Reef Resilience Training Workshop

Pacific Theological College

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Outcomes Report

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Executive Summary

Climate change is a global phenomenon affecting every ecosystem in the world, and sensitive coral reef ecosystems are one of the first to experience strong consequent direct and indirect impacts. Coral reefs are affected physically, biological and ecologically due to climate change impacts, such as changes in water temperature, weather patterns and rainfall patterns. Change in reef ecosystems also affects social systems/communities that depend on reef resources for livelihood.

To minimize the impact of climate change on reef ecosystems and help them thrive in the future, we introduced the concept of reef resilience to partners of the Fiji Locally Managed Marine Area network (FLMMA), who include representatives from communities and conservation organizations. The workshop was aimed at educating reef managers with the science and benefits of reef resilience principles in order to improve management strategies.

To begin with, the participants entered the workshop with high expectations as the concept of reef resilience is quite new and has only been implemented through targeted community-based management actions to boost resilience at in one site Fiji to date in the district of Kubulau, with the support of conservation partners from the Wildlife Conservation Society (WCS). Through this workshop, we tried to get more people involved with adaptive management using the principles of reef resilience. Although WCS used advanced conservation planning tools to integrate robust scientific data, we focused this workshop on low-technology, low-cost community-based techniques to identify resilient reefs and help communities protected them within a network of MPAs. Emphasis was given to the components of reef resilience used to design resilient MPAs as a better management strategy to face climate change impacts. This does not mean that the existing strategies need to be eliminated, just that they can be adapted as new information becomes available.

One of the most important outcomes of the reef resilience training workshop was the community based bleaching response plan that was developed during one of the group activities which could be adapted to most of the communities within Fiji. The bleaching response plan is very simple and requires minimum expertise but is developed based on observations with four major components: (1) Coral health and impact assessment plan; (2) Early warning system; (3) Management action plan; and (4) Socio-economic implication plan. The other achievement of the workshop was the enthusiasm participants had to implement reef resilience principles in different parts of Fiji. Most of the community representatives went back to their sites with an implementation plan that includes updating communities about impacts of climate change, the concepts of reef resilience and resilient MPA design as a priority.

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Building resilience into coral reef management

Background: Why Resilience?

Climate change is affecting ecosystems globally and coral reefs are one of the most vulnerable ecosystems to impacts, mainly due to increases in sea surface temperature (Lough, 2007; Mann, Bradley, & Hughes, 1998). The seriousness of climate change impacts on resources are often misinterpreted due to ignorance and/or lack of knowledge or understanding. At times, resource users and community members fail to value the importance of their resources. Prioritization for conservation and management is based on cultural importance or sources of livelihoods. As soon as monetary needs drive resource use, resource management takes a “back seat” in the priority list. Short-term benefits seem more important and override long-term benefits of resources. The need for education and awareness becomes a high priority for local communities and resource owners on the importance of their resources and the threats hovering over ecosystems services, such as climate change impacts (Sykes & Lovell, 2008). The understanding of communities has to extend its boundaries from immediate needs to long-term sustainable food security, which requires communities to take ownership of resource management.

Coral reef ecosystems are essential not only for their aesthetic value, but they also have a number of important functions in maintaining the balance in the environment (Dalton & Carroll, 2011), which includes: shoreline protection; food provisioning; supporting income generation through eco-tourism;, and providing habitat for almost fish and invertebrate communities at different stages of their life cycles (Carilli et al., 2009). Improving the awareness and management skills of resource users and communities will assist them to better devise strategies for long-term preservation of these important coral reef services. Management will work wonders only if there is initiative, willingness and enthusiasm from resource owners and the management actions are achievable at local scale rather than being too ambitious.

The Wildlife Conservation Society (WCS) Fiji program, with support from The Nature Conservancy (TNC), hosted a two day reef resilience training workshop in Suva between February 8-9, 2012. This workshop was organised to familiarise more reef mangers in Fiji with the concept of reef resilience, using information learned during participation (by Y. Nand) in a Reef Resilience Training of Trainers course in Palau and lessons learned by WCS in implementing reef resilience principles on the ground in Fiji. Through adaptive management approach, WCS has been conducting robust biological (WCS 2010) and socioeconomic monitoring to helping communities in the Kubulau District, Bua Province, add resilience considerations into their ecosystem-based management plan. At the same time, WCS has been assisting the communities in the adjacent districts of Wainunu, Nadi, Sovelu and Wailevu to develop new, complementary resilient marine protected area networks.

Because WCS is part of the Fiji Locally Managed Marine Area network (FLMMA), there was already a good knowledge sharing platform to introduce the concept of reef resilience to FLMMA partners and community coordinators. In Fiji, signs of climate change are already being witnessed by communities, but some of them are not aware why things are happening and how they can contribute to minimize the impacts on resources. The workshop was focused on people who work closely with communities and have a balanced understanding between needs of resource users and resource management. Below, we present the workshop objective and then summary descriptions of the material presented and discussions regarding the major topics under each sub-heading.

Objective

The reef resilience workshop was conducted to improve understanding of reef managers throughout Fiji on how to locally apply science to boost reef resilience through more tailored management strategies. Our aims were to strengthen education and awareness of critical issues associated with climate change and build capacity of FLMMA partners to guide local managers to incorporate reef resilience principles into new and existing management strategies to preserve reef ecosystem services.

Workshop Expectations

Twenty-one participants (Appendix A) came to the workshop from different regions of Fiji and with experience working on different types of projects; therefore they came to the workshop with their own varying sets of expectations and objectives. To gauge their level of understanding, we developed a questionnaire for participants to complete before the planning stage of the workshop in order for us to tailor the training agenda to maximize their learning potential. The contents of the workshop targeted those areas/issues associated with reef resilience that were either new and/or had limited understanding amongst the participants.

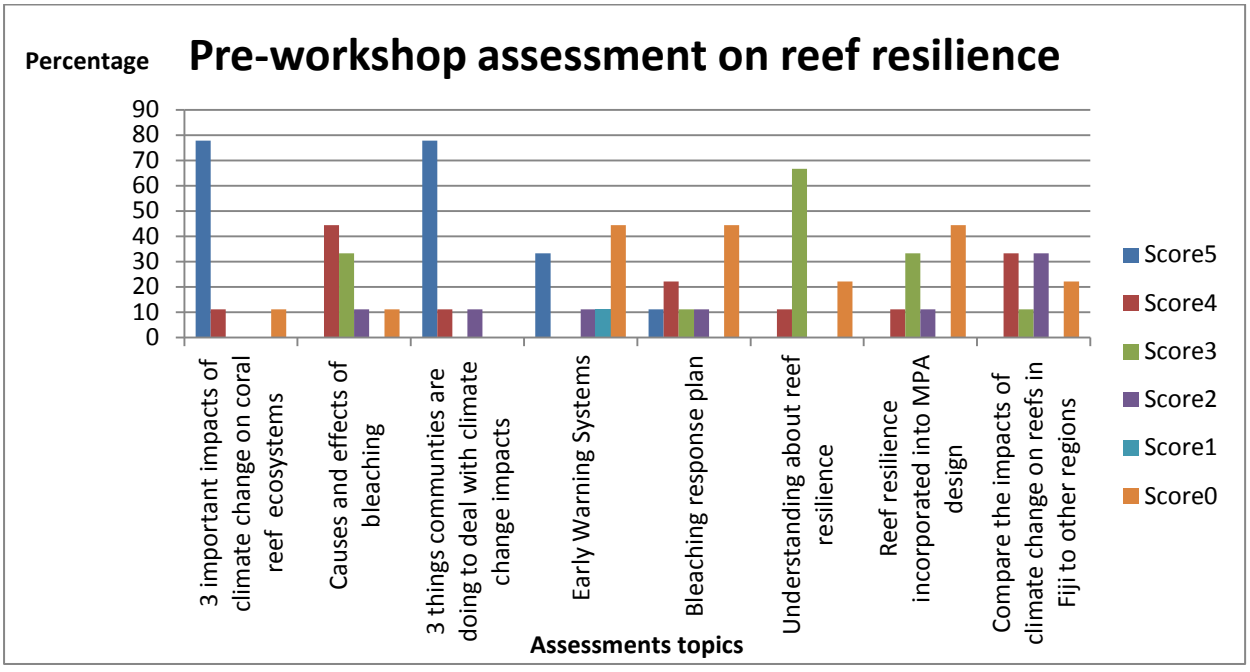

Figure 1: Results for pre-workshop assessment questionnaire. Scores indicate the percentage of respondents who correctly answered questions under the listed topics.

The pre-workshop assessment results indicated that the participants came in with a lot of expectations and were eager to use key message learned to implement better management strategies with the communities throughout the region. Most of them came with no and/or limited understanding of the concept of reef resilience and early warning systems, almost no understanding of designing a network of resilient MPAs and/or incorporating resilience principles into MPA design and bleaching response plan (Figure 1). However, they had a fair amount of understanding on the impacts of climate change and community-based management actions that can minimise the impacts. There was moderate knowledge about the causes of bleaching and the status of Fiji's coral reefs when compared with other regions in the Pacific.

The key concepts that majority of the participants wanted more information on included the impacts of climate change to reef ecosystems and the concepts of reef resilience. People were also eager to learn more about the benefits resilience principles have to offer over existing management strategies and how communities can adapt their strategies based on resilience principles in a local context. Participants were also interested in learning about techniques that could be incorporated into management strategies/rules in different areas that would engage different resource users. For instance, they wanted to know how relevant the techniques would be to local communities versus dive operators and resort owners versus other resource users.

Areas facing impacts of climate change in Fiji

Experience varied amongst participants in terms of the changes they have witnessed within the environment over the years: some have personally witnessed changes in the environment, others have worked with research teams to know more about changes, and had learned about changes through their academic background so it was quite interesting to have them share what they have witnessed in terms of impacts of climate change.

Five of the participants were FLMMA community coordinators (3 from Lomaiviti Province but from different islands; 1 from Macuata Province; and 1 from Cakaudrove Province) who have been exposed to different socio-ecological challenges and change in ecosystems. When requested to share their experience regarding indicators of climate change observed in their areas and what habitats and species they've remarked to be most susceptible to the impacts and talk about management actions in place, majority of the FLMMA coordinators stated that impacts to shorelines from rise in sea level was the most notable impact of climate change they could visually discern. Recently, some areas in Cakaudrove have experienced waves reaching over sea walls. The island of Ovalau in Lomaiviti is experiencing waves reaching heights near the sea wall which used to be occupied by houses about 10-15 years ago.

In addition, the town of Levuka on the island of Ovalau is bombarded with addition human influence which exacerbates climate change impacts: a fish processing factory owned by Pacific American Fish Company, Inc. (PAFCO) continually discharges waste products into the sea, making coral communities weak, causing greater mortality during storm events Impacts of climate change on different ecosystems often also have socio-economic implications: opening of the Levuka fish factory boosted local employment and reduced pressure on reef

resources, but when the factory closed, all of the unemployed women returned to fishing activities.

On the island of Gau, most of the villages are well above sea level, but in 2010 during tropical cyclone Tomas, the majority of villages expect one were flooded by storm surge. The University of the South Pacific (USP), together with the Pacific Centre for Climate Change and Sustainable Development (PACE) based at USP, had implemented a climate change adaptation projects in one of the villages of Gau prior to the storm, and this was the only village not affected by floods. The project aided villagers to construct a wave breaker and replant mangroves, which protected the coastline from the large storm waves generated during the tropical cyclone. Meanwhile in the Mamanucas in western Fiji, flooding is becoming a more regular occurrence, as droughts, which affect communities through water shortages and wildfires.

In addition, most participants noticed that the above climate-related impacts affect reef resources on which their communities rely. Usually strong waves break corals, which leads to a decrease in reef complexity that can affect fish population structure and diversity. Mangroves are also vulnerable habitat to climate change impacts, such as storms and drought. Decline in mangrove causes decline in crab and other invertebrate populations that depend on the habitat for shelter, feeding and breeding. Climate change impacts also leads to loss of biodiversity and ecosystem functions in terrestrial, freshwater and estuarine habitats, and can have consequent downstream impacts on marine systems. Therefore in Gau, people are trying to minimize the impacts on marine ecosystems by managing resources on land. Each village has decided to plant 3000 trees and improve land use practices to minimize soil erosion into rivers.

Rate of recovery of corals upon mass bleaching events

Various participants who have been actively fishing or managing coral reefs for multiple years observed coral reef recovery at different levels in different places depending on exposure to different environment conditions. Many participants stated that corals are not found in areas exposed to freshwater such as rivers and streams. Some fishermen have reported to the FLMMA site support leaders that they are seeing juvenile corals in many areas along the Lomaiviti group that have been previously damaged, which indicates good recovery potential. It was also brought up in discussion that places with no freshwater input showed signs of faster recovery e.g. more juvenile corals. In addition, there are anecdotal reports of more juvenile corals and faster recovery in protected areas compared with open fishing areas. Areas mostly in Vanua Levu appear to be recovering more slowly after impacts from tropical cyclone Tomas. Further, recovery from multiple disturbances has been moderate in the Mamanuca Islands; although some reefs transitioned to a completely degraded state after mass bleaching events severely impacted this area in 2000 and again in 2002.

There were a number of questions raised from the participants on the topic of reef recovery, such as:

Q1. How long does it take a reef to recover?

Q2. How do clouds minimise coral bleaching?

Q3. Which is the weakest reef in the world?

Dr. Stacy Jupiter, WCS Fiji Director, responded stating that, in general, Fiji reefs are quite resilient compared with other geographic locations in the world, such as in the Caribbean. Caribbean reefs have been weakened by overfishing, particularly of herbivores, and a disease which killed off most of the urchin population, thus vastly reducing grazing potential. People in the Caribbean are also considering strategies to improve coral health and diversity, such as coral farming and bans on fishing herbivores.

Q4. How is the temperature in Fiji different from the Caribbean?

Temperature range is quite similar but variability in climate, weather patterns, oceanography and human pressures has resulted in stressed corals in the Caribbean. Fiji is fortunate to consistently miss warm water pools in the Pacific, while Caribbean reefs are more chronically exposed to prolonged elevated temperatures.

Emphasis on coral diseases

After a short presentation on coral diseases that focused on how to differentiate bleached corals from diseased corals, a wave of interest was shown by participants on the topic as it was the first time for most of them to learn that corals could get diseases. The WCS Fiji program, unfortunately, does not have any specific expertise on coral disease identification, so the session was became more of a group discussion about what are the information needs regarding coral disease and capacity building to identify coral disease in Fiji.

Q1. Does age affect corals too?

Most hard corals are colonial, therefore without any form of disturbance or senescence, they could conceivable continue to survive for hundreds to thousands of years. For example, some massive *Porites* colonies have been aged at over 500 years. However, more typically, entire colonies are damaged from a major disturbance, such as a tropical cyclone or bleaching. When corals such as *Acropora* break during storm events, the fragments will often go on to establish entirely new colonies. Therefore, it is hard to determine the exact "age" of any coral.

Q2. How can you tell the difference between white-band and black-band disease?

As there was no coral disease expert among the mentors, we were unable to respond to this question. The participants discussed that FLMMA could help by getting a coral disease expert in Fiji who can train FLMMA community members and other partners. We were able to help differentiate between diseased, bleached, and healthy corals by projecting pictures of healthy corals vs. diseased coral with identification tips to spot disease in corals. Further, the participants requested assistance with coral identification and for pictures of coral disease, so WCS gave them coral identification sheets and pictures of common coral diseases found on corals in the Pacific region.

Q3. The Gau YMST coordinator pointed out seeing different colours in corals every time they visited a particular dive site and asked what this was related to?

This question required a more technical/scientific approach since corals get their colour from the different combination of pigments and also from the different clades of zooxanthallae. The colour could also be a result of stress or change in environmental conditions or it could also be related to change in concentration of fluorescent pigments in corals but the exact reason could not be verified until the site is studied properly.

Break-out group activity I: MPA design

Prior to presentation of information on important criteria to consider for MPA network design, the participants were divided into three groups to come up with designs for a hypothetic MPA network using any criteria that they thought were most relevant. The facilitators distributed maps showing habitat classes, fisheries management area boundaries, and village locations.

The rationale for areas selected by Group 1 (Figure 2) included:

- Areas away from land that would be less likely to be exposed to land-based pollution;
- All habitat types to be included in the network;
- Larger areas selected in the network so that neighbouring villages can assist with enforcement; and
- Inshore areas are left open for coastal communities to fish on.

The rationale for areas selected by Group 2 (Figure 3) included:

- Larger areas of coral reefs with multiple habitat types to be protected;
- Small islands within the larger protected area could also be part of MPAs if the larger area is protected (Fig.3);
- Areas protected near landmass can also be important in supplying resources to nearby villages;
- Passages are selected for protection due to high chance of being fish spawning sites;
- Passages can also have temporary closure during spawning seasons; and
- Reef flats along the coast to be protected so that they are easily enforced and managed by the villages.

The rationale for areas selected by Group 2 (Figure 3) included:

- Selecting small passage with a number of different habitats, allowing protection for different species;
- Connecting more than one habitat within MPA network area will allow for spill over effect; and
- MPA selected near the village for better enforcement

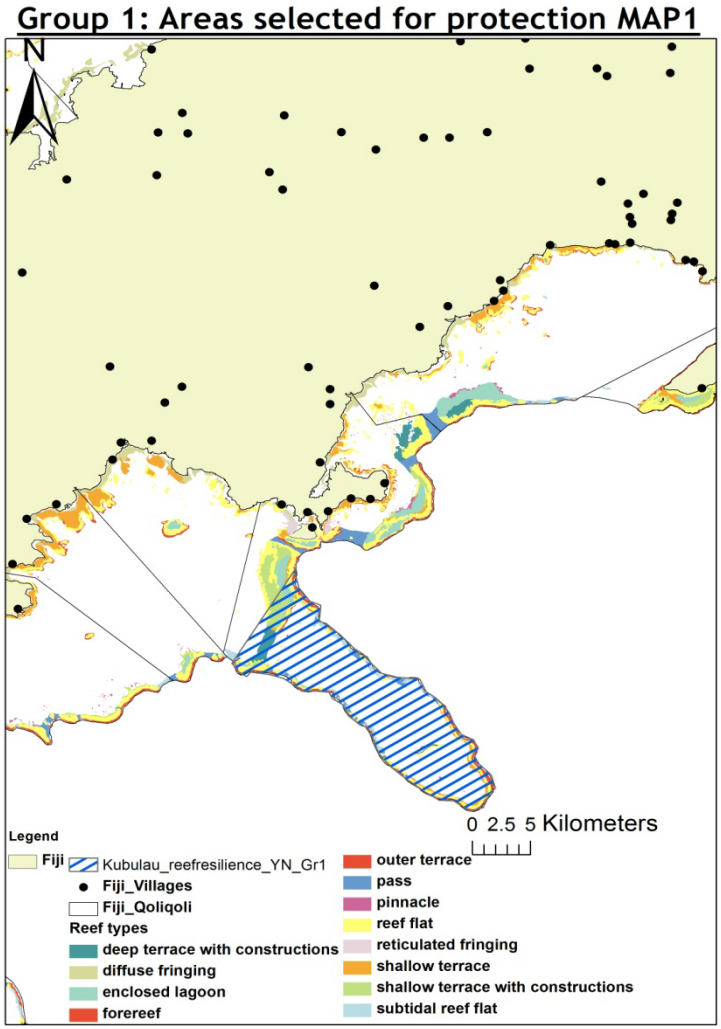

Figure 2: Areas selected by Group1 for protection (blue hash marks)

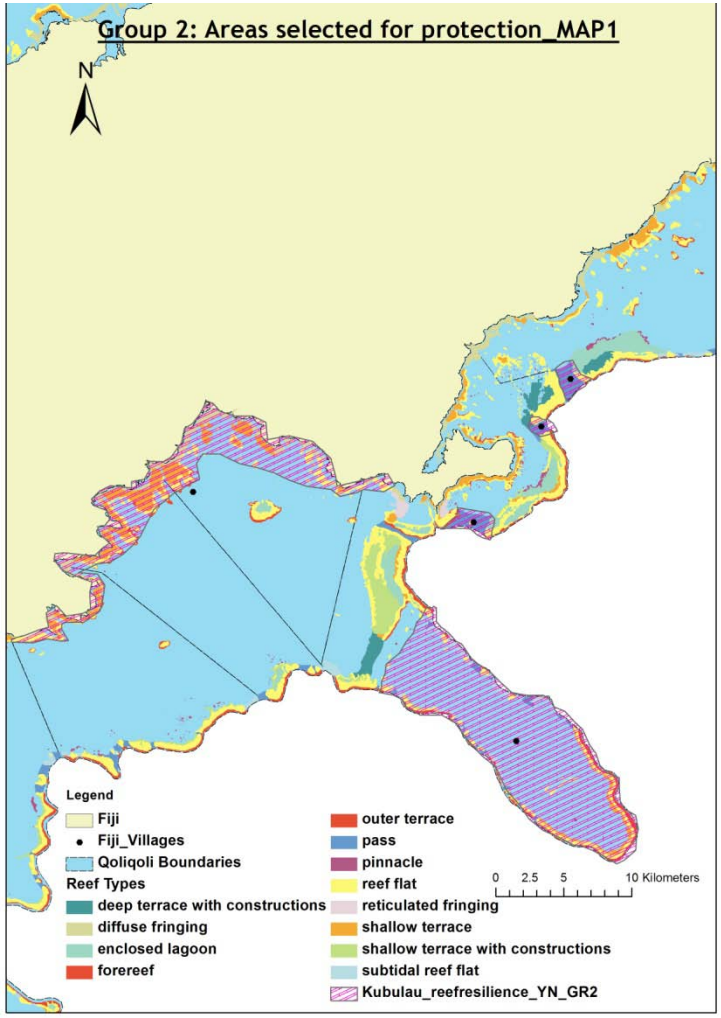

Figure 3: Areas selected by group 2 for protection (pink hash marks)

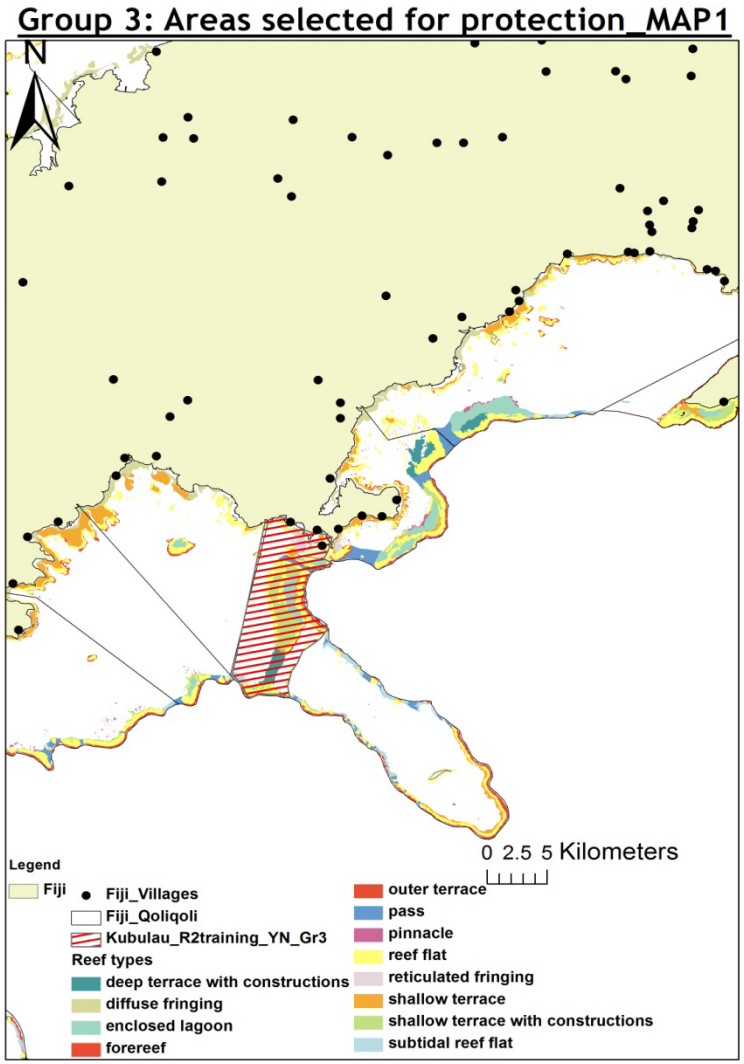

Figure 4: Areas selected by group 3 for protection (red hash marks)

Importance of reef resilience principles to communities

Following the break-out activity, we had a discussion about what reef resilience principles would be most important to Fiji communities. The following statements were presented to the participants to gauge if they were true or false and to generate discussion.

1. Resilience is a new and important concept that means we should revise our conservation strategies.

Reef resilience is a new concept to communities in terms of how to contextualize the impacts climate change in ways that are particularly relevant to rural Fijian lifestyles. But part of managing for reef resilience is to change local behaviour that may be adversely affecting conditions for coral reef ecosystems. For example, use of unsustainable harvesting techniques both reduces future food security and may make coral reefs more susceptible to climate impacts. The importance of impacts to coral reef ecosystem services need better understanding by all community members in order to garner support for management actions. Community understanding requires awareness raising on important functions of coral reef and adjacent ecosystems.

Some participants with existing management plans were of the opinion that their plans now need to be revised to incorporate reef resilience principles. Others considered implementation of reef resilience as already part of traditional cultural practice for marine resource management in Fiji.

2. If a reef has not bleached previously, this indicates strong resilience.

Potentially, particularly if it is known that the reef did not bleach when other reef in the area had bleached.*3. The number of coral recruits/juveniles tells us more about connectivity than about resilience?*

Participants generally thought that the number of recruit/juvenile corals were good indicators of connectivity. Facilitators pointed out that recruits/juveniles do not tell a lot about connectivity because we cannot tell where the recruits are coming from until there is an extensive research on genetic mapping is done to confirm that recruits are supplied from connected reefs. The presence of high number of recruits/juveniles is a good indicator of recovery potential, which is a critical component of resilience.

4. MPAs should be zoned to provide protection for bleaching resistant communities.

Participants supported the concept of MPA zoning, but also pointed out that more emphasis should be put on controlling threats for protection of resilient reefs.

5. Controlling the threats to coral communities ***inside*** *bleaching resistant refugia is all that is needed to achieve long-term reef survival.*

All participants recognized that threats from both inside and outside of tabu areas should be controlled.

6. Reefs in poor condition have low resilience and cannot be restored.

Some reefs in poor condition can be restored, particularly if there are existing colonies that only experience partial mortality, high levels of recruitment and high levels of herbivory. Facilitators pointed out that reefs with a broad range of coral colony sizes, that include older corals, should be prioritized for protection as this demonstrates that the communities have either not experienced much severe disturbance in the past or are able to tolerate more severe disturbance. In addition, the older, larger corals have the ability to produce more larvae during spawning.

Break-out group activity II: MPA design revision

Participants were again divided into the same three groups to revise their MPA design. This time, in addition to maps of general reef habitat classes, the groups were given maps with information on reef site/habitat resilience, predicted current direction, and locations of sighting endangered species. They were asked to work on revising their MPA network design based on the new information. Following a presentation on best practices for MPA network design, the groups were asked to take into consideration the following factors (1) Representation; (2) Replication; (3) Connectivity and (4) Effective management. The three groups came up with:

Group 1 amended their initial decision on site selection for protection by decreasing the size of the initial area selected and added 2 more sites for protection (Figure 5). A total of 3 larger sites were selected for protection, to manage for uncertainties to disturbance from climate change and human impacts, while 2 smaller sites were protected to ensure habitat replication. The 2 small sites covered areas that were thought to be some of the most resilient reefs within the planning region. Some of the larger areas included passages as they are potential sites for spawning aggregation. Strong current in upstream areas flowing down will allow some movement of larvae downstream, hence reefs in the middle were given consideration.

Group 2 began by selecting small areas were selected for protection based on information regarding site resilience. They also selected a larger area for protection (Figure 6). To ensure connectivity between MPAs, this group selected upstream sites based on current direction so that reefs with moderate to high resilience would be connected to downstream reefs through larval transport. Passages were given high priority as they are potential spawning aggregation sites and could also promote connectivity. Passages are also important site for dive tourism; hence Group 2 gave priority to their protection to keep these areas vibrant and attractive. A large inshore reef chosen initially was changed and replaced with protection over a small patch and outer reefs to prevent poaching and ease enforcement. The reason for selecting these areas was due to their high resilience, habitat representation, connectivity and because they are critical habitats for important species. Group 2 also gave weight to consider socioeconomic implications. For instance, they recognised that the villages close to protected sites might not be very happy with the decision as it might hinder with their fishing activity that could lead to poaching.

Group 3 amended sites they selected by changing the design from one large initial MPA to smaller, distributed MPAs to ensure habitat representation, protect some critical areas, and facilitate effective management. Site selection mostly focused on protecting sites with high resilience across a range of habitat types. To ensure connectivity and protect critical species'

refugia, passages were selected as protected areas and their locations were targeted to ensure larval transport downstream. Some sites were selected based on the revenue potential through dive tourism. Sites showing moderate resilience but located near a potential spawning aggregation site, with current direction towards a suitable reef, were also considered for protection.

The result of resilient MPA network design and reef resilience principles as stated in the output maps below:

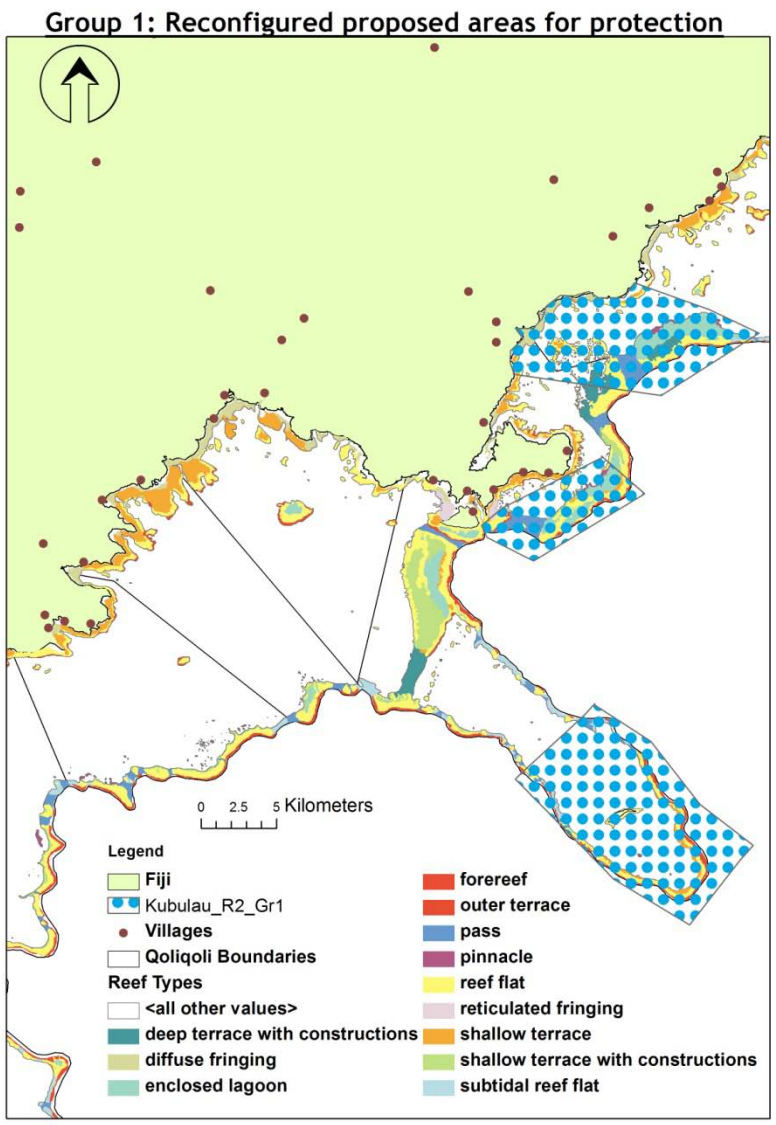

Figure 5: Reconfiguration of sites selected for protection by Group 1.

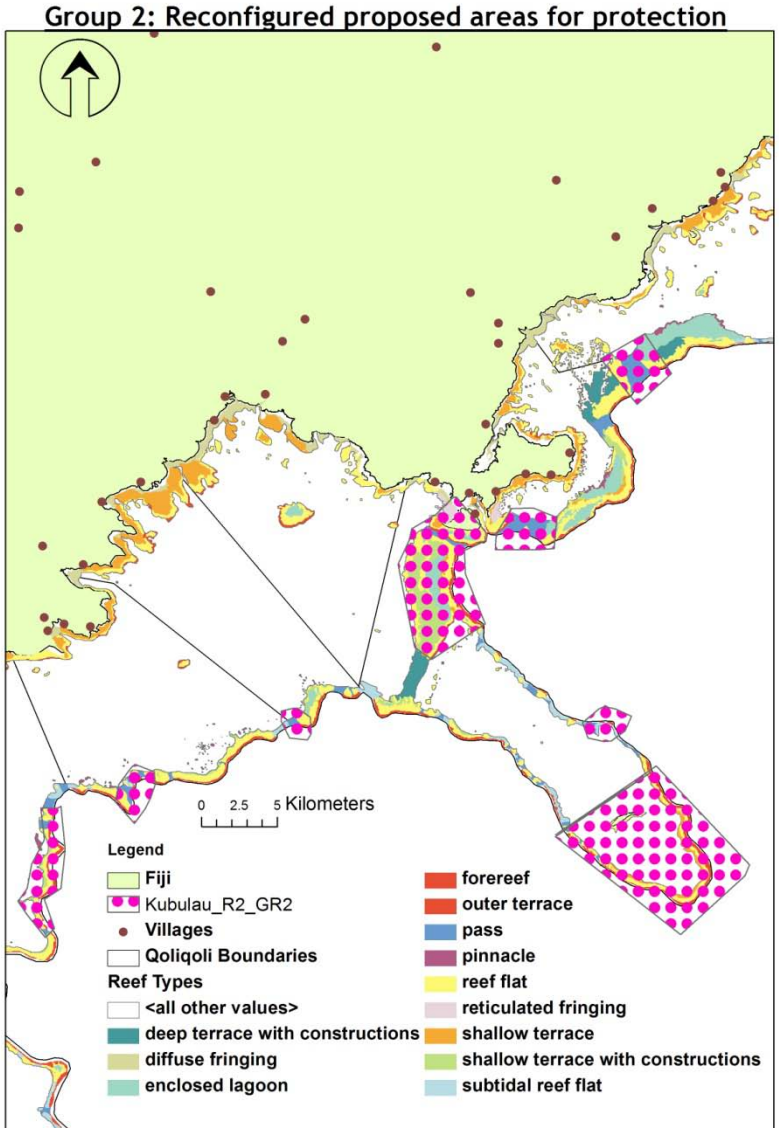

Figure 6: Reconfiguration of sites selected for protection by Group 2.

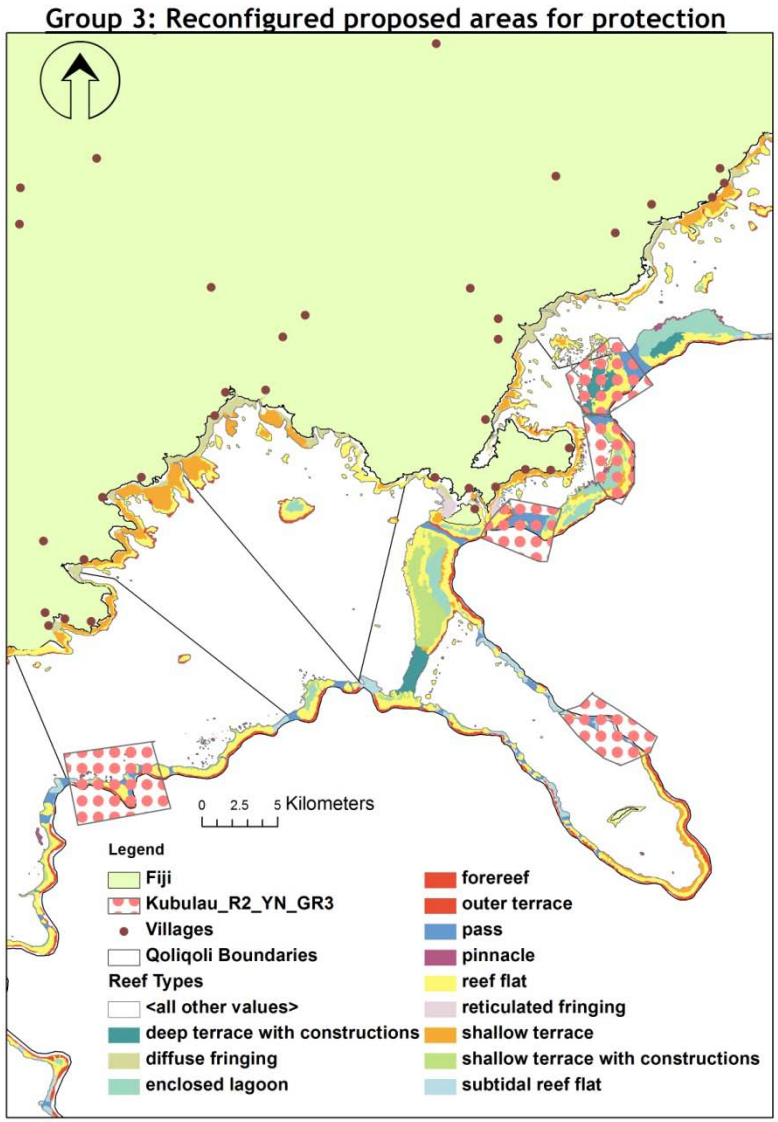

Figure 7: Reconfiguration of sites selected for protection by Group 3.

Highlights of Day 1

At the end of Day 1, everyone was happy to have improved their understanding and skills on the concepts of reefs resilience. Most participants were particularly appreciative about how much they learned during the MPA design activity. They considered this to be the best part of the day. We also remarked that the participants had done well to include some of the key principles of MPA design even before they were given formal learning on the topic, thus they had a very intuitive sense of what properties of coral reef ecosystems were important for reef resilience. After the concepts of reef resilience were presented, the participants modified their designs with new knowledge to ensure consideration of all important design criteria. Some community representatives pointed out that they never before considered characteristics of corals when establishing an MPA as they did not think that corals played a vital role in maintain fish population and being key components of healthy reef systems. By the end of the day, most participants fully understood the concept of incorporating the new information on reef resilience into adaptive management of existing locally managed marine areas in Fiji.

Bleaching response plan

On Day 2, we introduced the concepts of why and how to develop a bleaching response plan. Bleaching response is a way of preparing and responding to coral bleaching events and is a critical concept that helps reef managers prepare for mass bleaching events. Bleaching response plans may help minimize socioeconomic impacts and maximize potential for reef recovery. While developing a bleaching response plan, initial steps include identifying: resource users; people who need to get involved in implementing the plan; and the necessary needs for training and education.

A basic schematic model for developing a bleaching response plan is shown below in Figure 8.

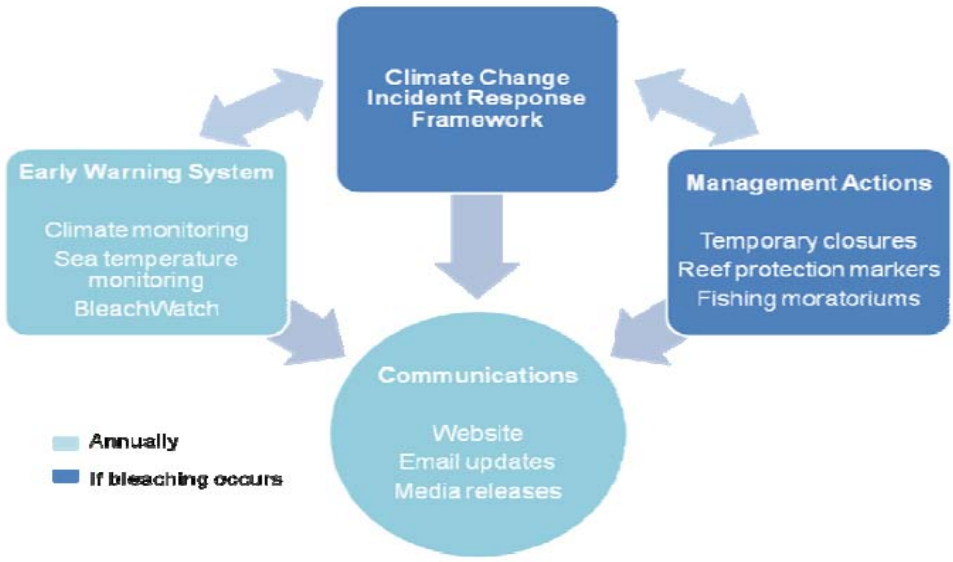

Figure 8: Basic flow of a bleaching response plan.

The cycle of developing a bleaching response plan has four basic steps: (1) developing a climate change incident response framework; (2) developing an early warning system; (3) identifying management actions and responsibilities for implementation, and (4) developing a communications plan.

The Great Barrier Reef Marine Park (GBRMP) in Australia is one of the few places in the world with a bleaching response plan that has been implemented since 2009 by the Great Barrier Reef Marine Park Authority (GBRMPA). The bleaching response plan that GBRMPA implemented relies considerably on advanced technologies that are not necessarily available to rural Fijian communities. Thus, this was a good opportunity to get reef resilience participants to develop a plan more suitable to the local Fijian context. To do this, we adapted the steps of the flow diagram in Figure 8 to include the following components (Figure 9):

1. Coral health and impact assessment plan;
2. Communication tools for early warning systems;
3. Community management actions plan; and
4. Socioeconomic implication plan.

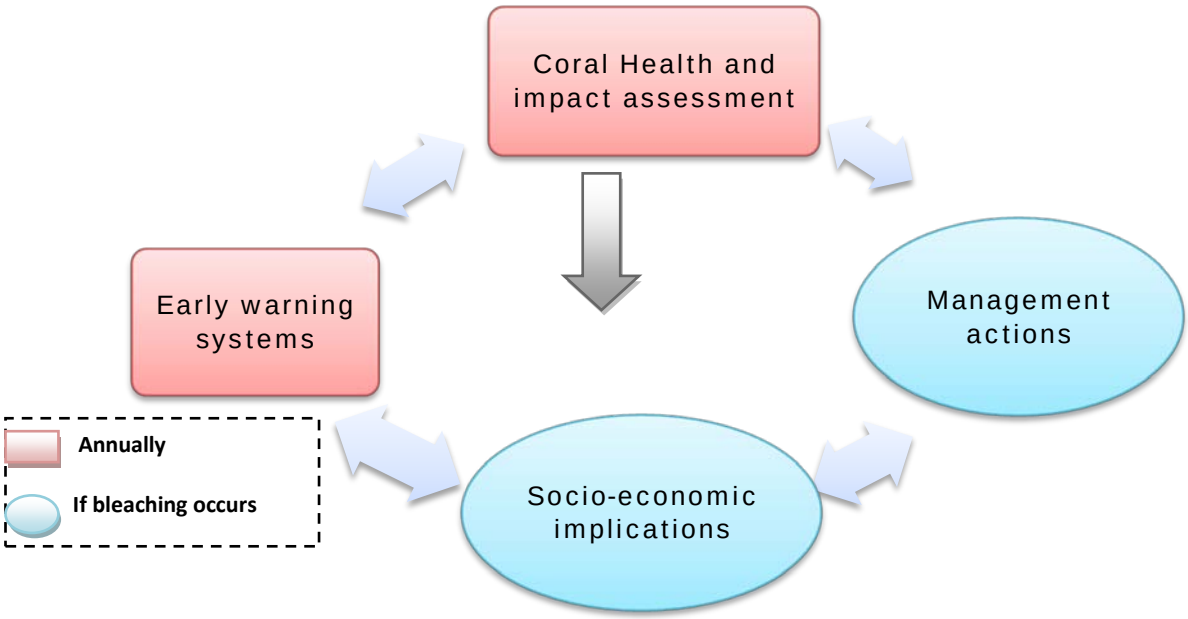

Figure 9: Bleaching response plan basic flow model adapted for Fiji

Specific components of a framework for an adapted bleaching response plan for Fiji (Table 1), based on consolidated plans developed by participants in 4 break-out groups, are described below:

Component 1: Coral health and impact assessment plan → Eyes on reefs

This component deals with identifying resource users and implementation personnel of the bleaching response plan. It largely relies on observations of people who spend a lot of time out in the sea to spot the first signs of any change. These people need to be made aware of potential coral health damage through early warning signs, such as: change in coral colour (particularly a brightening of coral pigments); signs of coral predators such as crown-of-

thorns starfish (COTS) and *Drupella* snails; presence of invasive species and algal overgrowth; and indications of coral disease. The next step is to think about what impacts these factors are having on reef health and evaluate coral responses over time. Things that need to be considered are:

- What are the indicators?
- How easily are they spotted?
- Do communities have the capacity to identify these indicators?
- Are there training needs for frequent reef users?
- Who will they report any signs of change in coral health?

Each community developing a bleaching response plan needs to address these questions, determine who are their 'eyes on the reef', and give these people adequate training to be able to spot early indications of a problem for coral reef health.

Component 2: Early warning systems → Communication techniques

In countries with access to reliable internet facilities, early warning systems usually rely on updates to reef managers regarding potential for bleaching based on analysis of satellite-derived sea surface temperature or other environmental anomalies. However, as most rural Fijians do not have internet access, another system must be devised. Reef managers and community members were required to think of techniques and tools that could be used in Fiji to alert communities about potential coral bleaching events. Participants listed village meetings, text messages, radio broadcasts, and personal communication as potential ways that messages to put people on alert for bleaching events could be delivered.

Component 3: Management actions plan

Participants were divided for the development of a framework for community-based action plans into 2 portions: (1) Preventative actions; and (2) Responsive actions. Preventative actions targeted management actions from communities that could minimise the impacts of mass bleaching events. These are actions that need to be taken care of before any bleaching events, such as managing catchment areas and avoiding destructive fishing practices. Responsive actions targeted activities to be undertaken after bleaching events to help coral reefs recover. These management actions include setting up seasonal and/or temporary MPA areas and minimizing the fishing of herbivores.

Component 4: Socioeconomic implication plan

The final component of the framework for a bleaching response plan focused on the effects of both bleaching events and management actions on social systems, including communities. For instance, if a responsive action called for no fishing of herbivores for 3 months, then what will the communities eat if they solely depend on fishing to feed their families? Setting up management actions requires close examination of the impacts of each action on social systems so that communities are able to switch to alternative methods/resources. For example, if there is a fishing ban, will the community be able to sustain themselves with farming? Developing a socioeconomic implication plan is not only important during bleaching events but could also be adapted to any natural disturbance and

will help communities adapt to change and survive rather than being helpless during times of disaster.

Table 1. Bleaching response plan framework for Fiji, consolidated from the outputs of 4 groups during a break-out activity.

Bleaching Response Plan Framework				
1. Coral Health and Impacts Assessment Plan	Resource Users	Indicators		Strategy for assessment
	• Local communities (fishermen and fisherwomen) • Researchers/Volunteers (NGOs, government researchers, field officers, students, community monitoring teams) • Tourist and Divers (dive operators, commercial divers, students) • Boat operators (commercial and community) • Commercial fishermen • Fish Wardens	Indicators	Signs	✓ Reef monitoring at regular intervals by community monitoring team. ✓ Collecting information from trained divers on specific indicators that they are able to monitor. ✓ Collating information from researchers and volunteers working in the areas. ✓ Collecting information from fishermen and fisherwomen.
		Change in sea temperature	1.Change in weather pattern 2.Change in atmospheric temperature 3. Prediction using traditional knowledge 4. Change in sea water temperature felt by frequent reef visitors.	
		Colour change in corals	1.Corals looking very fluorescent 2. Coral becoming white	
		Increase in abundance of algae	More than normal algae spotted on reefs	
		Decrease in fish population	1. Less fish seen on reefs 2. More time spent for fishing 3. Low catch	

			4. Decrease in fish diversity	
		Increased number of predators	1.More crown-of-thorns starfish (COTS) seen on reefs 2. More *Drupella* sighted on reefs	
		Usual signs on reefs	1.Signs of coral disease 2. Corals not looking healthy 3. White spots on corals	
2. Early Warning Systems → Communication	Threats/Indicators	Communication Flow	Communication Techniques	Communications Tools
	- Signs of bleaching and information gathered on stressed corals collated from coral health and impact assessment plan	Refer to the communications flow diagram.	1. Meetings (village, district, provincial) 2. Verbal/Direct communication 3.village workshop 4. Bleaching hotline network	1. Verbal presentations 2. Videos/Cameras 3. Charts, posters, brochures, letters 4. Media (TV, newspaper articles, radio-community bulletin) 5. Networking (phones, emails, internet, text messages)
3. Management Actions Plan	Preventative Actions		Responsive Actions	
	• Setting up MPAs on resilient reefs • Rotational fishing (changing fishing grounds) • Controlled fishing (restrictions on types of fish caught, types of fishing methods, and hours of fishing) • Bula Day ("Bula" not only means hello in Fijian, it also means crown-of-thorns seastar) – a day		• Temporarily closure on fishing grounds to protect bleached reefs (and adjacent mangrove areas). • Set up new MPAs • Minimize fishing and frequent use of reefs to allow it to recover • Fishing restrictions – on the type of fish and	

<table>
<tr><td></td><td colspan="3">allocated for communities to wear bula shirts while removing COTS from the reef
• Waste management, such as; (1.) Prevent land-based sources of pollution, (2) manage use of toxins/chemicals, (3) logging by land users, and (4) manage sewage spill.
• Reforestation such as, (1) plant more trees on land and (2) stop removal of mangroves.
• Improved enforcement – communities to contact local authorities for bridging when people break rules/regulations
• Gear management (e.g. only line fishing permitted)
• Catchment management – no farming near rivers</td><td colspan="3">invertebrate caught to allow herbivores to regulate coral and algal competition and allow for recovery. Minimize fishing of herbivores.
• Restriction on fishing methods/gear – Line fishing only
• Replanting coral and mangroves
• Community awareness activities to inform about the current state of bleaching and its impacts and plan for alternative food and income-generating activities
• Waste management for communities for all types of waste to promote recovery and minimize stress on corals.</td></tr>
<tr><td rowspan="2">4. Socioeconomic Implication Plan</td><td>Effects of moderate bleaching events</td><td>Strategy</td><td>Short-term effects of severe bleaching events</td><td>Strategy</td><td>Long-term effects of severe bleaching events</td><td>Strategy</td></tr>
<tr><td>Decrease in fish population</td><td>1. Financial literacy for communities
2. Use of local skills and knowledge
3. Farming of cash crops (Yaqona, dalo tavioka)
4. Planting of trees for sale as well as</td><td>Severe decrease in fish population</td><td>1.Seasonal ban of fishing
2. Use of local skills and knowledge
3.Ban on fishing techniques such as; allow only line fishing
4. Upstream management by planting more trees</td><td>Some places will have no edible fish left do to phase shift or very little fish for communities</td><td>1. Use of local skills and knowledge
2. Alternative sites form fishing
3.Alternative source of livelihood; such as; planting of trees for sale as well as upstream/terres</td></tr>
</table>

	Implementation of management actions due to bleaching events	upstream/terrestrial management 5. Tourist activities such as, (1) Bilibili (raft) race, (2) Meke (dance performance), (3) waterfall site seeing, and (4) hiking	Implementation of management actions due to bleaching events	5. Alternative sites with the potential to recovery faster chosen as temporary MPAs. 6. Fundraising through village social activities	Implementation of management actions upon post bleaching events	trial management 5. Tourist activities such as, (1) Bilibili race, (2) Meke, (3) waterfall site seeing, and (4) hiking 6. Village social activities such as Gunusede

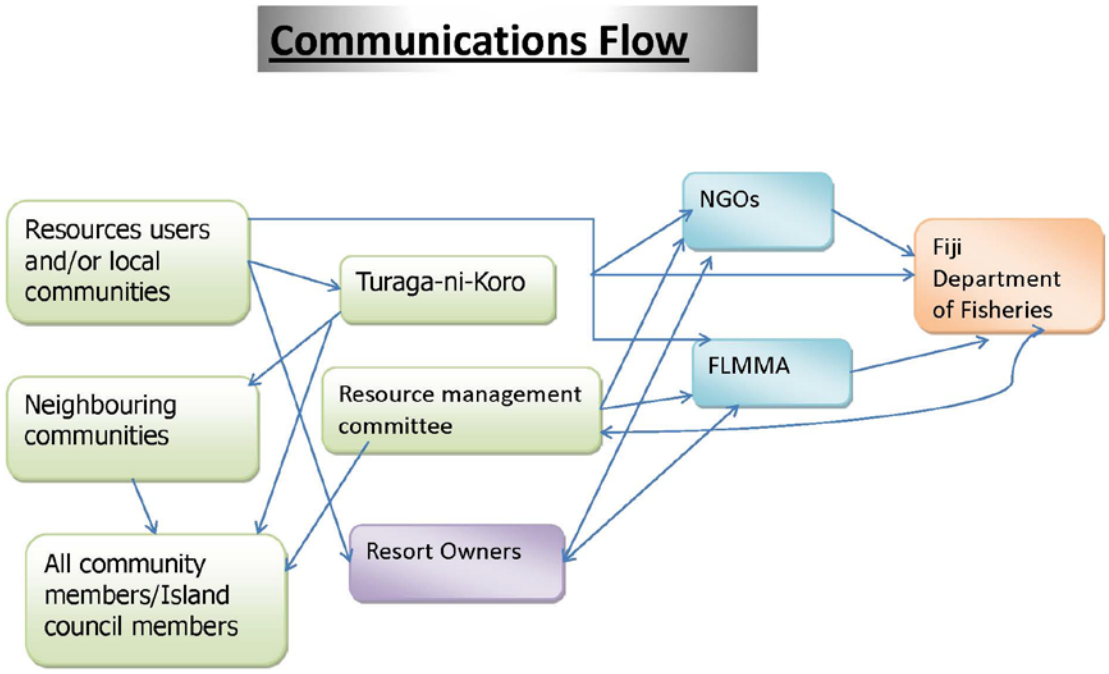

Figure 10: Communication flow in a Fijian village system.

Following the break-out activity to develop bleaching response plans, case studies were presented of how reef resilience principles were already being incorporated into coral reef management in Fiji.

Case Study 1: Implementation of reef resilience principles in Lomaiviti.

In April, 2011 a similar "training of trainers" workshop was conducted in Bali and 2 participants were sponsored by FLMMA to represent Fiji at the training. One of them (Miss Ana Tagivetaua) is an employee at the Ministry of iTaukei (Indigenous) Affairs, who has been doing small projects in Levuka, in the Lomaiviti groups. She has been working with local communities to help them implement reef resilience principles within some existing and some new projects. Removal of COTs is an existing project in Levuka and she has been providing the communities with addition resources and information. She has also helped with clean-up campaigns and giant clam farming. Ana conducted two day training in Levuka as part of her implementation plan, where she updated communities more about coral reef ecosystems and the threats. Participants became aware about the causes of coral stress and contributing factors and reviewed their protected area boundaries based on new information. The existing management plan for Levuka was also reviewed to include reef resilience principles. Some communities have decided to install buoys at dive sites to avoid coral damage while others have requested for more awareness programs. The group working in Levuka has yet to think about communication techniques to broadcast early warning alerts and to different channels within the communities. There are also challenges

due to lack of enforcement because the protected areas are quite big and many people are not aware of the boundaries.

Case Study 2: Applying Resilience Principles for Adaptively Managing and Designing a Network of Marine Protected Areas in Fiji

Dr. Rebecca Weeks from WCS presented some of the results of a successfully implemented project in Kubulau District to boost reef resilience, which has now expanded to neighbouring districts of Nadi, Solevu, Wainunu and Wailevu in Vanua Levu. The case study focused on WCS work in Kubulau since 2009 and how new information on reef resilience has improved the resource management strategies through adaptive management. Dr. Weeks emphasized how WCS has helped the communities of Kubulau develop Fiji's first ridge-reef management plan in 2009. Later, reef resilience principles were used to revise WCS's biological monitoring technique to identify resilient sites and incorporate those sites into MPA network design to help reefs survive better from future climate as well as anthropogenic disturbances. Resilience data were presented back to the communities and based on this new information, they agreed to reconfigure their protected area boundaries. WCS also discussed with the communities how to build social resilience to climate change by evaluating whether their current strategies to respond to climate disturbance (of any kind) were sustainable, and if not, how they could be improved. The neighbouring districts have also shown interest in protecting resources by proposing new MPAs in sites with high resilience, based on the information from the biological monitoring surveys presented to them during the consultation workshops. The field team are still working with communities in the 4 new districts through follow-up workshops, assisting them to finalize their ridge-to-reef management plans.

Outcomes of the reef resilience training in Suva for FLMMA partners

The workshop ended with some really good feedback from the participants, especially from the community representative (YMST coordinators) who discussed their follow-up measures. To begin with, most of the participants had an implementation plan for their area and were eager to update communities on reef resilience principles. The Ovalau-Motoriki YMST coordinator stated that he will share the information about reef resilience during a meeting with the division representatives and other YMST coordinators and work on a plan to make people aware about coral reef ecosystems and improve understanding on the impacts of climate change.

The YMST coordinator from Cakaudrove informed us that he has 7 workshops to attend in the coming months at which he will try to deliver the message while working with the communities of Cakaudrove Province to have marine protected areas established in all the districts. To this end, WCS assisted the YMST Cakaudrove representative by providing him with habitat maps for the province so that he can help communities plan their protected sites.

The representative from the Mamanuca Environment Society (MES) stated that she will deliver information from the training to all staff working for MES and then it will get delivered to villagers and resort owners during meetings. Although, Mananuca group of

islands currently have existing traditional MPAs, they are planning to use the concept of reef resilience to help them establish their first legalized MPA.

The YMST coordinator from Gau was very ambitious and has some support from other organizations (Frontier) working closely to management. Materials were taken to be presented during village to village workshops and during island council meetings so that communities are well informed of key concepts of climate change and how protecting resilient reefs can help them achieve their resource management goals. In the coming months, Gau will use resilient MPA design criteria to identify areas for protection and update WCS on any progress.

The YMST coordinator from Macuata stated that he will be presenting the information to the Cokavata Resource Management Committee at different levels and will make plans to update the communities and other resource users in the district.

Lastly, the representative from the Institute of Applied Sciences (IAS) at the University of the South Pacific suggested that information on reef resilience and related topics such as climate change, resilient MPA design, bleaching response plan and communications be given to community representatives in a poster and/or brochure format to be taken back to the communities so that it is easier for them to understand using visuals.

To move forward in conveying the reef resilience message and helping communities protected resilient reefs within a network of MPAs, commitment is required from both the facilitators and the participants. The facilitators will assist participants by providing them with posters focusing in key messages, such as; “How to spot signs of bleaching”. A glossary of scientific and commonly used terms will be translated into Fijian and distributed among FLMMA partners to avoid miscommunication and misunderstanding. WCS will provide FLMMA communities with the consolidated framework on developing bleaching response plan so that each district can make their own plan to detect bleaching events. Communities can develop both preventative and responsive actions as per sites and local requirements to help manage resources better.

Feedback on the reef resilience training

Upon completion of the training workshop, the participants were given a post workshop assessment form (Figure 6 below) and evaluation form (Appendix B). The results from the assessment indicated that more people understood the key message delivered during the workshop than prior to the training. The understanding on climate change impacts also improve while most improvement was shown on resilient MPA design. More people were able to understand about the causes and impacts of bleaching that helped in developing a successful bleaching response plan framework at the end of the workshop.

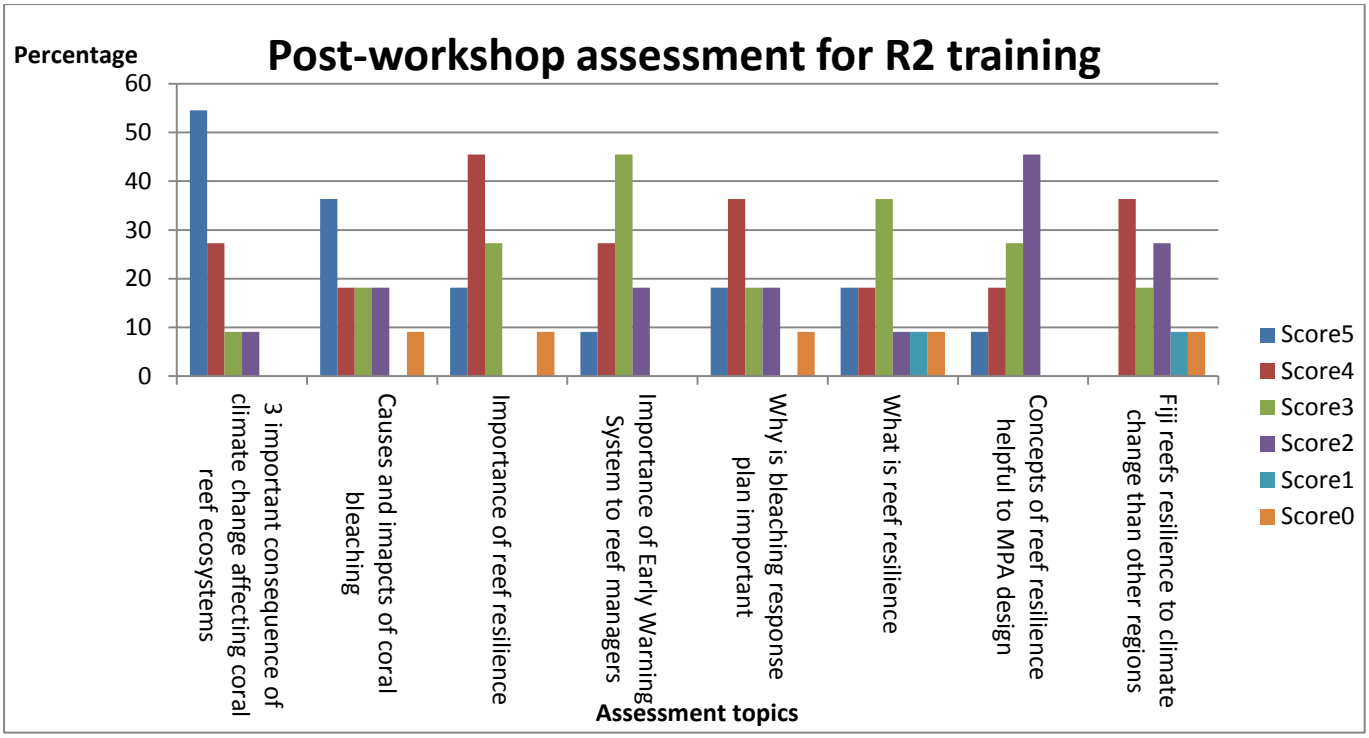

Figure 11: Results of the post workshop assessment. Scores indicate the level of understanding from participants. Score 5 indicate strong understanding while Score 0 indicate no understanding at all.

Approximately 40% of the participants had a fair bit of understanding about early warning systems compared with no-limited understanding at the beginning of the workshop. The concept of reef resilience was the focus of this workshop and it was encouraging to see that none of the participants at the end of the workshop stated that they did not understand the principles. Most of the participants had a good understanding of the importance of reef resilience, although expressing the concept could be a challenge.

Conclusions and Recommendations

The reef resilience training delivered messages on application of MPA design principles, which was a fairly new concept for most of the participants. It also covered the importance of considering the properties of corals themselves when considering locations to establish management. Further, this training was able to provide more information and techniques of identifying signs of coral stress caused by both local and global factors. To move forward, WCS and other FLMMA partners will be assisting communities to implement adaptive management strategies by developing information materials such as posters and/or brochures on “how to spot signs of bleaching” and /or “how to identify resilient sites” using coral as indicators.

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Appendix A. Participant List.

No.	Name	Organization	Email	Phone contact	Why are you interested in the workshop?
1.	Amelia Pei	FLMMA	Ameliapei26@gmail.com	7772050	Capacity building in terms of climate change and reef systems.
2.	Samuela Tuidravu	Macuata YMST		3580945	Effects of climate change
3.	Joni D. Vakamino	Cakaudrove YMST	rokotuicakaudrove@yahoo.com	8507139	- Reef resilience - Coral Bleaching - Climate change
4.	Saimoni Dobui	Koro YMST		7606335	About climate change
5.	Mesake D.	Ovulau-Motoriki YMST		9942115	Climate change in Fiji
6.	Kalisiana Marama	WWF Volunteer	k.marama@yahoo.com	9558031	Understand what reef resilience is

7.	Tevita Seru	Gau YMST		8364136	Understand the effects of climate change
8.	Andra Whiteside	WWF Volunteer	Stixwhiteside13@gmail.com	9293929	Reef resilience is an area of particular interest.
9.	Diana Tora	MES	diana@mesfiji.org	7500644	Learn more about reef resilience
10.	Unaisi Waqanivere	CI	unawaqanivere@gmail.com	9363754	Learn more about reef resilience and climate change
11.	Mili Tikoinasau	NEC volunteer	miliscartiko@yahoo.co.nz	7673626	To learn more about reefs and climate change
12.	Sovaia Nabobo	NEC volunteer	soralexsarai@yahoo.co.nz	8416949	Learn more about reef resilience and marine
13.	Fulori Waquraget	IAS	fvnainoca@yahoo.com	9930782	Reef resilience information
14.	Semisi Meo	IAS	meos@usp.ac.fj	3232974	Reef resilience methods
15.	Ana Tagivetaua	Lomaiviti Provincial Council	d_anata@yahoo.com	3440038	Reef resilience principles
16.	Pitila W	Department of Fisheries	pgracewaqainabete@gmail.com	3361122	
17.	Viliame Tui	Department of Fisheries		3361122	Learn about reef resilience
18.	Diana V	Department of Fisheries	Dee_valotu@yahoo.com	3361122	Learn about reef resilience
19.	Taione Delai	G.V.I	taionedelai@gmail.com	9458212	Broaden reef resilience knowledge
20.	Howard Foster	South Pacific Projects	howard@spp.org	8667662	MPAs design
21.	Lepani	Fiji National	lepanikolinisau@fnu.ac.fj	9207655	Reef

	Kolinisau	University (FNU)			resilience
22.	Alumeci Nakeke	SeaWeb			Facilitator
23.	Margaret Fox	WCS			Facilitator
24.	Rebecca Weeks	WCS			Facilitator
25.	Stacy Jupiter	WCS			Facilitator
26.	Yashika Nand	WCS			Facilitator

Appendix B. Training Evaluation.

Evaluation from the workshop stated that 80% of the participants mentioned that their expectations were fulfilled, while ~20% stated that most of their expectations were met during the workshop. The tangible success of this workshop could be measured from the implementation plan that most of the participants have made commitments to carry forward. The workshop was designed quite well, as indicated by the high percentage on clarity of message delivery, although some cons of the workshop was as stated in Figure 8.

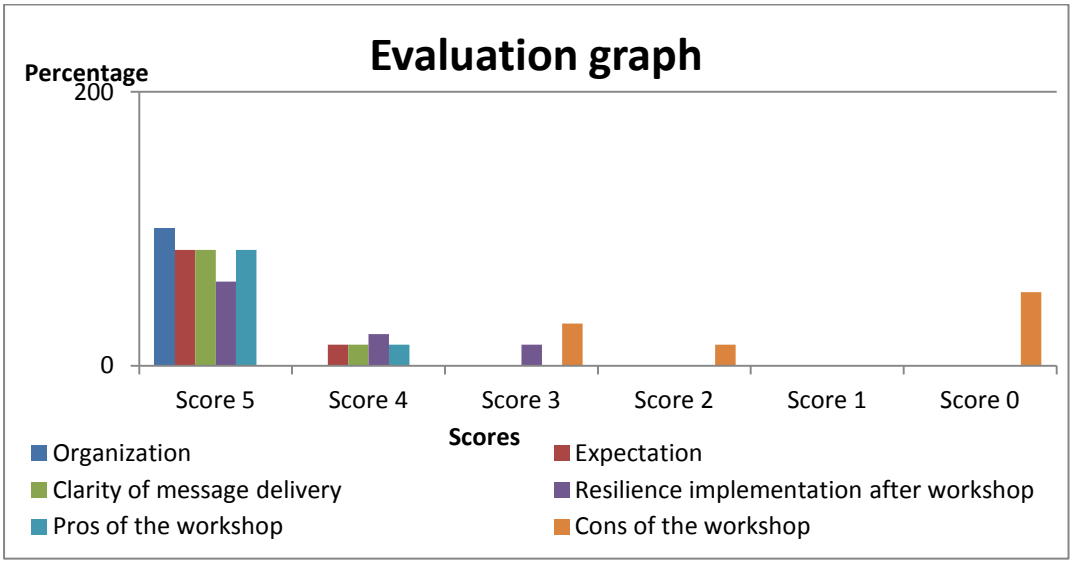


Figure 12.Evaluation of the workshop. The scores 1-5 indicate the positivity of the R2 training. For instance, if organization was given a of score5, most participants liked it, hence the higher the score the more appreciation by the participants.

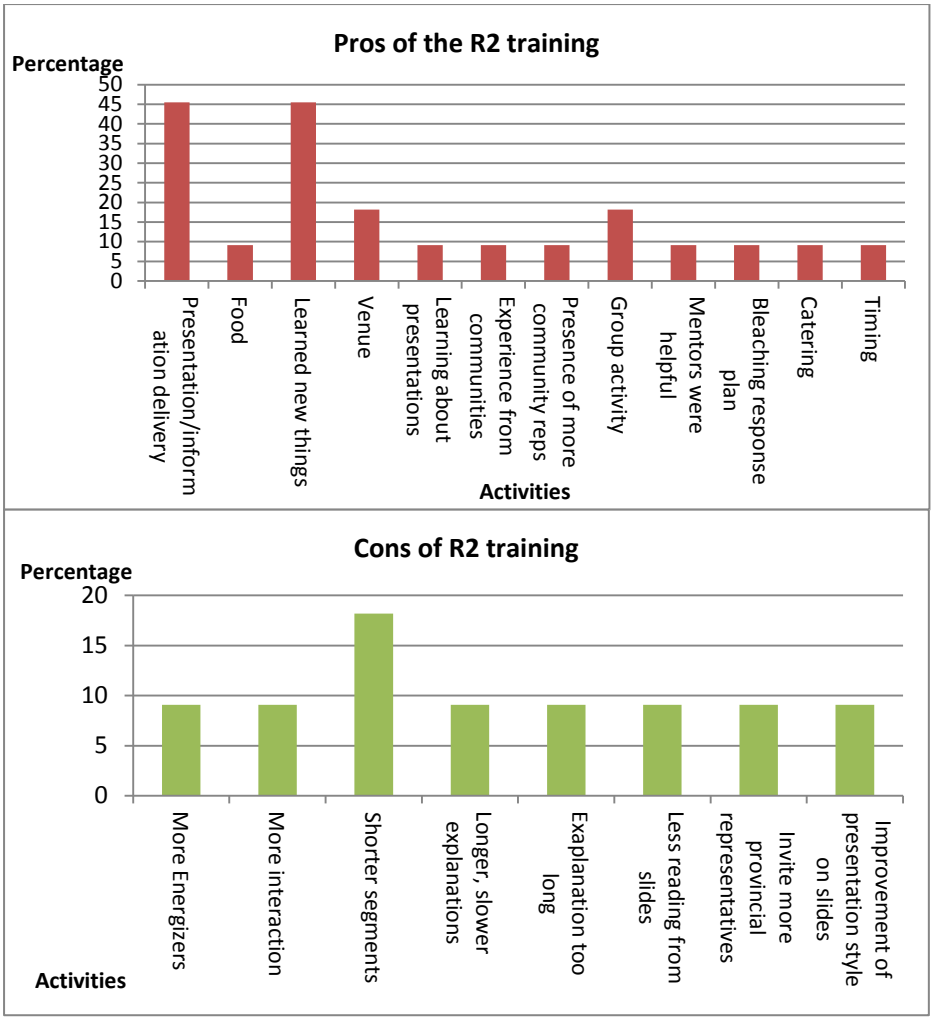
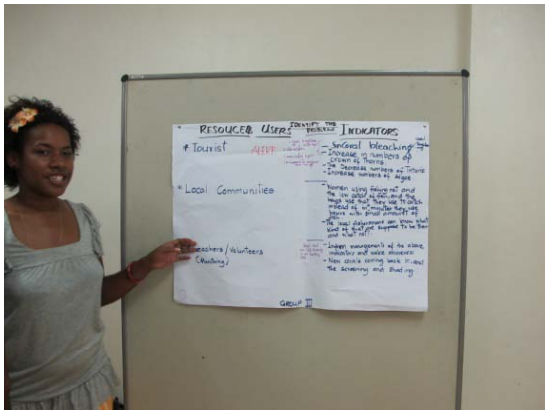


Figure 13: Positives and negatives of the workshop that participant thought should be considered.

Appendix C: Participants in action at the reef resilience training in Suva

Figure 14: Participants busy with selecting sites for protection prior to resilient MPA design.



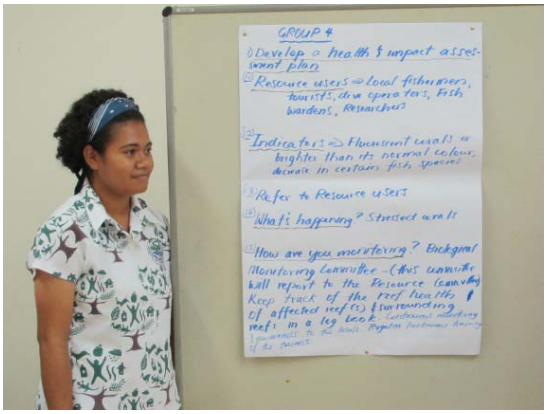


Figure 15: Participants presenting on *developing a coral health and impact assessment plan* on behalf of their groups.

Figure 16: Participants presenting on *Early Warning Systems* and its importance.

Figure 17: Participants talking about *developing a management action plan* for communities.

Figure 18: YMST coordinators presenting ideas on social implications during the activity of *developing a bleaching response plan*.