu	TARGET
5	na	na	na		Wild Pig Hunting Area	OUT
6	0%	50%	50%		Nikoba Bird Nesting Area	TARGET
7	0%	50%	50%		Hornbill Home	TARGET
8	0%	25%	25%		Flying Fox Tree	TARGET
9	na	na	na		Area of Interest for Conservation	POSITIVE COST
10	na	na	na		Protected Area	LOCK IN
11	na	na	na		Managed Area	LOCK IN
12	0%	25%	50%		Mud Crab Area	TARGET
13	0%	17%	25%		Bat Cave	TARGET
14	0%	50%	100%		Source of Fresh Water	TARGET
15	na	na	na		Barrier Reef	OUT
16	na	na	na		Patch Reef	OUT
17	na	na	na		Fringing Reef	OUT
18	0%	50%	50%		Kurukuru Nesting Area	TARGET
19	na	na	na		Dugong Feeding Area	OUT
20	0%	25%	25%		Baitfish Area	TARGET
21	0%	17%	34%		Seagrass	TARGET
22	0%	50%	50%		Milkfish Area	TARGET
23	na	na	na		Oyster Area	OUT
24	0%	30%	50%		Coconut Crab Area	TARGET
25	0%	17%	25%		Pandanus Area	TARGET
26	0%	17%	25%		Bush Crab (kakamata)	TARGET
27	0%	25%	50%		Opossum Area	TARGET
28	0%	25%	50%		Iguana Area	TARGET
29	0%	50%	50%		Freshwater Eel Area	TARGET
30	0%	34%	50%		Frigate Bird Sleeping Area	TARGET
31	na	na	na		Clam Shell Area	OUT
32	na	na	na		Fish Spawning Aggregation site	LOCK IN
33	0%	50%	50%		Bamboo Area	TARGET
34	0%	50%	50%		Sago Palm Area	TARGET
35	na	na	na		Rice Paddy	OUT
36	na	na	na		Coffee Field	OUT
37	na	na	na		Coconut Plantation	OUT

Class	Scenario A	Scenario B	Scenario C	Reef Simple	Class Description	Use in models
38	na	na	na		Kava Area	OUT
39	0%	50%	50%		Lawyer Cane Area	TARGET
40	0%	17%	25%		Surfing Area	TARGET
41	na	na	na		Local Tobacco (lekona) Area	OUT
42	na	na	na		Ngali Nut Area	OUT
43	0%	50%	50%		WW2 Wreck Area	TARGET
44	0%	50%	100%		Tubi Tree Area	TARGET
45	na	na	na		Alienated Land	OUT
47	na	na	na		Arnadra Species (bivalves)	OUT
48	na	na	na		Dugong Area (breeding)	OUT
49	na	na	na		Marine Nursery	OUT
50	na	na	na		Rare Bird Area	POSITIVE COST
51	na	na	na		Trochus	OUT
52	na	na	na		Beach De Mer	OUT
53	0%	17%	34%		Bonito path	TARGET
54	na	na	na		Ecotourism Site	POSITIVE COST
55	0%	50%	50%		Dolphin Area	TARGET
57	0%	17%	34%		Riki Najaghu Shell	TARGET
58	0%	17%	34%		Custom Fishing Ground	TARGET
59	0%	17%	34%		Dove Resting Place	TARGET
60	0%	17%	34%		Waterfall	TARGET
101	na	na	na		First Cut	DISCOUNT VEG
102	na	na	na		Second Cut	DISCOUNT VEG
103	na	na	na		Third Cut	DISCOUNT VEG
104	na	na	na		Fourth Cut	DISCOUNT VEG
105	na	na	na		Licensed but Not Logged	POSITIVE COST
106	na	na	na		Log Pond/Point	NEGATIVE COST
107	na	na	na		Lucas Sawmill Logging	OUT
108	na	na	na		Scrap Metal Logging Debris	OUT
109	na	na	na		Logging Operational Damage	OUT
110	na	na	na		Sedimentation (Rivers/Reefs)	NEGATIVE COST
111	na	na	na		Mining Sites	NEGATIVE COST
112	na	na	na		Potential Plant Area	OUT
113	na	na	na		Blasting Areas in Reef for Passage	OUT
114	na	na	na		Flooding	OUT
115	na	na	na		Landslides	OUT
116	na	na	na		Coastal Erosion	OUT
117	na	na	na		Coral Bleaching	OUT
118	na	na	na		Crown of Thorns	OUT
119	na	na	na		Sea Level Rise	OUT
120	na	na	na		Agriculture and Fertiliser	OUT

Class	Scenario A	Scenario B	Scenario C	Reef Simple	Class Description	Use in models
121	na	na	na		Over-fishing	OUT
122	na	na	na		Solid Waste	OUT
123	na	na	na		Flooded wells from Seawater	OUT
124	na	na	na		Oil Spill	OUT
125	na	na	na		Expanding Gardens	NEGATIVE COST
126	na	na	na		Anchorage	OUT
127	na	na	na		No Licence, Not Logged but Planned	OUT
295	0%	17%	50%		Rivers	TARGET
2000	17%	17%	17%		Freshwater Swamp Forest	TARGET
2010	17%	17%	17%		Freshwater Swamp Forest - Degraded forest (anthropogenic gardens etc)	TARGET
2020	17%	17%	17%		Freshwater Swamp Forest - Freshwater swamp forest mixed spp composition	TARGET
2030	17%	17%	25%		Freshwater Swamp Forest - Pandan swamp forest	TARGET
2040	17%	17%	17%		Freshwater Swamp Forest - Sago swamp forest	TARGET
2050	17%	17%	17%		Freshwater Swamp Forest - Terminalia swamp forest	TARGET
2060	17%	50%	100%		Hill Forest - Casuarina dominated hill forest	TARGET
2070	17%	17%	17%		Hill Forest - Degraded rainforest on hills	TARGET
2080	0%	0%	0%		Hill Forest - Logged Forest	TARGET
2090	17%	17%	17%		Hill Forest - rainforest on hills mixed spp composition	TARGET
2100	17%	50%	100%		Lowland rainforest on Near Level Lands - Casuarina dominated lowland rainforest	TARGET
2110	17%	17%	17%		Lowland rainforest on Near Level Lands - Degraded forest (anthropogenic gardens etc)	TARGET
2120	17%	17%	17%		Lowland rainforest on Near Level Lands - Logged Forest	TARGET
2130	17%	17%	17%		Lowland rainforest on Near Level Lands - Lowland rainforest mixed spp composition	TARGET
2140	17%	17%	17%		Saline Swamp Forest - Degraded forest (anthropogenic gardens etc)	TARGET
2150	17%	34%	50%		Saline Swamp Forest - Saline swamp forest mixed spp (mangroves)	TARGET
2160	17%	17%	17%		Upland forest on Hills - Upland forest on hills mixed spp composition	TARGET
2170	na	na	na		Other Areas - Cloud Obscured areas	OUT
2170	na	na	na		Other Areas - Cloud Obscured areas	OUT
2180	17%	17%	17%		Other Areas - Herbaceous swamps mixed spp composition	TARGET
2190	17%	17%	17%		Other Areas - Open water (inland)	TARGET
2200	na	na	na		Other Areas - Plantation areas for timber production	OUT

Class	Scenario A	Scenario B	Scenario C	Reef Simple	Class Description	Use in models
2200	na	na	na		Other Areas - Plantation areas for timber production	OUT
2210	10%	10%	10%		Other Areas - River courses braided streams	TARGET
5040	10%	10%	10%	Lagoon	Island lagoon - deep lagoon	TARGET
5060	10%	10%	25%	Patch	Patch land - land on reef	TARGET
5070	10%	10%	10%	Terrace	Bank lagoon - deep terrace	TARGET
5080	10%	10%	10%	Deep terrace	Bank lagoon - deep terrace with constructions	OUT
5090	10%	10%	25%	Patch	Bank patch - forereef	TARGET
5100	10%	10%	25%	Patch	Bank patch - reef flat	TARGET
5110	10%	10%	25%	Barrier	Barrier-Fringing Reef Complex - forereef	TARGET
5120	10%	10%	10%	Pass	Barrier-Fringing Reef Complex - pass	TARGET
5130	10%	10%	25%	Barrier	Barrier-Fringing Reef Complex - reef flat	TARGET
5140	10%	10%	10%	Terrace	Barrier-Fringing Reef Complex - shallow terrace	TARGET
5150	10%	10%	25%	Fringing	Bay exposed fringing - bay exposed fringing	TARGET
5230	10%	10%	25%	Patch	Coastal/fringing patch - reef flat	TARGET
5250	10%	10%	25%	Fringing	Diffuse fringing - diffuse fringing	TARGET
5260	10%	10%	10%	Terrace	Fringing of barrier-fringing complex - shallow terrace	TARGET
5280	10%	10%	10%	Basin	Intra-lagoon patch-reef complex - enclosed basin	TARGET
5290	10%	10%	25%	Patch	Intra-lagoon patch-reef complex - forereef	TARGET
5300	10%	10%	25%	Patch	Intra-lagoon patch-reef complex - reef flat	TARGET
5310	10%	10%	10%	Terrace	Intra-lagoon patch-reef complex - shallow terrace	TARGET
5320	10%	10%	25%	Patch	Intra-lagoon patch-reef complex - subtidal reef flat	TARGET
5330	10%	10%	10%	Basin	Intra-seas exposed fringing - enclosed lagoon or basin	TARGET
5340	10%	10%	25%	Fringing	Intra-seas exposed fringing - forereef	TARGET
5350	10%	10%	10%	Fringing	Intra-seas exposed fringing - reef flat	TARGET
5360	10%	10%	10%	Terrace	Intra-seas exposed fringing - shallow terrace	TARGET
5380	10%	10%	10%	Basin	Intra-seas patch-reef complex - enclosed basin	TARGET
5390	10%	10%	25%	Patch	Intra-seas patch-reef complex - forereef	TARGET
5400	10%	10%	25%	Patch	Intra-seas patch-reef complex - reef flat	TARGET
5410	10%	10%	10%	Terrace	Intra-seas patch-reef complex - shallow terrace	TARGET
5420	10%	10%	25%	Patch	Intra-seas patch-reef complex - subtidal reef flat	TARGET
5430	10%	10%	25%	Fringing	Lagoon exposed fringing - forereef	TARGET
5440	10%	10%	25%	Fringing	Lagoon exposed fringing - reef flat	TARGET

Class	Scenario A	Scenario B	Scenario C	Reef Simple	Class Description	Use in models
5450	10%	10%	10%	Terrace	Lagoon exposed fringing - shallow terrace	TARGET
5490	10%	10%	10%	Basin	Ocean exposed fringing - enclosed lagoon or basin	TARGET
5500	10%	10%	10%	Fringing	Ocean exposed fringing - forereef	TARGET
5510	10%	10%	10%	Pass	Ocean exposed fringing - pass	TARGET
5520	10%	10%	25%	Fringing	Ocean exposed fringing - reef flat	TARGET
5530	10%	10%	10%	Terrace	Ocean exposed fringing - shallow terrace	TARGET
5540	10%	10%	25%	Barrier	Outer Barrier Reef Complex - barrier reef pinnacle/patch	TARGET
5550	10%	10%	25%	Barrier	Outer Barrier Reef Complex - deep drowned reef flat	TARGET
5560	10%	10%	10%	Terrace	Outer Barrier Reef Complex - deep terrace	TARGET
5570	10%	10%	10%	Basin	Outer Barrier Reef Complex - enclosed basin	TARGET
5580	10%	10%	10%	Lagoon	Outer Barrier Reef Complex - enclosed lagoon	TARGET
5590	10%	10%	25%	Barrier	Outer Barrier Reef Complex - forereef	TARGET
5600	10%	10%	10%	Pass	Outer Barrier Reef Complex - pass	TARGET
5610	10%	10%	10%	Barrier	Outer Barrier Reef Complex - reef flat	TARGET
5620	10%	10%	10%	Terrace	Outer Barrier Reef Complex - shallow terrace	TARGET
5630	10%	10%	25%	Barrier	Outer Barrier Reef Complex - shallow terrace with constructions	TARGET
5640	10%	10%	25%	Barrier	Outer Barrier Reef Complex - subtidal reef flat	TARGET
5660	10%	10%	10%	Basin	Shelf patch-reef complex - enclosed basin	TARGET
5670	10%	10%	25%	Patch	Shelf patch-reef complex - forereef	TARGET
5680	10%	10%	25%	Patch	Shelf patch-reef complex - reef flat	TARGET
5690	10%	10%	10%	Terrace	Shelf patch-reef complex - shallow terrace	TARGET
5700	10%	10%	10%	Patch	Shelf patch-reef complex - subtidal reef flat	TARGET

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