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Regional Technical Assistance for Strengthening Coastal and Marine Resources Management in the Coral Triangle of the Pacific (Phase 2)

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Asian Development Bank

Responding to climate change using an adaptation pathways and decision-making approach

(Formerly: Building capacity to assess vulnerability and adapt to climate change in the Coral Triangle of the Pacific)

A component of project ADB/GEF project R-PATA 7753: Strengthening Coastal and Marine Resources Management in the Coral Triangle of the Pacific (Phase 2)

Final report

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Abbreviations

ADB	-	Asian Development Bank
CCAFs	-	Climate Change, Agriculture and Food Security (CGIAR Research Program)
CGIAR	-	Consultative Group on International Agricultural Research
CTI	-	Coral Triangle Initiative
FAO	-	Food and Agriculture Organization of the United Nations
NDFA	-	National Directorate of Fisheries and Aquaculture, Timor-Leste
NSD	-	National Statistics Directorate
SEWPaC	-	Australian Department of Sustainability, Environment, Water, Population and Communities

Glossary

Aldeia	-	subvillage within a suco
Chefe	-	chief
Local authority	-	local government officials and the chefe sucos. They make decisions and hold meetings at the sub-district level
Lia'Nian	-	traditional village chief of justice. The appointment is generally only given to a man, who then acts as "advisor, arbitrator, and judge" in traditional justice systems
Loro sa'e	-	east in Tetum
Loru-monu	-	west in Tetum
RoLu	-	Roman Luan, local nongovernmental organization and important project partner located on Atauro Island
Selatan	-	south in Tetum
Suco	-	village cluster
Tara Bandu	-	traditional laws used by communities in Timor-Leste to regulate relations between people and groups as well as between people and the environment
Utara	-	north in Tetum

Executive Summary

1. This final report details activities, reflections, and policy recommendations arising from the project*: Responding to climate change using an adaptation pathways and decision-making approach*. The project is a component of the ADB/GEF-funded RETA R-PATA 7753: Strengthening Coastal and Marine Resources Management in the Coral Triangle of the Pacific (Phase 2).

2. The report highlights the results of activities undertaken in collaboration with community members and regional and national nongovernment organizations (NGOs) and government representatives in Timor-Leste and Solomon Islands. The activities entailed (a) engaging community members in assessing the likely impacts of climate change on their fishing and farming livelihoods and evaluating options for adaptation specifically in Atauro and Batugade in Timor-Leste, and Malaita Province in Solomon Islands; and (b) reviewing materials produced by fishers and farmers in Timor-Leste on climate change, and planning for implementation of chosen adaptation actions.

3. The results produced from three case studies of Atauro, Batugade, and Malaita Province consisting of 12 research activities are considerable in detail and therefore difficult to summarize. An analysis of long-term climate data suggests that some climate trends in the region are consistent with projections of long-term climate change. It is anticipated that climate change will have a substantial impact on fishing and farming livelihoods in the Coral Triangle. While some opportunities may arise from these changes (e.g., potential to harvest and store water during increased wet season rainfall), there are also likely to be severe challenges to ecosystems, and the people that depend on them for their livelihoods. The analysis also shows that fishers and farmers are already adapting practices to variable weather conditions. In all three case studies, they proposed ideas for further adapting existing livelihood activities through small modifications and incremental change. In many cases, the scale of these proposed changes mean that fishing and farming activities may need to be adapted frequently on an ongoing basis. It is also likely that more fundamental changes to these aquatic agricultural systems will also be needed in time if they are to realize the transformative change necessary to adequately respond to projections of future climate change.

4. The climate change assessment approach developed in this project and undertaken in the three case studies,is described below and a summary of the results and policy implications follow.

A. Development of a Community-based Adaptation Assessment

5. The assessment process uses a series of participatory research activities to facilitate a structured discussion with community members on climate change and adaptation. These activities include (i) collating background information on the natural resource challenges facing the communities, (ii) analyzing observed climate in respect to projections of future climate, (iii) assessing the likely impacts of climate change on community livelihoods and the potential for adaptations to address these, (iv) developing decision-trees to guide partial cost-benefit analysis and decisions regarding the economic value of an adaptation action, (v) analyzing social networks to consider strategies for implementing and iteratively managing adaptation actions, (vi) analyzing institutional capacity to understand the influence of formal and community governance on the capacity to adapt, (vii) analyzing key ecological functions and processes in the landscape necessary for sustainably managing natural resources, (viii) mapping of ecosystem services to understand their importance in underpinning livelihoods, and (ix) planning for the implementation of selected adaptation choices and the ongoing

management of adaptation. Collectively, these nine activities were designed to address the following three considerations.

6. **The need to genuinely engage with all community members.** The location of fishing and farming communities in coastal regions and the reliance of livelihoods on the natural resource base, result in high levels of vulnerability to climate change. Within these communities, existing disparities in the vulnerability of individuals is likely to be exacerbated by the negative impacts of a changing climate and a low capacity to adapt. The most vulnerable regularly include women, children, the disabled and minority groups. The assessment process aimed to engage representation from all groups in the community. Despite these efforts at inclusion, adequate representation of women in the studies was poor, as it was particularly difficult to overcome cultural norms that fail to support women in participating in decision making that influences the allocation of resources and benefits. Nevertheless strongly gendered fishing and farming activities, along with cultural differences in accessing resources and services, mean that ways must be found to ensure that women are equitably engaged in assessments of climate change.

7. **The need to consider not only adaptation technologies but also to build a socioeconomic environment conducive to enabling change.** Activities intended at understanding the capacity and influence of formal and traditional institutions in supporting adaptation, such as the one included in this assessment process, seek to identify existing norms and governance structures that act as a barrier to change. Identifying and addressing such structural issues is necessary to progress climate change adaptation beyond technical fixes alone, and ensure that adaptive capacity is built and community resilience is enhanced in relation to climate change issues and agendas.

8. **The need to address climate change adaptation as a sectorally-integrated and multiscale issue.** The institutions that influence the capacity of community members to adapt regularly operate or have influence at multiple scales ranging from global to the individual. Implementing and iteratively managing responses to climate change necessitate that formal and traditional institutions and governance arrangements are well aligned and integrated across these scales in their attempts to provide an enabling environment for realizing change. In the assessment process developed for this project, consideration was given to the relationship between community members; local, national, and international NGOs; and regional and national government representatives in terms of their individual and collective influence on building adaptive capacity. Importantly, the assessment has been used to consider the changes needed to make relationships and governance arrangements more effective in supporting adaptation.

B. Trialing the Assessment Process in Timor-Leste and Solomon Islands

9. While the series of activities included in this climate change assessment process have been developed to engage communities in a structured sequence of conversations about adaptation, the stand-alone nature of each also enabled a subset of the activities to be selected to suit the specific needs of a case study. For example, in comparison with Timor-Leste, Solomon Islands has already been the focus of a number of climate change and vulnerability studies. Many of the activities described in this broader assessment have therefore previously been conducted in some places, to varying extents. A customized version of the assessment was constructed for use in Malaita Province, Solomon Islands. This was used to engage farmers interested in exploring the practice of pond aquaculture as a potential adaptation response to climate and other drivers of change. In this way, the assessment process has been trialed: (i) in its entirety with two communities (i.e., in Atauro and Batugade, Timor-Leste), and (ii) as a refined subgroup of activities with a community of practice (i.e., those interested in pond aquaculture on Malaita, Solomon Islands). In Timor-Leste, there was no focus on a specific adaptation; the assessments were undertaken in a

manner similar to other community-based adaptation assessment processes (e.g., LEAP). In Solomon Islands, the assessment process provided a more focused ex-ante consideration of the development of pond aquaculture. The outputs reflected a need to use a climate change lens when considering existing management recommendations and the potential environmental and social impacts of aquaculture development.

C. Outputs and Outcomes

10. The collection of outputs produced from engaging community members in Timor-Leste and Solomon Islands in the assessment process are essentially diagnostic in nature. They have been produced to provide information that will assist in informing decisions that are presently being made about how to respond to climate change. The outputs are a synthesis of local knowledge and scientific information of both a social and biophysical nature that has been sourced from community members, NGOs, government representatives, and the WorldFish multidisciplinary research team. Outputs include the communities' assessments of climate change impacts and options for adaptation, social network maps to help identify who is needed to implement and sustainably manage adaptations, governance and institutional capacity analysis to identify deficiencies and challenges to adequately fund adaptation and promoting an enabling environment, partial cost-benefit analyses of a number of fishing methods to identify the most financially viable approaches, and analyses of landscape function and ecosystem services to enable adaptations to be considered in terms of their impacts on the natural environment.

11. Feedback obtained from participants during a project evaluation activity suggests the participatory activities have also improved the capacity of those engaged to independently assess the ongoing impacts of climate change and iteratively manage adaptation. To further support this capacity building, a series of eight brochures has was produced from the project. These briefly describe the methods used for each activity in the assessment process and provide a selection of results from Timor-Leste and Solomon Islands as examples of the type of information that can be produced. The brochures are primarily intended for use where assessment resources are limited or where it is more appropriate to use a rapid, qualitative, and non-data-intensive method of assessment. These brochures have been based on activities in Timor-Leste and Solomon Islands, but community leaders, local NGOs, and regional and national government representatives in other countries of the Coral Triangle and Pacific region may find this series useful.

D. Evaluating the Usefulness of the Assessment Process

12. The community members and NGO and government representatives participating in the case studies provided feedback on the utility of the assessment process and the material produced through evaluation activities and interviews. The feedback was predominantly positive. Providing useful information back to communities was aided in no small part by requesting them to determine the format of materials. As a consequence, the posters written in Tetum (language used in Timor-Leste), feedback booklet on pond aquaculture, and series of method brochures were all particularly well received. Fundamental to all of these was the accurate capturing of local knowledge; as summed up by a fisher from Timor-Leste… *the analysis of fishing methods was useful because it contained the fisher's' own information*. However, as useful as information is, the strong message emanating from all communities was that having now assessed adaption measures and identified barriers to taking action, it was time for on-ground activities to begin and the resources needed must be supplied from outside the communities to realize the benefits from their new knowledge and skills.

E. Building Adaptive Capacity and Resilience in Coastal Communities

13. Many climate change adaptation assessments aim to enhance adaptive capacity and build resilient communities; however, it remains difficult to rigorously evaluate if and how projects have achieved their aim. Regardless, the real and immediate need to respond to a changing climate is driving a boom in climate change adaptation investments in research and development; hence, funding agencies need to evaluate the efficacy and outcomes of the assessment methods and activities they fund. As the scope of this project only included the assessment phase of a community-based adaptation activity and produced outputs that are predominantly diagnostic in nature, evaluating the project's efficacy to build adaptive capacity and resilience in coastal communities is further confounded. Nonetheless, the activities included in this assessment process were both individually and collectively selected for their potential to enhance adaptive capacity and resilience through awareness raising relating to climate change; social learning; increasing livelihood options and flexibility; co-producing knowledge; developing an appreciation of uncertainty; strengthening social networks and the communications, social support, social inclusion, and sense of belonging they foster; promoting a sense of self-organizing and agency; capacity building in problem solving; building knowledge, skills, and learning; and promoting community problem solving and community togetherness.

F. Policy Context

14. While the above calls for more resources and training will undoubtedly increase and diversify options for contributing to food security, and broader adaptive capacity and resilience, it is clear from the project analyses that truly resilient communities cannot result from these activities alone. Existing barriers and structural issues involving both formal and informal institutions mean that all community members, and in particular those regularly marginalized and excluded from decision making and positions of power (e.g.,, women and children), will continue to be vulnerable. Climate change is likely to exacerbate the vulnerability of these communities. Addressing such barriers and structural issues will require new norms and policies. Policy recommendations based on the study results are included in this report. These recommendations emphasize that effective policy development must empower communities to take action and make it possible for the benefits of adaptation to be realized by all. At the heart of all policy development, efforts must be made to genuinely engage all community members, ensuring representation of their diverse voices, issues, values, and cultural contexts. While the policy recommendations and issues are based on activities in Timor-Leste and Solomon Islands, it is likely that the messages arising from these case studies are also relevant to other communities throughout the Coral Triangle faced with addressing the challenges and capitalizing on the opportunities presented by climate change.

15. However, the assessment of institutional capacity undertaken in Timor-Leste and Solomon Islands shows that developing policy is not the complete answer to building resilient coastal communities. Implementation of policies at all levels, from community to national, is equally necessary. A critical lack of resources is a substantial impediment to this and in the short term, support from NGOs and other institutions may be required. The social network analysis conducted clearly indicates the challenges of integrating multiple agencies and agendas to make this happen. These findings echo those reported elsewhere, stating that adaptation to climate change requires strong cooperation, coordination, and consensus building among multiple partners. Ultimate leadership and responsibility for ensuring long-term support for communities in addressing climate change rests with the national governments in the Coral Triangle.

I. Timor-Leste Case Study

1. Sections I and 3 detail the two field trips to Timor-Leste undertaken in 2013. These constitute the third and fourth trips to Timor-Leste as part of this ADB-funded project (see mid-term report, Park et al., 2013, for details of the prior assessment activities conducted in Timor-Leste). In the third trip, taken in March, a series of workshops was held with project stakeholders. First, evaluation workshops were held with community members in both Batugade and Atauro with the aim of:

- providing details of the adaptation actions;
- understanding how this information could be used by community members for developing a plan for implementing adaptation actions;
- ascertaining if, and how useful, the material produced during the project is likely to be in respect to building the capacity of communities to adapt (particularly in respect to making decisions about how to adapt and how to plan implementation).

2. An overview of these workshops and a presentation of their findings are provided in Section 3.1 below. For the fourth trip, a workshop was held with NGOs, development programs, and government staff for the purpose of:

- providing details of the evaluation analyses conducted on the adaptation actions identified by the community as being potentially useful;
- understanding how the broader project findings can be used by NGOs, development programs, and the Government of Timor-Leste to evaluate, plan and implement climate change adaptation projects and initiatives;
- exploring the methods manual (i.e., series of eight brochures), including a participatory activity that uses one of the brochures;
- ascertaining if, and how useful, the methods manual is likely to be in respect to supporting communities to adapt to climate change.

3. The trip was also used to collect footage for the audio visual output described in Section I.A.3.

A. Timor-Leste climate analysis

4. An abbreviated version of the climate analysis for Timor-Leste is shown below (Table 1). The full description of the methods used and analysis can be found in the mid-term report.

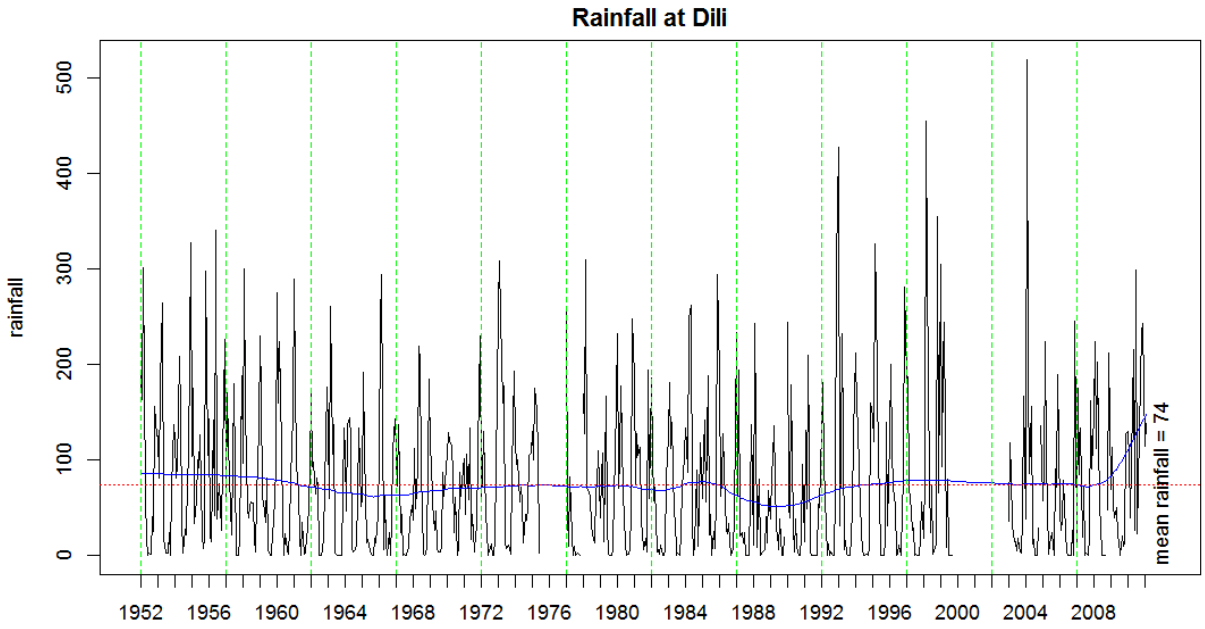
Table 1: Climate analysis for Timor-Leste

Activity:	Assessment of climate using: • Analysis of observed (historic) temperature and rainfall data • Assessment of projections of future climate change
Aim/ Key question:	Are there any trends in past temperature and rainfall data, and are these trends consistent with projections of future climate change?
Brief details of method:	• Observed climate data for mean monthly temperature and rainfall interrogated using statistical analysis and statistical modelling to identify trends • Consideration of climate change projections
Key results:	Summary of trends in observed data • Inter- and intra-annual rainfall is highly variable in Timor-Leste, but the long-term trend has been somewhat stable over the past 60 years (1952-2011) • Average dry season rainfall has fallen substantially in recent decades, while

	average rainfall in the wet season may have slightly increased (although not statistically significant) • On average, the start of the dry season (May to October), has shifted ~45 days earlier over the past 60 years (assuming <20 mm to be the dry season) • Air temperatures are higher during the wet season, than in dry season months • The duration of the cooler season has contracted between 1900 and the present day (as indicated by both sea surface and air temperature). Conversely, the warm season has expanded • Marine temperatures (both sea surface and air temperature) have increased over the past century, across almost all months <u>Summary of climate change projections (ABoM and CSIRO, 2011)</u> • Reduced quantity of rainfall in the dry season • Increased quantity of rainfall in the wet season • Increase in the intensity of rainfall • Increase in surface air temperature (and sea-surface temperature) • Rise in sea level

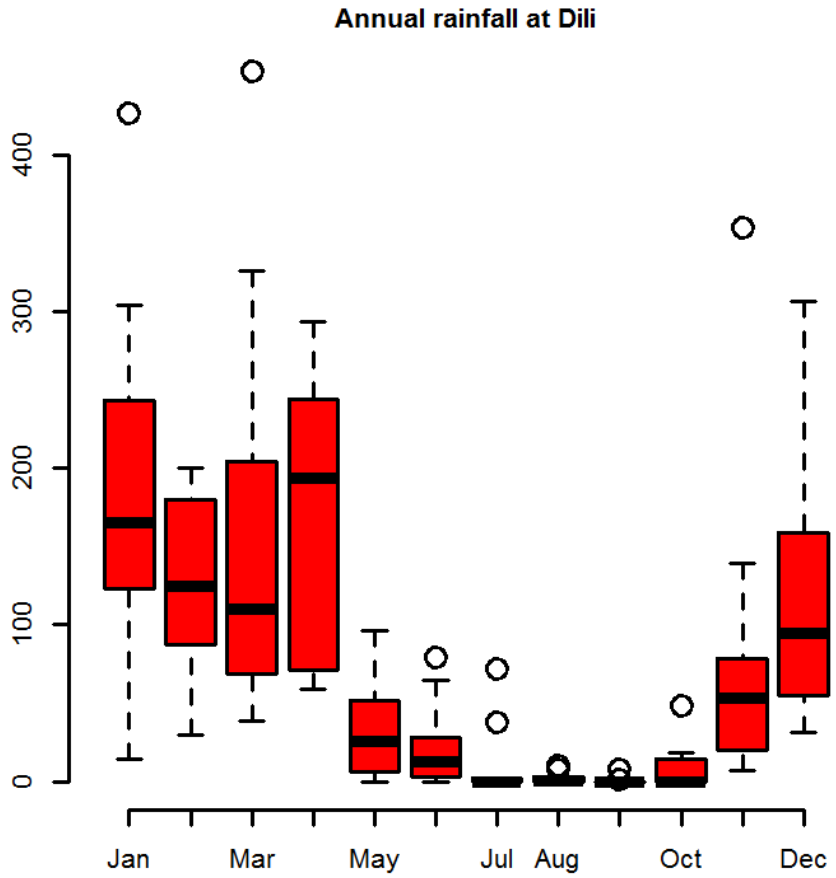
5. Average rainfall at Dili Airport was 74 mm over all months between 1952 and 2011 (Figure 1). The driest months on average were July, August and September; the wettest typically January, February, March and April. In November, December, January, February, March, and April (wet season) the average rainfall was 120 mm, while from May to October (dry Season) the average was 29 mm (see **Figure 2** for a summary of the typical annual cycle in rainfall). These graphs also show that inter- and intra-annual rainfall is highly variable in Timor-Leste. Inter-annual variability in rainfall in Timor-Leste has been attributed to the strong influence of El Niño Southern Oscillation (ABoM & CSIRO, 2011). However, the overall average long-term trend in monthly rainfall (at least at Dili Airport), has been somewhat stable over this 60 year period.

Figure 1: Average rainfall at Dili airport 1952–2011*



*The black lines are the raw data, the red line is the long-term mean and the blue line is the *supsmu* smoothing function which summarizes long-term trend.

Figure 2: Average rainfall at Dili Airport for the period 1952 to 2011*



*The horizontal black lines show the median, the third quartiles are defined by the top and bottom of each box. The whiskers are the maximum and minimum, and the open circles are 'outliers' that may require 'special attention'. See http://msenux.redwoods.edu/math/R/boxplot.php.

6. The long-term trends in monthly rainfall over the period 1952 to 2011 are shown in Figure 3. These also indicate the highly variable rainfall received during the wet season and almost total absence of rain in the dry season. When the rainfall data were aggregated (somewhat arbitrarily) into 'dry season' and 'wet season' categories, it was clear that the overall average dry season rainfall has fallen quite substantially in recent decades (Figure 4), while the wet season average rainfall appears to have risen slightly in Figure 5.

Figure 3: Long-term trend in monthly rainfall over the period 1952 to 2011 at Dili Airport.

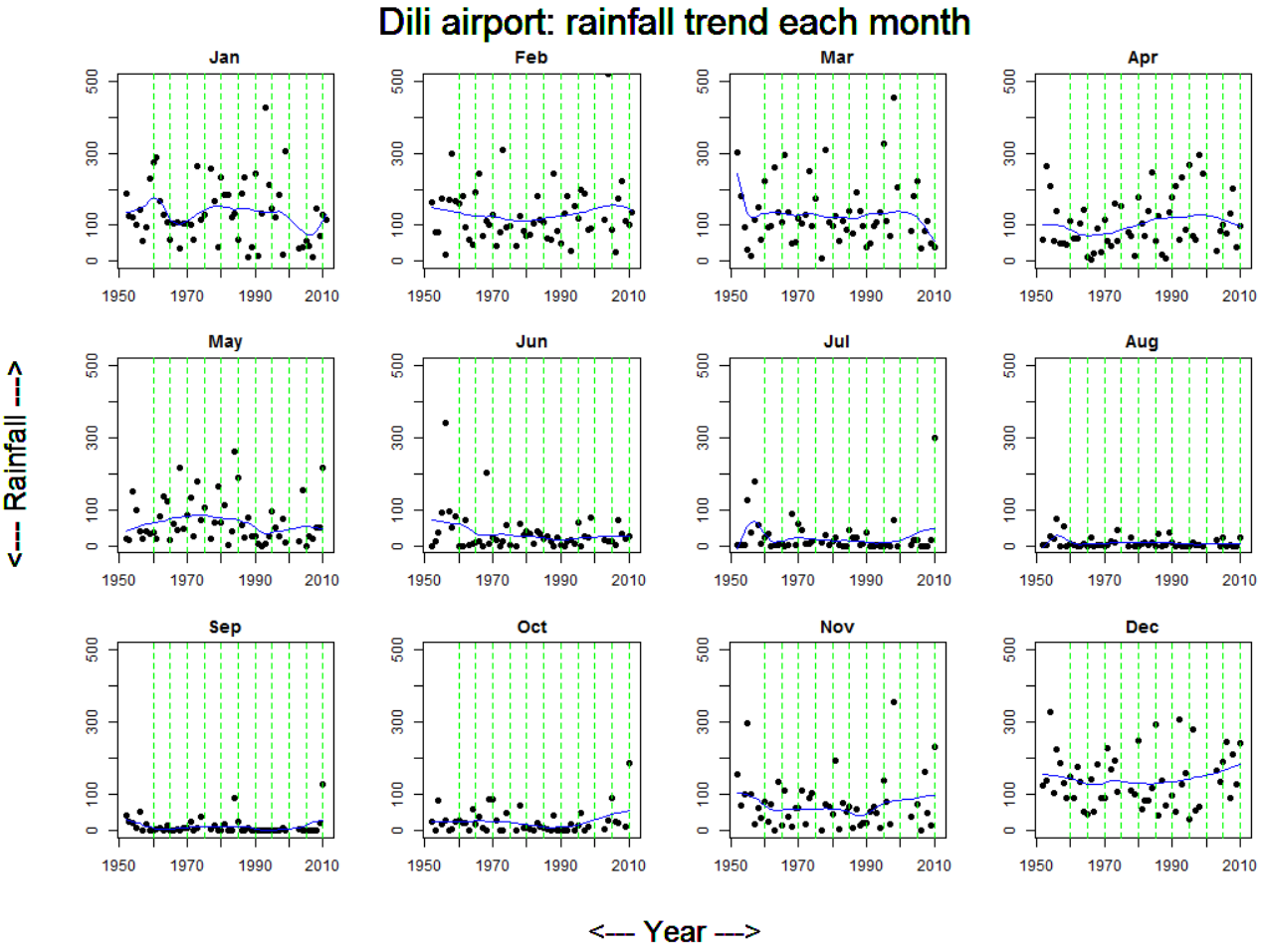


Figure 4: Dry season rainfall at Dili airport 1952–2011. 1975 = Independence from Portugal and 2002 = end of war with Indonesia.

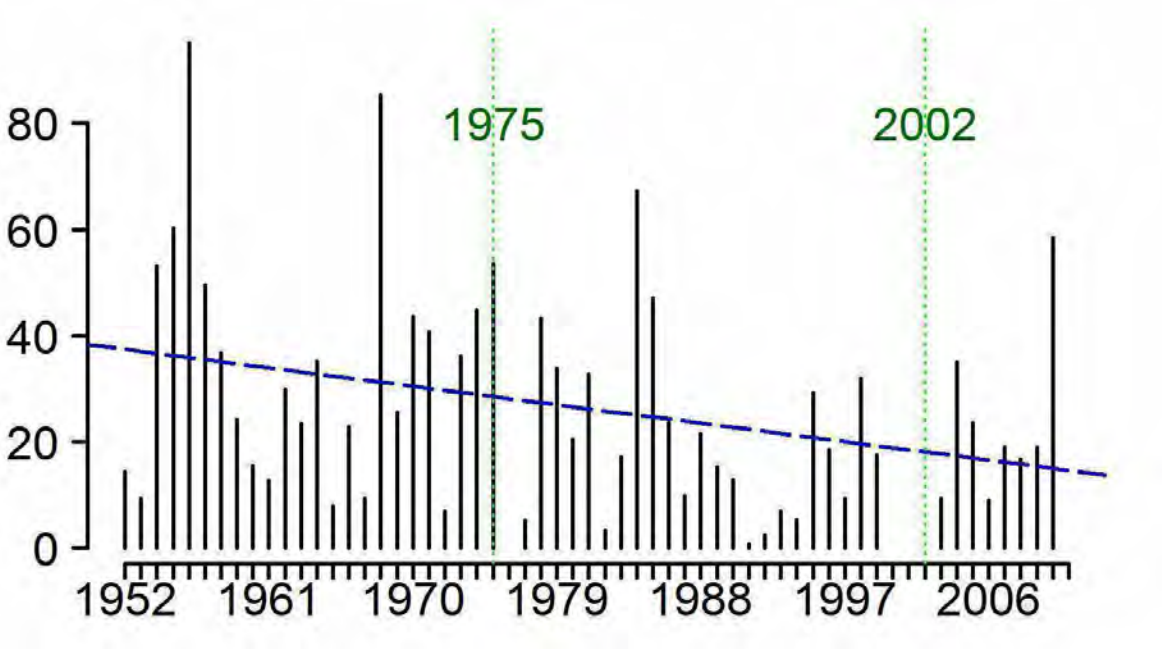
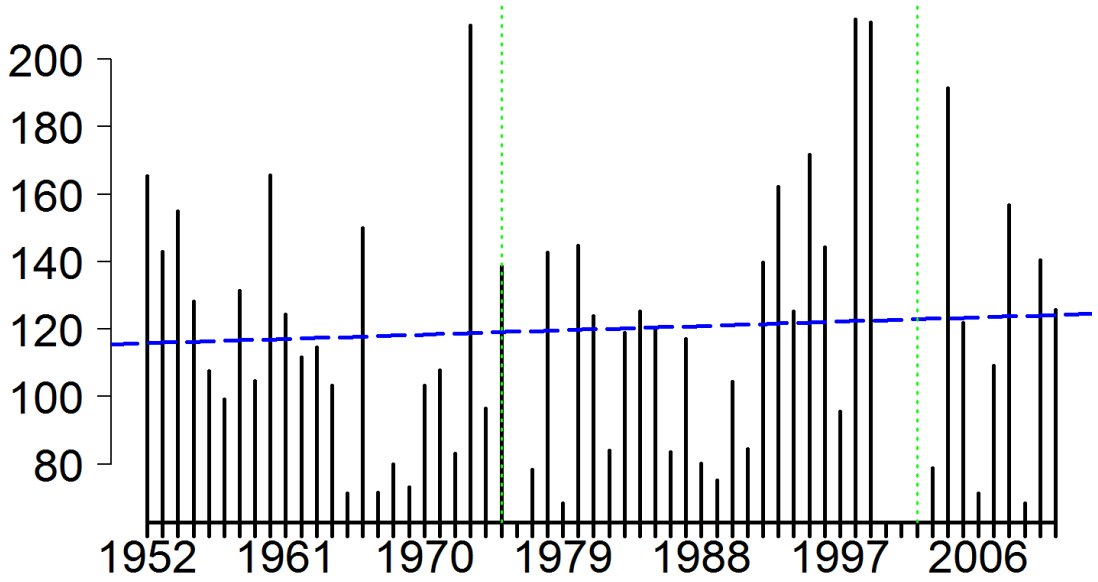


Figure 5: Wet season rainfall at Dili Airport 1952–2011



7. Predictions from the regression (GAM) described above, are plotted in Figure 6 and Figure 7. The time-series modelled data in Figure 5, suggest that rainfall has been relatively constant in Timor-Leste since 1952. However, when the same data is plotted as a 3D 'surface plot' (**Error! Reference source not found.**, it is possible to discern changes in the shape and timing of the seasonal cycle in precipitation. The red area in this plot represents the dry season, and the contour lines (also referred to as isoline) show gradients or change in observed monthly rainfall. From the contour lines it is possible to see that in more recent decades, the airport site has started to receive less than 20 mm of rainfall around mid-June each year. This contrasts with rainfall levels from the middle of the 1960s, when monthly rainfall of less than 20 mm did not tend to occur until early August.

8. These same modelled data are re-examined again in Figure 7 in which seasonal cycles from the model output have been extracted for the years 1960, 1975, 2002, and 2011. These plots simply clarify the interpretation of Figure 6 described above. In the 1960s and mid 1970s the driest period focused on the months of August, September, and October. More recently (2002 and 2011) June and July have been equally as dry. This suggests that, on average, the start of the dry season (as defined by a monthly rainfall level of 20 mm), has shifted from the start of August to mid-June (i.e., approximately 45 days) over the past 60 years.

Figure 6: - Modeled data for rainfall at Dili Airport (1952–2011) plotted as a time series (top) and 3D surface (bottom)

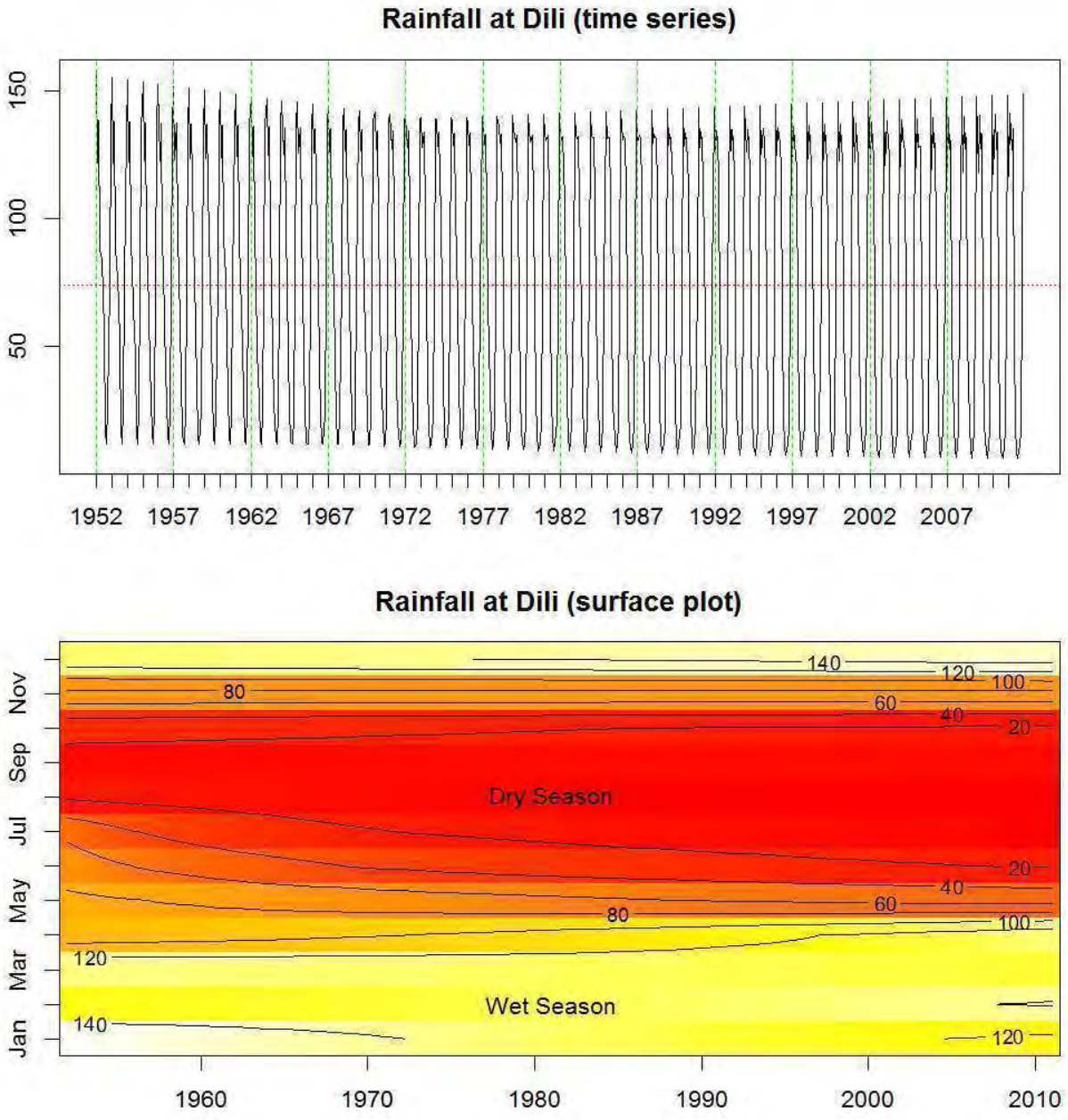
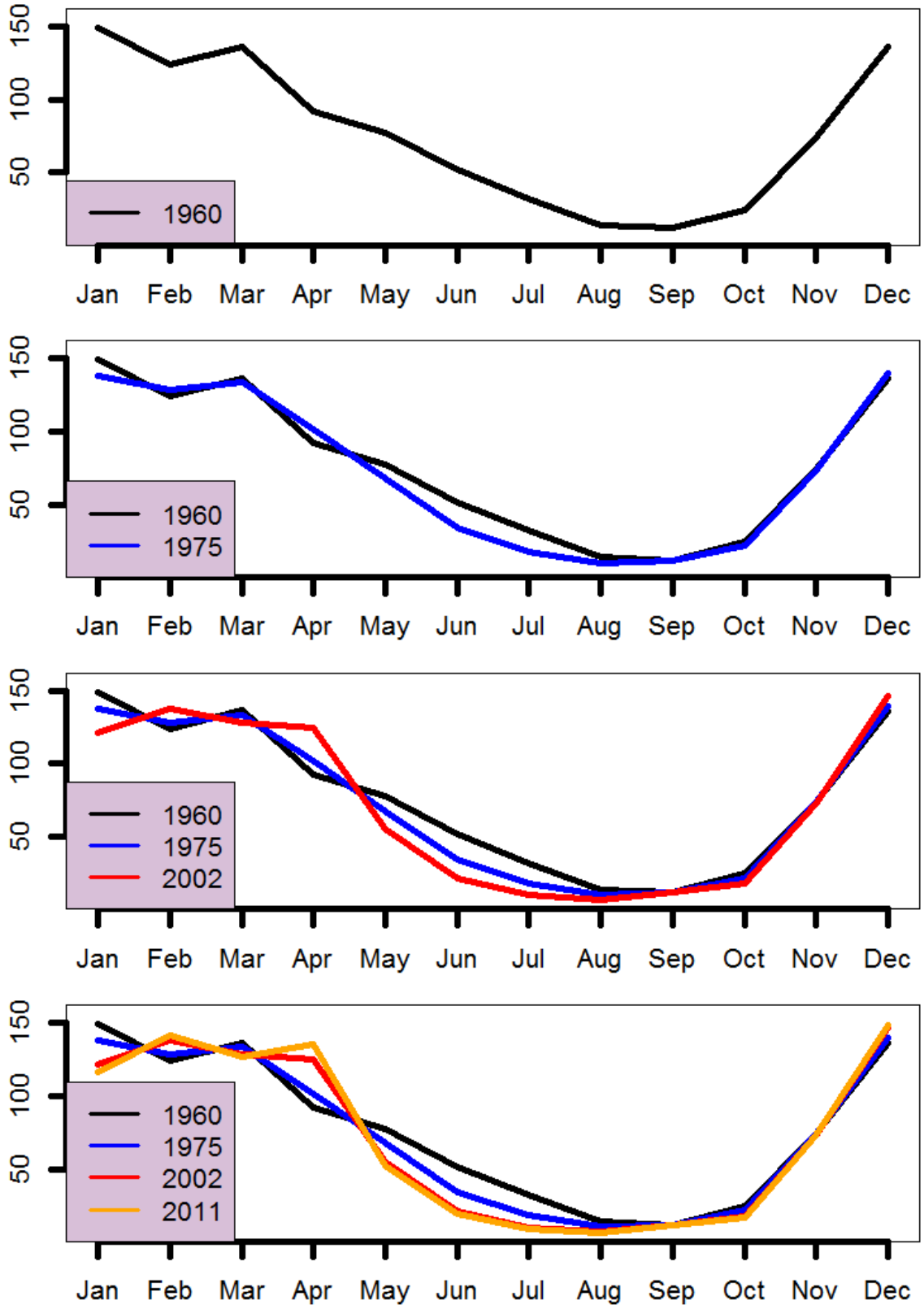


Figure 7: Modelled monthly rainfall data at Dili Airport. Note that seasonal cycles have been extracted for the years 1960, 1975, 2002, and 2011 using model 4 above



1. Temperature

9. Temperature has risen dramatically at Dili Airport between 1952 and 2011 (Figure 8). In 1952 the median temperature was 26.9 ^{o}C while in 2011 it was 28.55 ^{o}C, an increase of nearly 2 ^{o}C during this 60 year period. The average seasonal cycle in temperature (Figure 9) shows a tendency for it to be warmer during the wet season and cooler during the dry season months. Median January temperatures were 27.4 ^{o}C, while August, the coolest month, had a median temperature of 24.65 ^{o}C.

Figure 8; Long-term change in temperature at Dili Airport 1952-2011

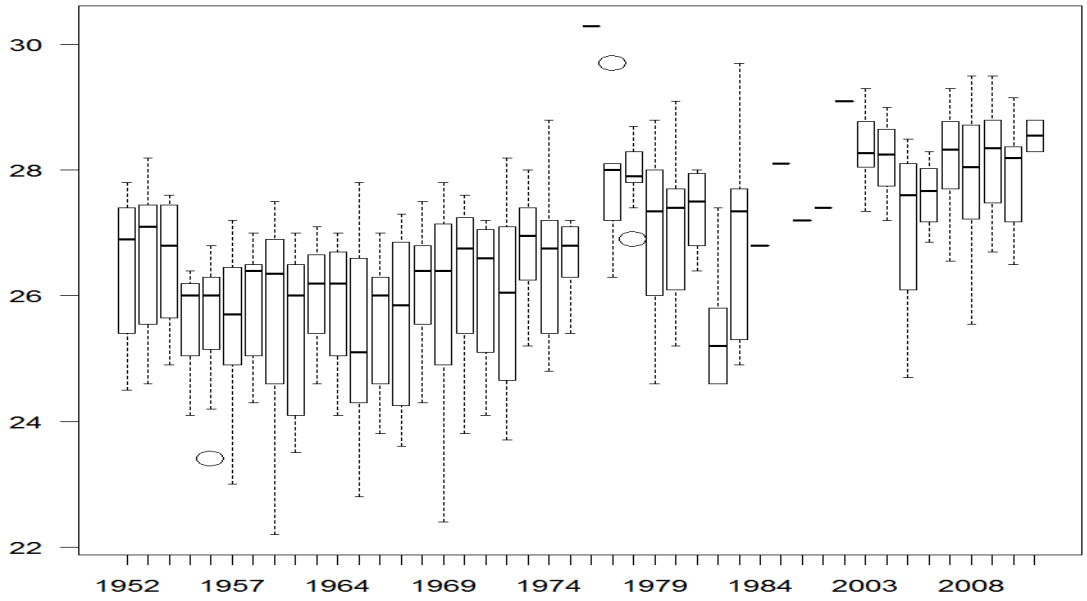
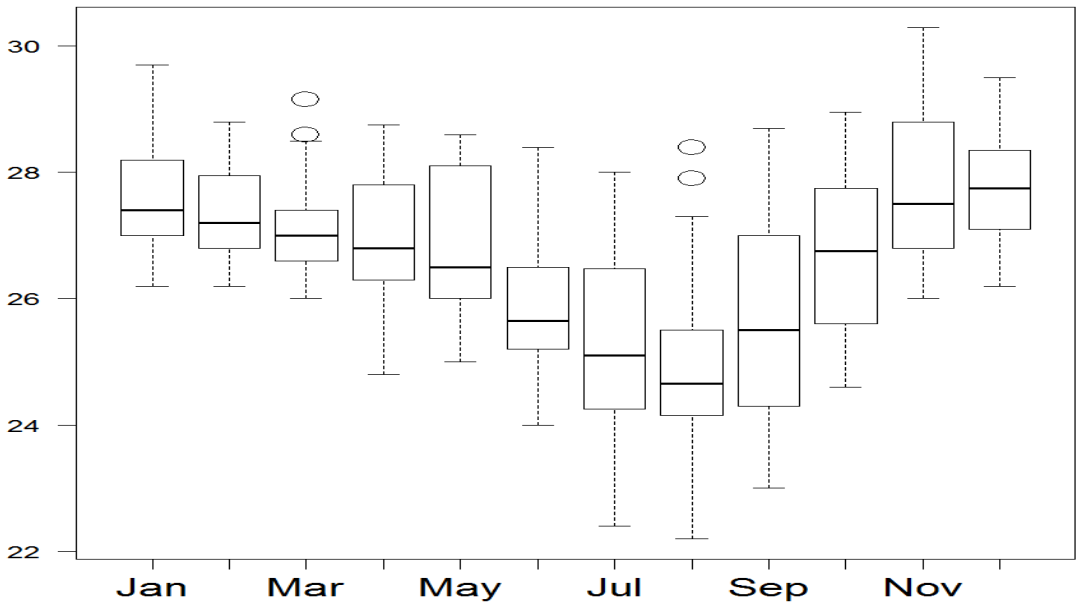


Figure 9: Average seasonal change in temperature at Dili Airport based on available data between 1952 and 2011*



*The horizontal black lines show the median, the third quartiles are defined by the top and bottom of each box. The whiskers are the maximum and minimum, and the open circles are 'outliers' that may require 'special attention'. See http://msenux.redwoods.edu/math/R/boxplot.php.

2. Air and sea temperatures from the Exclusive Economic Zone (EEZ) of Timor-Leste

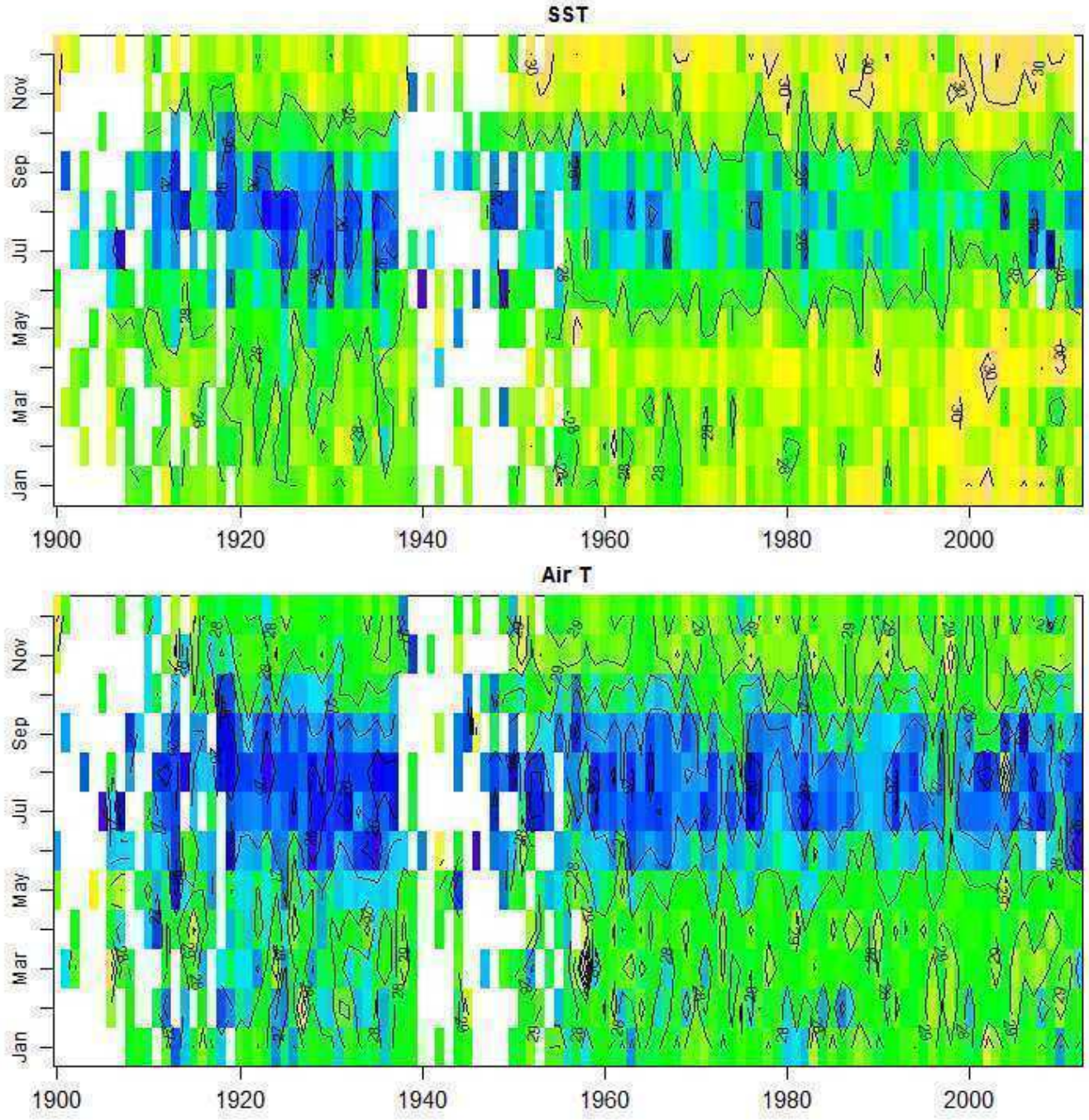
10. Averages of air and sea-surface temperature for Timor-Leste (obtained from the ICOADs dataset) were calculated and plotted as 3D surfaces in Figure 10. It is evident from these plots that the duration of the cooler season (blue) has contracted between 1900 and the present data for both sea surface temperature (Figure 10, top) and air temperature (Figure 10, bottom). This has clearly coincided with an expansion in the warmer season (green and yellow) for both air and sea surface temperatures. When the same sea surface data were plotted by month (**Figure 11**), and the trends are summarized using the 'supsmu' smooth function (solid red line), it clearly shows a trend for increasing marine temperatures (sea surface and air temperature) over the past century, across almost all months.

11. In summary, the temperature data from Dili Airport (terrestrial station) and ICOADs (marine locations) are supportive of each other. Terrestrial air temperatures show an increasing long-term trend, generally over all months, which is supported by similar increasing long-term trends recorded over the marine area. Sea surface temperatures also show increasing annual trends both when examined overall and by individual months. The terrestrial and marine data show that, on average, both air and sea surface temperatures are cooler during the dry season compared to the wet season.

12. It is clear from **Figure 2** and Figure 9 that seasonal patterns in temperature (both terrestrial and marine) are positively correlated with each other. One might assume from this that one drives the other; if it rains heavily it should then be warmer, and similarly, if it is dry, then it should be cooler. Our data show, however, that over the long-term, precipitation during the dry season has declined while temperatures have increased (Figure 4 and Figure 8). The findings imply that precipitation and temperature are positively correlated over the seasonal cycle, but negatively correlated over the longer term. This may suggest wider meteorological changes caused by climate change. In future work, rather than exploring each time-series dataset separately, we will find methods to examine them simultaneously, thereby exposing the connection between precipitation and temperature in more detail.

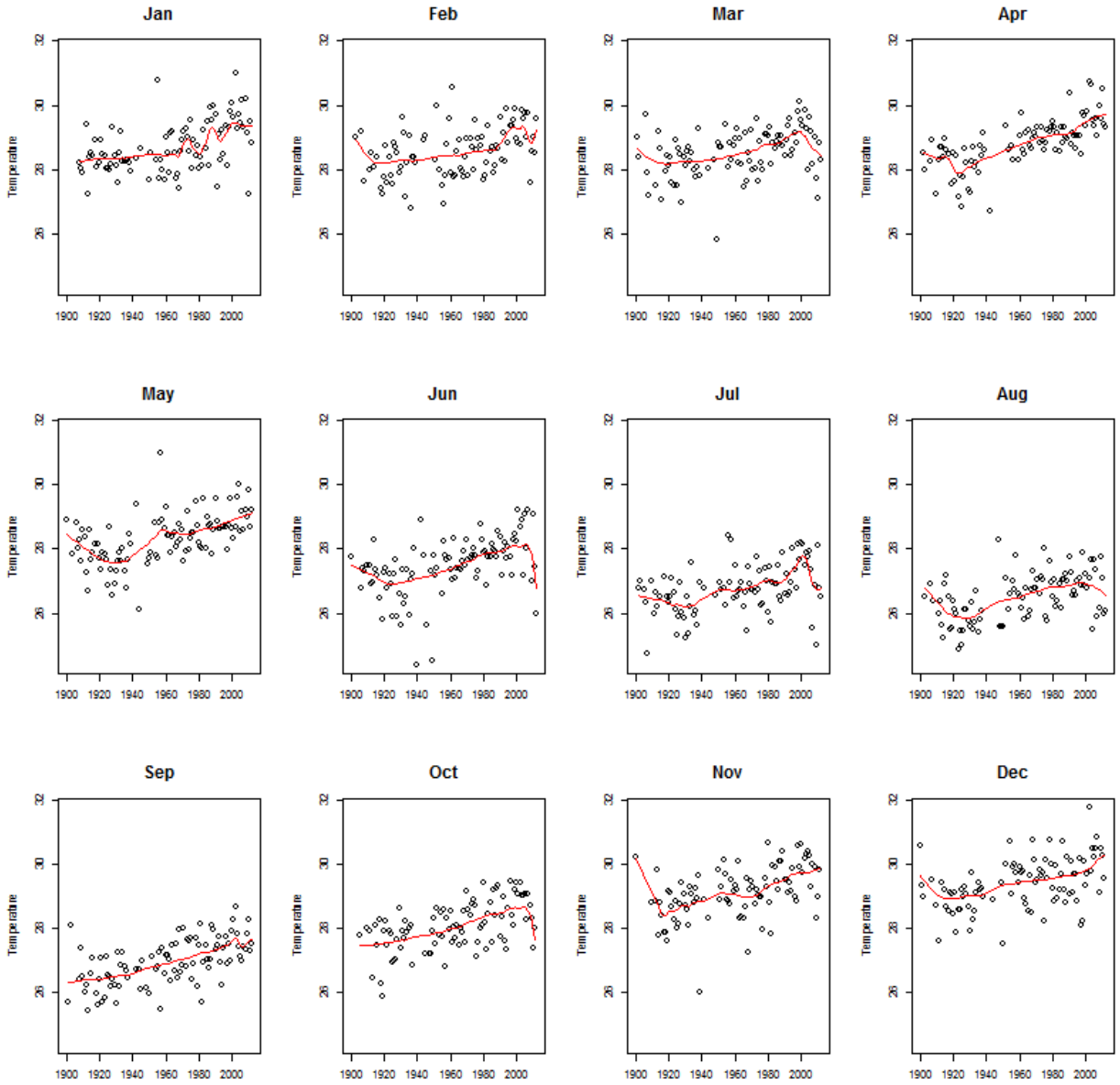
13. With an increase in the duration of the dry season being observed in rainfall data over the past 60 years, the relatively cooler period in the year may therefore be expected to similarly increase. However, while there has been a shift to a longer cooler period within the year, the absolute temperatures during this cooler period have increased in absolute terms. Thus, inter-annual warmer period temperatures experienced a couple of decades ago, may become more redolent of cooler period temperatures as the trend for increasing absolute temperatures continue into the future.

Figure 10: Average sea surface (top) and air temperature (bottom) in Timor-Leste's EEZ between 1900 and 2012*



*Blue indicates cooler periods and green and yellow indicates warmer periods.

Figure 11: Change in average sea surface temperature by month between 1900 and 2012*



*Red line shows the supsmu (op cit) smoother function.

3. Climate change projections

14. Projections of climate change for Timor-Leste were obtained from the Australian Bureau of Meteorology and CSIRO (2011). Key projections relative to farming and fishing activities in Timor-Leste have been summarised in Table 2. This table also includes summary findings from the trend analysis conducted above on observed climate data for Dili Airport. To avoid unintentionally suggesting that past trends are attributable to long-term climate change, we collectively refer to these projections and observed trends as 'changing climate issues'.

Table 2: List of historic trends in climate and climate change projections for Timor-Leste (collectively referred to as 'changing climate issues')

Changing climate issue	Source
Early start to the dry season	Climate trend analysis (Section 3.2.1)
Reduced quantity of rainfall in the dry season	ABoM & CSIRO (2011)
Shorter wet season (because of longer dry season)	Climate trend analysis (Section 3.2.1)
Longer dry season	Climate trend analysis (Section 3.2.1)
Increased quantity of rainfall in the wet season	ABoM & CSIRO (2011)
Increase in the intensity of rainfall	ABoM & CSIRO (2011)
Increase in surface air temperature and sea-surface temperature	ABoM & CSIRO (2011)
Rise in sea level	ABoM & CSIRO (2011)

15. When the trends identified in the climate analysis are compared to corresponding climate variables in the projections of climate change (ABoM & CSIRO, 2011), there is a high degree of conformity (Table 3).

Table 3: Correspondence of trends in climate identified in analysis in Section 3.2.2 and climate change projections

Trend analysis	Projections of climate change (ABoM & CSIRO, 2011)
Long-term trend in annual rainfall has been relatively stable over the past 60 years	Little change in total annual rainfall over the course of the 21st century.
Average dry season rainfall has fallen quite substantially in recent decades	Reduced quantity of rainfall in the dry season
Average rainfall in the wet season has perhaps risen slightly	Increased quantity of rainfall in the wet season
On average, the start of the dry season (as defined by a monthly rainfall level of less than 20 mm), has shifted approximately 45 days earlier over the past 60 years.	No projections given for the onset of the dry season, however it is noted that El Niño events generally bring drier conditions to Dili and often lead to a late onset and early finish to the wet season. "There is no consistency in projections of future ENSO activity."
There is a tendency for terrestrial air temperatures to be warmer during the wet season, than in the dry season months.	No projections provided for monthly temperatures.
The duration of the cooler season has contracted between 1900 and the present day for both sea surface and air temperature. This has coincided with an expansion of the warmer season in marine temperatures.	Increase in inter-annual surface air temperatures (and sea-surface temperature)
Marine temperatures (sea surface and air temperature) have increased over the past century, across almost all months.	Increase in annual surface air temperature (and sea-surface temperature)

B. Stakeholder participatory workshops in Timor-Leste

16. Community workshops were held in Atauro and Batugade in August 2012. A previous study had identified decision makers in the Atauro and Batugade communities that were important in decision-making for successful implementation of interventions relating to nature resource management (Abernethy et al., 2012). This group of actors were invited to the community workshops.

Activity:	Stakeholder participatory workshop
Aim/Key question:	What are the likely impacts of a change in future climate on key livelihood activities for fishers and farmers in the two focal locations in Timor-Leste, and what adaptation actions may help to reduce negative impacts and capitalize on opportunities?
Brief details of method:	• Identify climate-sensitive livelihood activities and changes in their management in response to changing temperature and rainfall • Consider the above in terms of past trends and projections of future changes in climate (i.e., identify impacts of climate change on livelihoods) • Identify appropriate adaptation strategies and actions • Identify visions of a desirable future for communities to guide their adaptation actions
Key results:	A total of 28 and 46 impacts were identified for farming and fishing activities in Atauro and Batugade, respectively, and some 41 and 49 related adaptation actions. The adaptation actions identified by the community were categorized into broad themes by the project team. For both locations, the underpinning themes relate broadly to improving the resilience of the natural resource base that underpins fishing and farming activities. Local authority level community members identified the following as the adaptation themes they wanted to be evaluated from a social, environmental and economic perspective: <u>Atauro fisheries</u> • Special regulation to enhance the condition of nearshore (coral) fisheries • Enhanced exploitation of deep water fisheries (e.g., through the use of echo sounders and fish aggregating devices (FADS), and also including training and knowledge via courses and overseas trips) <u>Atauro agriculture</u> • Improved collection of water (during the wet season), its storage, and delivery to crops and animals • Enhanced knowledge and training for improved agricultural production techniques <u>Batugade fisheries</u> • Increase ability to fish different species using new technologies and skills • Improve income and food production from non-fishing activities, such as aquaculture <u>Batugade agriculture</u> • Increase production of trees, crops and animals using sustainable agriculture techniques (including training) • Improve income and food production from improved management of water harvesting, storage and distribution

17. The participants were asked to form focus groups according to the main focus of their livelihoods, i.e., fisher, farmer, or local authority. The members of the livelihood focus groups were encouraged to be specific about the likely impacts that may occur to an activity, e.g., name the fish or crop species, and explain how this impact affected their livelihood (i.e., not just that “it will be difficult to plant crops”). Once the exercise was complete, each livelihood focus group presented their findings to the whole workshop, and plenary discussions were facilitated with the aim of allowing all community members’ views to be expressed.

1. Outputs produced from community workshop in Atauro (assessment of impacts of a changing climate and possible adaptation options)

18. Farming related impacts and adaptations. A total of 15 impacts were identified for agricultural activities in response to a future change in climate. These were thought to likely result from an increasingly early start date to the dry season, a decrease in rainfall in the dry season (or the months immediately before and after the dry season), an increase in rainfall in the wet season and an increase in the intensity of rainfall. Two further impacts were identified for non-specific changes in climate. A total of 24 adaptations were identified for the above impacts on agriculture. In many cases the adaptation actions suggested were already being practiced in some form or another. However, in some instances the adaptation options put forward by the community were more aspirational in nature. When these were categorized in terms of adaptation themes (Table 4), nearly two-thirds (64%) of the suggested adaptations (namely, themes A, A(i), A(ii), and D) were specifically related to practices that could be described as sustainable agriculture (Box 1).

Table 4: Themes identified from the adaptations associated with agriculture in Atauro, and the number of actions falling into each theme

Code	Theme	Count
A	Adaptations aimed at combining (a) improved collection of water (during the wet season), storage of water, and deliver of water to crops and animals; (ii) improved use of sustainable agriculture practices (including the use of new crop species and varieties with increased tolerance to drier conditions), and (iii) improved use of agricultural practices with increased suitability to drier conditions.	4 (17%)
A(i)	Adaptations specifically aimed at improved collection of water (during the wet season), storage of water, and delivery and use of water for crop and animal production	9 (36%)
A(ii)	Adaptations specifically aimed at improved management of soil resources for agricultural production, with an emphasis on enhancing soil nutrients and capacity to retain soil moisture, improving pest management, improving soil drainage, and improving the management (e.g., corralling for containment and manure collection) of animals	2 (8%)
B	Adaptations aimed at improved ability to purchase and store food	3 (13%)
C	Adaptations aimed at improving the effectiveness of services provided to support farmers in making changes to their agricultural practices	1 (4%)
D	Adaptations aimed at improving land management practices (including reforestation and agricultural practices, with increased emphasis on erosion control)	3 (13%)
E	Adaptations based on fishing-related activities	2 (8%)

Box 1 - Sustainable Agriculture

Sustainable agriculture is based on the use of farming practices that are underpinned by the principles of ecology (i.e., the study of relationships between organisms and their environment). Sustainable agriculture has been defined as "an integrated system of plant and animal production practices having a site-specific application that will last over the long term. It is consider to do this through: (a) satisfying human food and fibre needs; (b) enhancing environmental condition and function and the natural resource base on which the agricultural economy depends; (c) making the most efficient use of non-renewable resources and on-farm resources and integrates, where appropriate, natural biological cycles and controls; (d) sustaining the economic viability of farming activities, and enhancing the quality of life for farmers and society as a whole (US Congress, 1990). Many of the practices used in permaculture (an agricultural production approach widely known about in both Atauro and Batugade) have a similar ecological underpinning to sustainable agriculture. The types of activities undertaken include permanent agriculture as an alternative to shifting cultivation (e.g., slash and burn), the integration of trees and agro-forestry into the production system, activities to increase soil fertility (e.g., legume crops, mulch, compost, fertilisers and the use of manure) and reduce erosion (e.g., contour lines), integrated pest management, crop diversity and rotations, and seed saving. Many of these activities are described in Live & Learn Environmental Education (2011).

19. Fishing related impacts and adaptations. A total of 13 impacts were identified for fishing activities in response to a future change in climate. These were thought to likely result from an increasingly earlier start date for the dry season, an increase in surface air temperature (and sea-surface temperature), increase in rainfall in the wet season, trend for a longer dry season, projected increase in sea level, and trend for a shorter wet season. A total of 17 adaptations were identified for the above impacts on fishing. Similar to the agricultural adaptations suggested by the community members, in many cases the adaptations for fisheries were already being practiced in some form or another, although there were a number of adaptation options put forward that were more aspirational in nature (e.g., fish aggregating devices [FADs]). Table 5 shows the Project Teams' categorization of these adaptations in terms of themes.

Table 5: Themes identified from the adaptations associated with fishing in Atauro, and the number of actions falling into each theme

Code	Description	Count
A	Adaptations aimed at increasing fishing activity (non-specific to nearshore or	1 (6%)
A(i)	Adaptations focused on increased exploitation of deep water fisheries, through: (a) enhanced technical capability (e.g., fish aggregation devices); (b) knowledge and skills training; and (iii) alternative techniques.	5 (28%)
A(ii)	Adaptations specifically aimed at continuing the exploitation of nearshore	2
B	Adaptations specifically aimed at improved the health and condition of nearshore (coral) fisheries through regulation	1 (6%)
C	Adaptations aimed at fishing-related land based (e.g., mending gear, drying fish, collecting and drying seaweed) activities	3 (17%)
D	Adaptations based on relocation of communities or fishing infrastructure	1 (6%)
E	Adaptations specifically aimed at revegetation for coastal protection	1 (6%)
F	Adaptations aimed at non-fishing-related activities (e.g., agriculture, trading)	3
G	Adaptations aimed at educating community members in relation to climate	1 (6%)

20. Table 6 shows the adaptation themes identified by the small groups of local authority-level decision makers related either to agriculture or fisheries, as being the most appropriate for evaluation by the Project Team from a social, environmental and economic perspective.

Table 6: Adaptation themes for Atauro

Sector	Adaptation theme
Fisheries	Special regulation to enhance the condition of nearshore (coral) fisheries
	Enhanced exploitation of deep water fisheries (e.g., echo sounders and FADS, and also including training and knowledge via courses and overseas trips)
Agriculture	Improved collection of water (during the wet season), its storage, and delivery to crops and animals
	Enhanced knowledge and training for improved agricultural production techniques

2. Outputs produced from community workshop in Batugade (assessment of impacts of a changing climate and possible adaptation options)

21. Farming related impacts and adaptations. A total of 35 impacts were identified for agricultural activities in response to a future change in climate. These were thought to likely result from an increasingly earlier start date for the dry season, a longer dry season, a hotter dry season, a decrease in rainfall in the dry season (or the months immediately before and after the dry season), an increase in the amount of rainfall in the wet season, an increase in the intensity of rainfall and a shorter wet season.

22. A total of 32 adaptations were identified for the above impacts on agriculture. In many cases the adaptation actions suggested were already being practiced in some form or another and the focus was on extending or enhancing the present practices (e.g., the capture, storage and distribution of water from the river). However, in some instances the adaptation options put forward by the community were more aspirational in nature (e.g., increased knowledge for improved decision making, and selling surplus produce at Dili and local markets). When the ideas for adaptations were categorized into themes (Table 7), nearly one third (31%) of them are related to managing water for human consumption or animal and crop production. The second most common (21%) theme is related to actions aimed at improving the effectiveness of services provided to support farmers in making changes to their agricultural practices (including access to new varieties, providing information and training).

Table 7: Themes identified from the adaptations associated with agriculture in Batugade, and the number of actions falling into each theme

Code	Theme	Count
A	Adaptations aimed at combining (a) improved collection of water (during the wet season), storage of water, and deliver of water to crops and animals; (ii) improved use of sustainable agriculture practices (including the use of new crop species and varieties with increased tolerance to drier conditions), and (iii) improved use of agricultural practices with increased suitability to drier conditions.	0 (0%)
A(i)	Adaptations specifically aimed at improved collection of water (during the wet season), storage of water, and deliver of water to crops and animals	9 (31%)
A(ii)	Adaptations specifically aimed at improved use of agricultural practices with increased emphasis on enhancing soil nutrients and capacity to retain soil moisture, improving pest management, improving soil drainage, improving perennial crops, and improving the corralling of animals	4 (14%)
B	Adaptations aimed at improved food storage or increasing access to food (i.e., purchasing)	4 (14%)
C	Adaptations aimed at improving the effectiveness of services provided to support farmers in making changes to their agricultural practices (including access to new varieties, providing information and training)	6 (21%)
D	Adaptations aimed at improving land management practices (including reforestation and agricultural practices with increased emphasis on erosion control)	3 (10%)

Code	Theme	Count
E	Fish-related activities (e.g., fishing or aquaculture)	3 (10%)

Note: Themes and codes used for Batugade have been aligned to those for Atauro to enable comparisons to be made.

23. Fishing related impacts and adaptations. A total of 11 impacts were identified for fishing activities in response to a future change in climate. These were thought to likely result from an increasingly earlier start to the dry season, a hotter dry season, less rainfall in the dry season, increase in the intensity of rainfall, projected increase in sea level, trend for a shorter wet season, and the projection for more rain in the wet season. A total of 17 adaptations were identified for the above impacts on fishing. Similar to the agricultural adaptations suggested by the community members, in many cases the adaptations for fisheries were already being practiced in some form or another (e.g., fishing in Indonesian waters). Interestingly, nearly half (44%) of the adaptation options suggested related to non-fishing activities, including agriculture and aquaculture. Table 8 shows the Project Teams' categorization of these adaptations in terms of themes.

Table 8: Themes identified from the adaptations associated with fishing in Batugade, and the number of actions falling into each theme

Code	Description	Count
A	Adaptations aimed at increasing fishing activity (non-specific to nearshore or deep water), which may include support services, education and training and credit	4 (25%)
A(i)	Adaptations focused on increased exploitation of deep water fisheries, through: (a) enhanced technical capability (e.g., fish aggregation devices); (b) knowledge and skills training; and (iii) alternative techniques	2 (13%)
A(ii)	Adaptations specifically aimed at continuing the exploitation of nearshore (coral) fisheries	0 (0%)
B	Adaptations specifically aimed at improved the health and condition of nearshore (coral) fisheries through regulation	1 (6%)
C	Adaptations aimed at fishing-related land based (e.g., mending gear, drying fish, collecting and drying seaweed) activities	0 (0%)
D	Adaptations based on relocation of communities or fishing infrastructure	1 (6%)
E	Adaptations specifically aimed at revegetation for coastal protection	1 (6%)
F	Adaptations aimed at non-fishing-related activities (e.g., agriculture, trading)	7 (44%)
G	Adaptations aimed at educating community members in relation to climate change	0 (0%)

24. Table 9 shows the adaptation themes identified by the small groups of local authority-level decision makers related either to agriculture or fisheries, as being the most appropriate for evaluation by the Project Team from a social, environmental and economic perspective.

Table 9: Adaptation themes for Batugade

Sector	Adaptation theme
Fisheries	Increase ability to fish different species using new technologies and skills
	Improve income and food production from non-fishing activities, such as aquaculture
Agriculture	Increase production of trees, crops and animals using sustainable agriculture techniques (including training)
	Improve income and food production from improved management of water harvesting, storage and distribution

C. Evaluation of adaptation strategies from an economic perspective using decision-tree analysis and partial cost-benefit analysis

Activity:	Decision tree analysis and partial cost-benefit analysis
Aim/Key question:	What are the key decisions and design steps that need to be taken in order to progress an idea for adaption through to its implementation, and set it up for on-going iterative management? Given a range of possible designs for an adaptation strategy (produced above), what are the relative partial costs and benefits of each one?
Key stages in method:	Identify key decisions and design steps that need to be taken for each adaptation strategy and the full permutation of decision pathways that could be taken. Identify the costs and benefits associated with each decision and design stage to produce a partial cost-benefit analysis.
Key results:	<u>Atauro</u> • Fuel cost is the most important annualized cost items reported by fishers in Atauro Island. • Traditional fishing and modern net fishing methods are viable adaptation options if appropriate regulation systems (formal and informal) are strengthened. • Comparative advantage and effectiveness of offshore fishing methods such as fish aggregating devices (Rumpong), pull landline and longline are unclear because they are subject to high uncertainty regarding climate change factors and availability of fisheries stocks in deep waters. • Pool landline, longline, and Rumpong fishing methods cannot be economically efficient fishing methods if operated in isolation, but can be integrated with other fishing methods to improve fisheries yields. <u>Batugade and inland communities in Balibo sub-district</u> • Aquaculture may be a viable adaptation to increase income and food production for poor local communities in Batugade and other villages in Balibo, Bobonaro district; • Aquaculture development is associated with issues of land convertibility. Costs associated with land use conversion are unknown so far. • Freshwater fishes are not traded in coastal communities and demand in inland community as well as trading systems haven't been established yet.

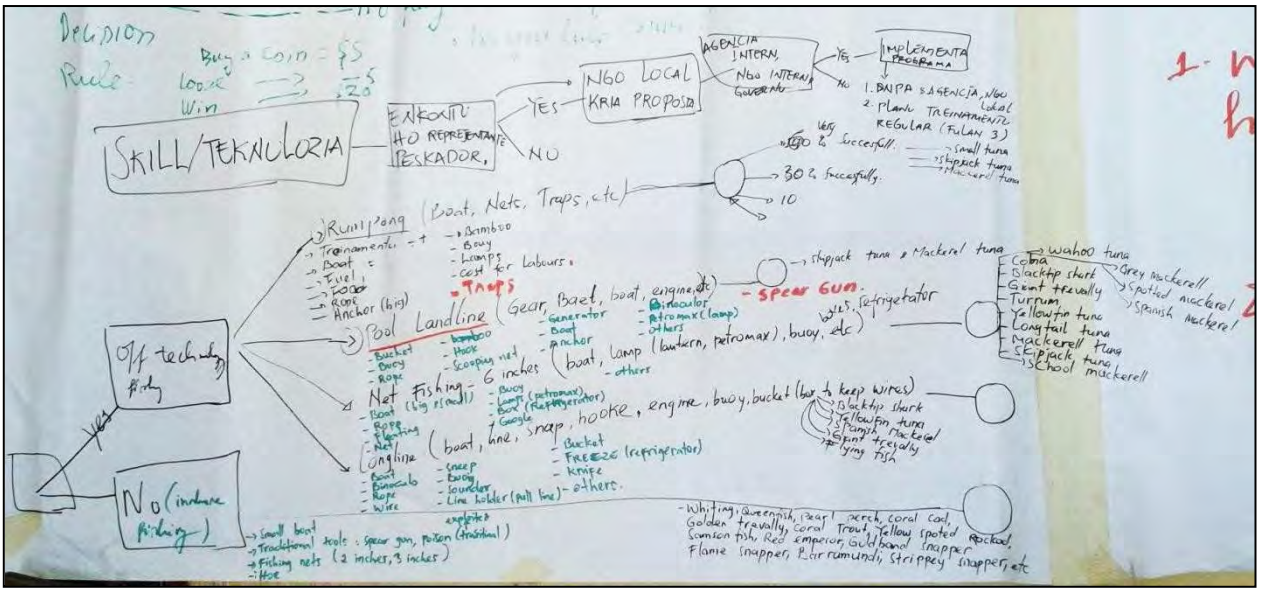
1. Results

a) Atauro

25. **Figure 12** presents a decision tree on offshore fishing adaptation actions developed by participants attending the local authority level meeting held in Vila village, Atauro Island (see Table 61 in the mid-term report appendix for a text version of this figure). The objective of the adaptation strategy is to increase fishers' income by applying alternative fishing methods. As depicted in **Figure 12**, from the root decision, five fishing methods (decision alternatives) were identified by the participants namely:

- explore the rumpong (FAD) fishing method;
- apply the pool landline fishing method;
- apply the modern net fishing method;
- apply the longline fishing method;
- continue the traditional fishing method.

Figure 12: Decision tree for offshore fishing adaptation developed by local authority- level community members during the focus group discussion held in Vila on 14 October 2012



26. For each decision alternative, possible cost items and possible fish species that fishers might catch were identified by meeting participants. Due to time constraints there were no discussion on how climate change might affect decision alternatives and what sequential decisions might be taken, subject to updated information on climate change and other drivers of change. The simple decision tree created in **Figure 12** was used for focus group discussions at community level to calculate partial costs and benefits of each alternative fishing methods chosen by the community.

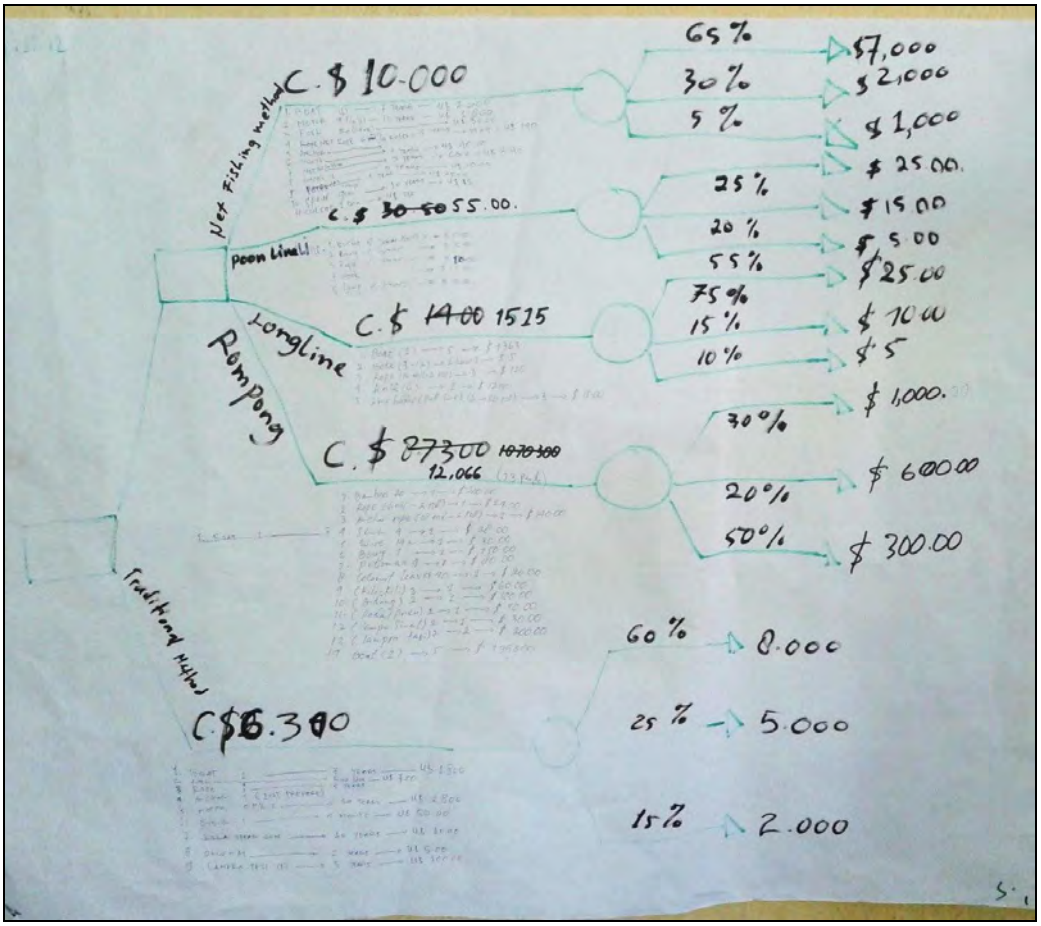
27. Results of partial costs and benefits of alternative offshore fishing methods estimated by fishers groups in Makili and Biqueli villages are presented in Figures 17b and 17c, respectively. Detailed information on cost and benefit for each alternative fishing methods are presented in the mid-term report Appendix 19, Tables 62-66 for Makili village and Tables 67 to 71 for Biqueli village.

28. As presented in Figure 13 and Figure 14, the decision trees developed during the authority level meeting were re-arranged by the fishers to reflect their priorities and experiences. The traditional fishing method is included as the present alternative for comparing with alternative offshore fishing methods (the modern net fishing method, the pool landline fishing method, the longling fishing method, and the rumpong, local name for the FAD fishing method).

29. For fishers in Makili village, among five alternative fishing methods considered, total partial costs of the modern net fishing method and the traditional fishing method options were estimated at $4,105 and $5,600, respectively. Averaging over three possible outcomes (very successful, normal, and unsuccessful fishing years), expected gross benefit (income) of these two fishing methods were at $5,200 and $6,350 per year. Thus, net benefits of these two fishing methods are positive, estimated at $1,095 for the modern net fishing method and $749 for the traditional net fishing method. As presented in Table 62 and Table 66 (Appendix 19 of the mid-term report), for each dollar invested, a net benefit of $0.27 and $0.13 dollars can be expected for the modern net fishing method and the traditional fishing method respectively. In contrast to these two methods, the pool landline, longline and rumpong fishing methods required lower investment costs and also resulted in negative net benefit ratio (Tables 63-65, Appendix 19 of the mid-term report). According to partial costs

and benefits estimates provided by the Makili fishers, the modern net fishing method is the most economically beneficial adaptation decision.

Figure 13: Partial costs and benefits calculated for the decision analysis of alternative offshore fishing methods by fishers in Makili village, Atauro.

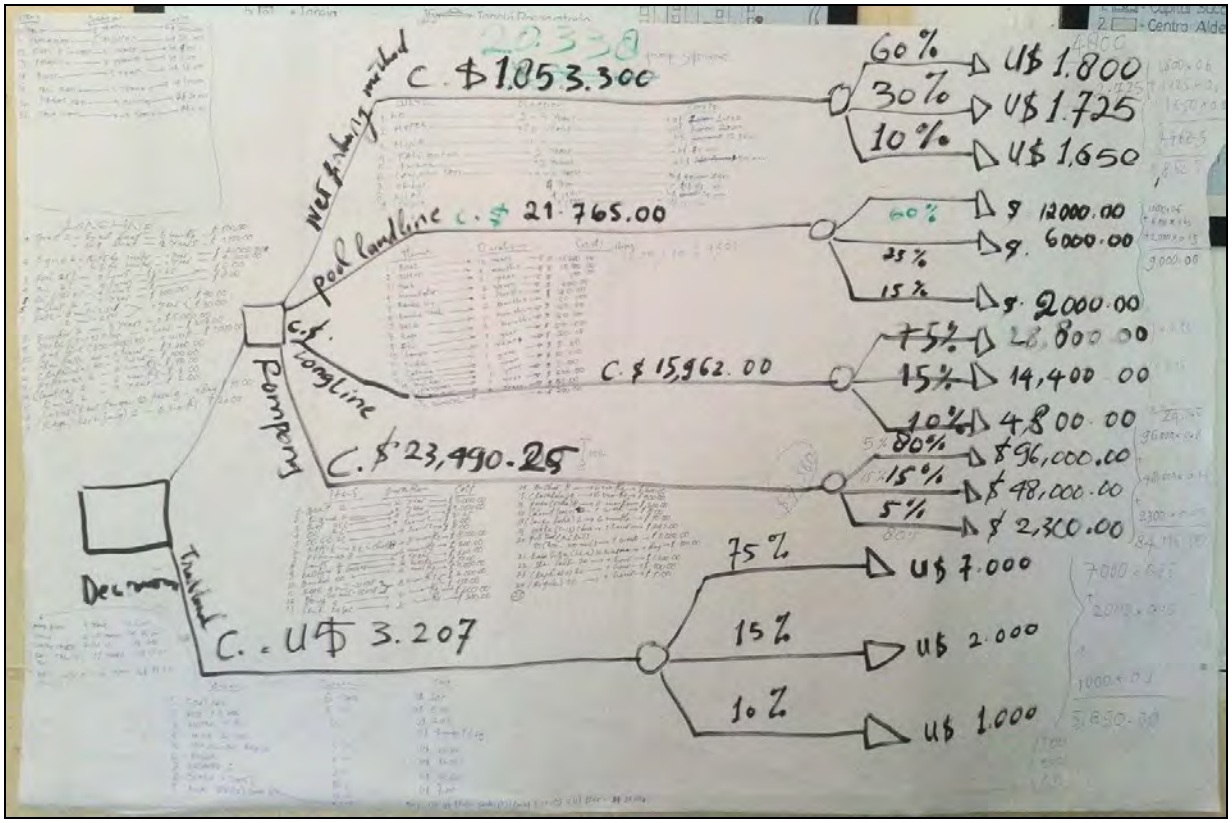


30. Partial costs and benefits estimation for alternative offshore (deep water) fishing methods by fishers in Biqueli village are reported in the mid-term report Appendix 19, Tables 67 to 71. According to the estimates provided by the Biqueli fishers, two fishing methods produced positive net income ratios, these are the longline and traditional fishing methods (with total partial costs estimated at $17,178 for the longline method, and $4,250 for the traditional fishing method). The modern net fishing and pool landline fishing methods have negative net benefit ratios; for each dollar invested in these methods, a net loss of $0.13 and $0.30 are expected.

31. For the rumpong fishing method, total partial cost was estimated at $23,880. Benefit/income from the rumpong fishing method is subjected to fishers perceptions of risks and uncertainties, which were expressed in terms of probability of outcome occurrence (i.e., very successful, normal, and unsuccessful harvest). At first, the group assigned a positive outcome occurrence (80% very successful, 15% normal and 5% unsuccessful) and after discussions the group changed the outcome occurrence belief in the opposite direction. Consequently the net benefit ratio of the rumpong fishing method changed from a negative figure (-$0.69), to a positive one ($2.52). This shows that the rumpong method is sensitive to risks and uncertainties, and is dependent on the expected income fishers can get from this fishing method. Thus, in terms of partial costs and benefits ratio, the traditional fishing

method seems the preferred decision option for fishers in Biqueli, with a total partial cost estimated at $4,250, for each dollar invested, and a net benefit of $0.33.

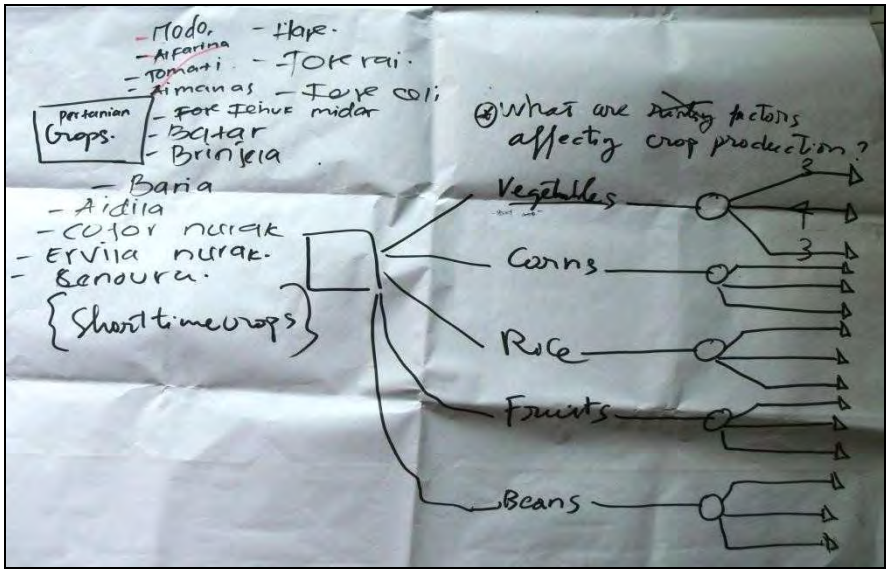
Figure 14: Partial costs and benefits calculated for the decision analysis of alternative offshore fishing methods by fishers in Biqueli village, Atauro



b) Batugade, Balibo sub-district

32. The decision tree developed by participants during the authority level meeting in Batugade on 22 October 2012 is presented in Figure 15. In comparison to Atauro, data and information collection activities in Batugade faced several constraints, including a poorer proficiency of English by the local interpreters. As local farmers were mostly involved in subsistence production, it was not always possible to obtain estimates on income and costs.

Figure 15: Decision tree developed for agriculture crop production evaluation by local authority stakeholders in Batugade 22 October 2012



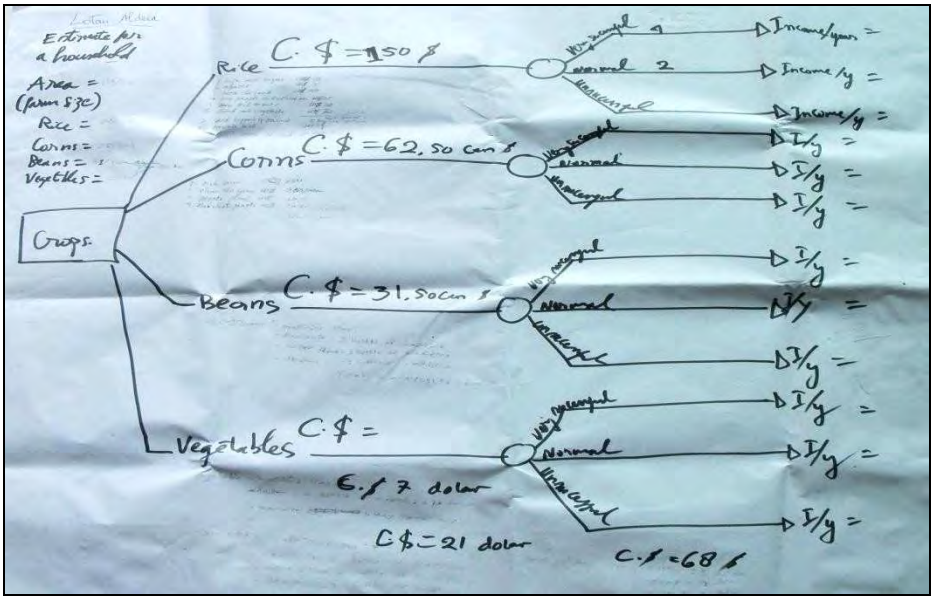
c) Agriculture crop production in Lotan village (suco), Balibo sub-district.

33. A decision tree developed for agriculture crop production evaluation by farmers in Lotan village is presented in Figure 16. The decision tree captures the following decision alternatives:

- rice production;
- corn production;
- long beans production;
- vegetable production.

34. Efforts were made by farmers and facilitators/interpreters to estimate partial costs and benefits for agriculture crop production of an average household in the village with an average farm size of 0.5 ha, including 0.3 ha of rice, 0.2 ha of corns, 0.1 ha of beans and vegetables. Partial costs and benefits data estimated by farmers joining the focus group discussion in Lotan village are reported in the mid-term report Appendix 19, Tables 72-75. Unfortunately partial cost and benefit analysis of agricultural crop production cannot be undertaken due to insufficient data collected, especially with regards to benefit information.

Figure 16: Decision tree for agriculture crop production evaluation developed by farmers in Lotan village (Aldeia), Batugade, Balibo sub-district, Timor-Leste



d) Batugade, Leohito and Batugade villages (suco), Balibo sub-district

35. Key informant interviews and focus group discussion were conducted in Batugade and Leohito villages to collect data and information for partial cost and benefit evaluation of aquaculture development as an adaptation strategy for improving income and food production for local communities. Interviews with two farmers who had already installed pond based fish culture in their gardens revealed that about 4-5 households in the Batugade village had dug ponds for aquaculture currently operating. They estimated that in Batugade there are about 40 households which have rice fields that can be used for developing aquaculture. Aquaculture development however depends on how the early aquaculture adopters perform. Presently freshwater fishes have not been marketed in coastal communities such as Batugade and coastal people have not experienced eating freshwater fishes. Interviewed farmers considered that the potential markets for fresh aquaculture products, are likely to be inland communities such those in Maliana.

36. A focus group discussion was held in Leohito village (aldeia) to assess aquaculture development as an option for income and livelihood diversification in response to climate change. Personal interviews with fish farmers attending the group meeting suggested that there are about 200 households living in the village. On average a household in Leohito has a farm size of 0.8 to1 ha; the largest farms can be 2 ha and the smallest about 0.5 ha. About 20 households in the village have developed ponds for fish culture. Each fish farmers have 2 to 3 fish ponds with a common pond size of 7x10 m, the maximum size of 7 x 15 m; and the smallest pond size is at 5x7 m. The first fish pond was dug in 1982 by the chief of the village. During the 1992-1999 period, all ponds were destroyed and with support from UNDP fish culture was renewed and re-developed since 2001. Land for making fish ponds was originally used for rice production. Farmers produce two rice crops per year. The first rice crop lasts from December to February and the second crop is from March to May. After rice crops, rice field can be used for fish culture.

37. Factors constraining aquaculture development identified by local fish farmers include limited fish breeding capacity, market access, and intensive aquaculture technical know-how. Fish culture was successful during 2006 to 2009 when NGOs came and bought

fingerlings from their aquaculture project participants. During that period, about 10 households in the group were able to sell fingerlings with an estimated fish income of $500-$600/ household/year.

38. A decision tree developed for evaluating aquaculture development by fish farmers attending the group meeting in Leohito village is presented in Figure 17. As shown, there are three alternative decisions farmers considered:

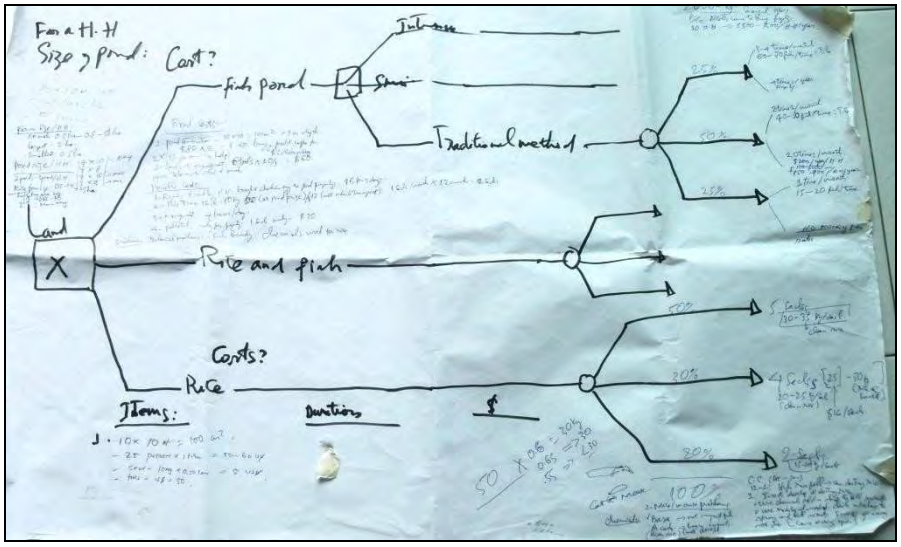
- use land for pond aquaculture;
- use land for rice culture;
- use land for rice and fish culture.

39. For the aquaculture development option, there are three alternative decisions farmers can make:

- develop intensive aquaculture;
- adopt semi-intensive aquaculture;
- practice the traditional aquaculture method.

40. Partial costs and benefits analysis for aquaculture development options are reported in the mid-term report Appendix 19, Tables 76 and 77. The cost and benefit data were estimated for a pond/rice field of 100 m^2.

Figure 17: Decision tree for aquaculture development evaluation developed by fish farmers in Leohito village, Balibo sub-district, Timor-Leste



41. As reported in Table 76 (the mid-term report Appendix 19), annual partial cost for operating a fish pond of 100 m^2 in Leohito village is estimated at $195 and partial gross benefit averaging for very successful, normal, and unsuccessful years were at $250. This results in a net benefit of $55 per year; for every dollar invested in pond fish culture, fish farmers are expected to get a net benefit of $0.28. It is important to note that the benefits accrued to family nutrition as a result of consuming fish are not included in this net benefit estimation.

42. In contrast to fish culture, partial cost for a field of rice approximately 100 m^2, is estimated at $90 and averaged partial net benefit is estimated at $66. Consequently, rice production incurs a net loss of $24; every dollar invested in farming the rice field therefore

results in a net loss of $0.27. It is however noted that partial cost estimated for rice production can be reduced if the cost of buying food and drink for people coming to help with land preparation and harvesting can be limited to only the helper themselves (laborers coming to help with rice production may bring their children along, thereby requiring farmers to buy food and drink for these dependents too).

2. Discussion

43. Adaptation actions and strategies identified by communities, partners and the WorldFish project team for economic evaluation have direct and indirect links to climate change and other drivers of change. As reported by Abernethy et al. (2012) climate change has clearer direct impacts on the agriculture sector and unclear indirect impacts on fisheries. Climate change just adds a compounding factor with other drivers of change such as natural resource depletion, and degradation due to poor management and regulation. Climate change adaptation actions and strategies therefore must be considered in wider social, economic and environmental contexts faced by communities. The concept of adaptation deficit in economic language and thus the concept of no regret adaptation in sociological language are implied in this report.

44. The offshore fishing adaptation strategy in Atauro Island, and sustaining agriculture production and aquaculture development were selected by local participants for decision tree and partial economic analysis. Simple decision trees involving one decision node, one chance node, and one outcome node were developed for the three selected adaptation strategies. By applying the logic of decision tree development, sequential decision trees can be developed sequencing through time scale and climate thresholds, linking identified adaptation actions and strategies together to provide a diagrammatic figure of adaptation implementation structure. While this process requires complex and dedicated social and economic analysis it can provide realistic adaptation implementation scenarios to communities.

45. The results of the offshore/inshore fishing decision tree and partial cost and benefit analysis developed by Atauro fishing communities elaborates the discussion above. The results show that the traditional fishing method and modern net fishing method can both be viable adaptation options given the partial cost and benefit estimations produced. However, sustaining these livelihood activities requires that inshore and offshore fisheries are regulated to ensure that stocks are sustainably harvested. Similarly, offshore fishing technologies such as the rumpong, pull landline, and longline fishing methods also need enhanced informal and formal regulations to regulate behaviors of fishers and related actors. It is also noted that the rumpong fishing method cannot be operated by individual fishers, but must be operated by a group of fishers. This will make decision making, and consequently the decision tree and economic analysis associated with this adaptation option more complex, and not unlike many other joint decisions faced by communities.

46. In communities in Balibo sub-district, such as Batugade and Leohito, most of the farmers carry out subsistence production and do not have much experience with market-oriented production systems. Many products, including agriculture products and farmed fish, are grown for family consumption, with only a limited amount traded in local markets. In those cases where products are traded, they tend not to be sold by weight but by a local measuring system, such as a sack or a barrel, per fish, or a string of fish. In the case of maize, a sack can be sold for $30; and a big barrel of maize (1.5 m length x 0.6 m diameter) can be sold for $70. Where these situations exist, limited costs and benefit data can be collected for partial cost and benefit analysis.

47. As a traditional way of growing livestock, local people in Batugade regularly allow farmed animals, such as pigs and goats, free-range and remain un-tethered. Local people

do not feed livestock and livestock have to go around finding food. Many problems are associated with this way of livestock farming such as the destruction of crops. Livestock management practices can be adapted to sustain agriculture crop production and boost yields (see the mid-term report Section 4.8).

48. The results of partial cost and benefit analysis of aquaculture development option previously discussed above suggest that aquaculture might be a viable adaptation option to increase income and food production for poor local communities in Batugade and other villages in Balibo, Bobonaro district. However, aquaculture development is associated with land convertibility issues. Costs and benefits associated with this conversion are not completely known so far. Similarly which villages and which households have suitable land for aquaculture development are also unknown and need to be carefully assessed. Aquaculture development might face social acceptability and market access constraints. If aquaculture development is to be realized, feasibility studies (considering economic, social and environmental aspects) need to be undertaken.

3. Conclusion

49. The decision tree analysis and partial cost and benefit analysis methods were used to evaluate climate change adaptation actions and strategies identified by local communities in Atauro Island and Batugade. By adopting the participatory evaluation approach, communities were provided with a method for building capacity for planning and implementing adaptation actions in response to climate change. The decision tree approach helped in-country partners and farmers understand what adaptation actions and strategies look like and what is the relative cost and benefit associated with alternative decision pathways if they are chosen for implementation. Partial cost and benefit analysis implies the use of rapid data collection techniques and analysis method to provide communities with cost and benefit data associated with selected adaptation actions.

D. Evaluation of adaptation strategies from a social perspective using social network analysis

Activity:	Social network analysis
Aim/Key question:	Who is necessary in farming and fishing social networks to facilitate the effective planning, implementation, and on-going application of selected adaptation actions?
Key stages in method:	• Produce baseline social networks by identifying key actors (agents) that influence the capacity of farmers/fishers to produce food for consumption and cash sales • Understand the links that exist between the farmers/fishers and other actors in their networks in terms of the flow of information, physical support (e.g., equipment), financial support (cash and loans), and services (e.g., training, marketing) • Identify what additional actors may need to be included in the baseline networks if a specific adaptation strategy is to be effectively planned, implemented and iteratively managed.
Key results (preliminary):	<u>Atauro fisheries</u> • The National Environment Department, Suco Chiefs, Local Authority, Catholic Church, and Protestant Church are seen as the most influential actors within the Atauro fishing network. • The Local Authority includes the District Administrator, the Sub-District Administrator, and National Sectors: education, health, police, rural development, fisheries and agriculture. This group are a source of information for the community, especially regarding agriculture and fisheries. • Both the Catholic and Protestant Churches serve as an important source of moral guidance in addition to socializing (distributing) information. • The fishers are seen as the least influential actors in the fisheries network.

Activity:	Social network analysis
	• International organisations, the Maritime Police and the Defence Force were all considered actors needing to be integrated into the fishing network if special regulations are to be implemented and enforced to enhance the condition of nearshore (coral) fisheries or for enhance opportunities for further exploiting deep water fisheries. <u>Atauro agriculture</u> • The Sub-District Administrator, Suco Chief, Ministry of Agriculture and Fisheries, and the Catholic and Protestant Churches are seen as the most influential actors within the Atauro farming network. • Described as the center of all information, the Sub-District Administrator receives information from the community and distributes it and ensures programs are implemented according to the needs of the community. • The Suco Chiefs provide an important link between the community and above levels of governance, raising information and issues from the community level up to the sub-district and district levels. • The Ministry of Agriculture and Fisheries provides programs, training and equipment, such as seeds and hand tractors. implement programs. • The Catholic and Protestant Churches provide moral guidance on how members of the community should behave. • The Farmers of Atauro are seen as the least influential actor in the agriculture network. • The national water services were considered important for improving the collection of water (during the wet season), its storage, and delivery to crops and animals. It will be important to establish links with this national department via their local representative as they are not presently operating in the farmers' network. <u>Batugade fisheries</u> • Moris Rasik (credit supplier) was listed as the most influential actor within the Batugade fishing network. The next most influential actors within the network were the Middlemen and the 'Whole Community' (fishers were identified as a separate actor from the 'Whole Community'). • The fishers (alone) were seen as having zero influence over their fishing decisions and network; however the Whole Community was identified as the second most influential actor in the fisheries network. • If the fishers wish to implement either of the adaptation actions selected in Section 3.3, no additional actors were considered necessary. <u>Batugade agriculture</u> • The Ministry of Agriculture (national level) and the Farmers (community level) were identified as the most influential actors within the Batugade farming network. Farmers are important because they produce food for their families and sometimes pass on food to government officials if these officials have not been able to plant crops for themselves. • The Ministry of Agriculture is seen as having control over making things happen. • If the communities wish to increase production of trees, crops and animals using sustainable agriculture techniques (including training), additional actors are considered necessary within the farming network. These are needed to provide technical knowledge. Liking them to the farmers will be necessary to facilitate planning, implementing and iteratively managing the practices.
Recommen-dations (preliminary)	Preliminary recommendations for all networks: • Consideration should be given to improving information, support and problem solving links where these have been identified as presently hindering the effectiveness of farmers' and fishers' livelihood activities. • Consideration to be given to how new actors required for implementing and iteratively managing adaptation actions can most effectively be linked into the

Activity:	Social network analysis
	existing networks.

1. Results

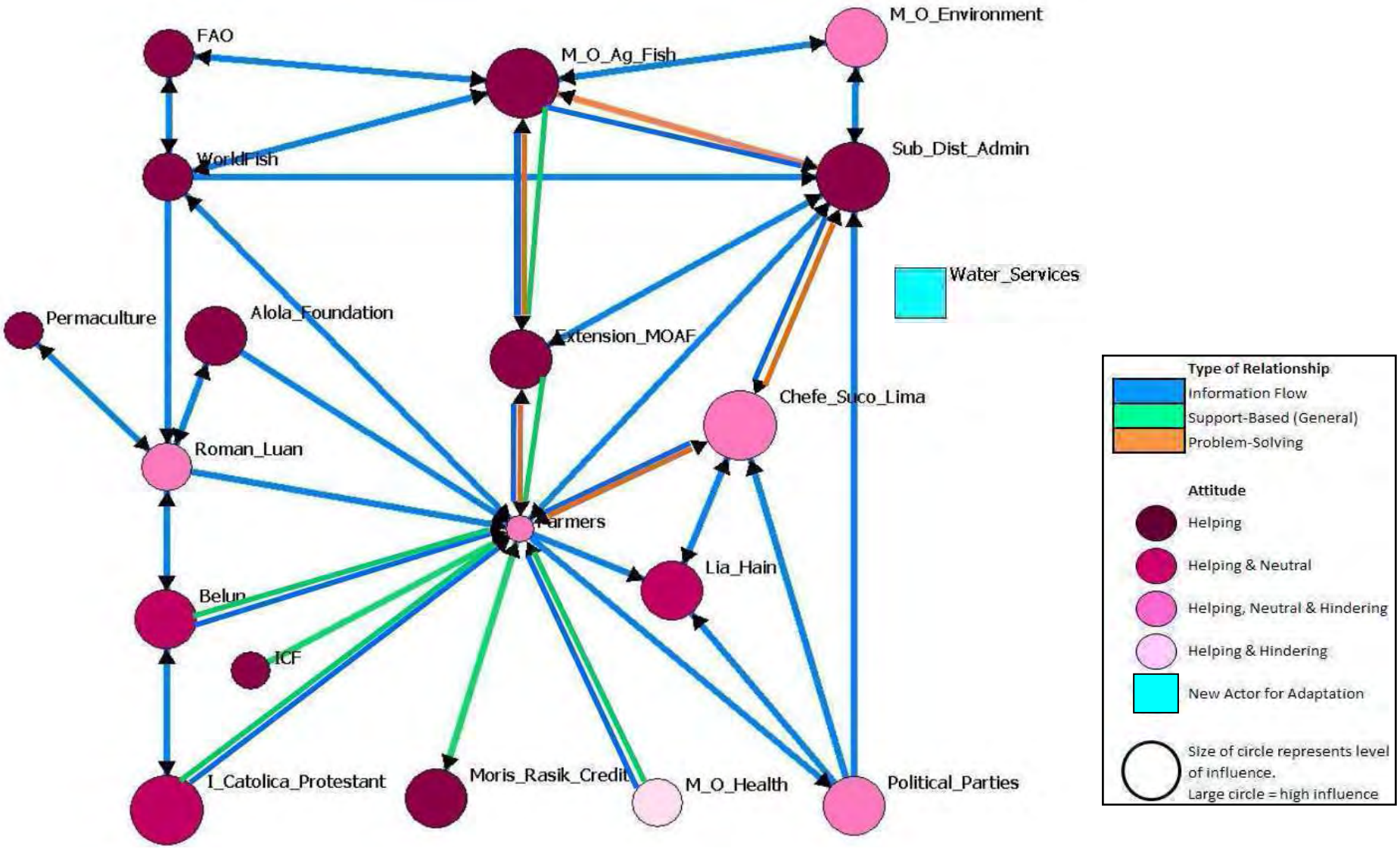
a) Farming – Atauro

50. Figure 18 shows the social network as perceived by the participating farming-related local authority representatives from Atauro. Each of the circles in the network represents an actor (also referred to as nodes). The different colored lines indicate the current relationships existing between the actors in terms of the flow of information, provision of support (split into financial, physical /technical, and services), and pathways for problem solving. Table 10 summarizes the actors in the network. Actors were identified by farming-related local authority representatives who are important for decision making and in successfully maintaining/improving income or food production from farming activities.

Table 10: Summary of actors within Atauro farming community

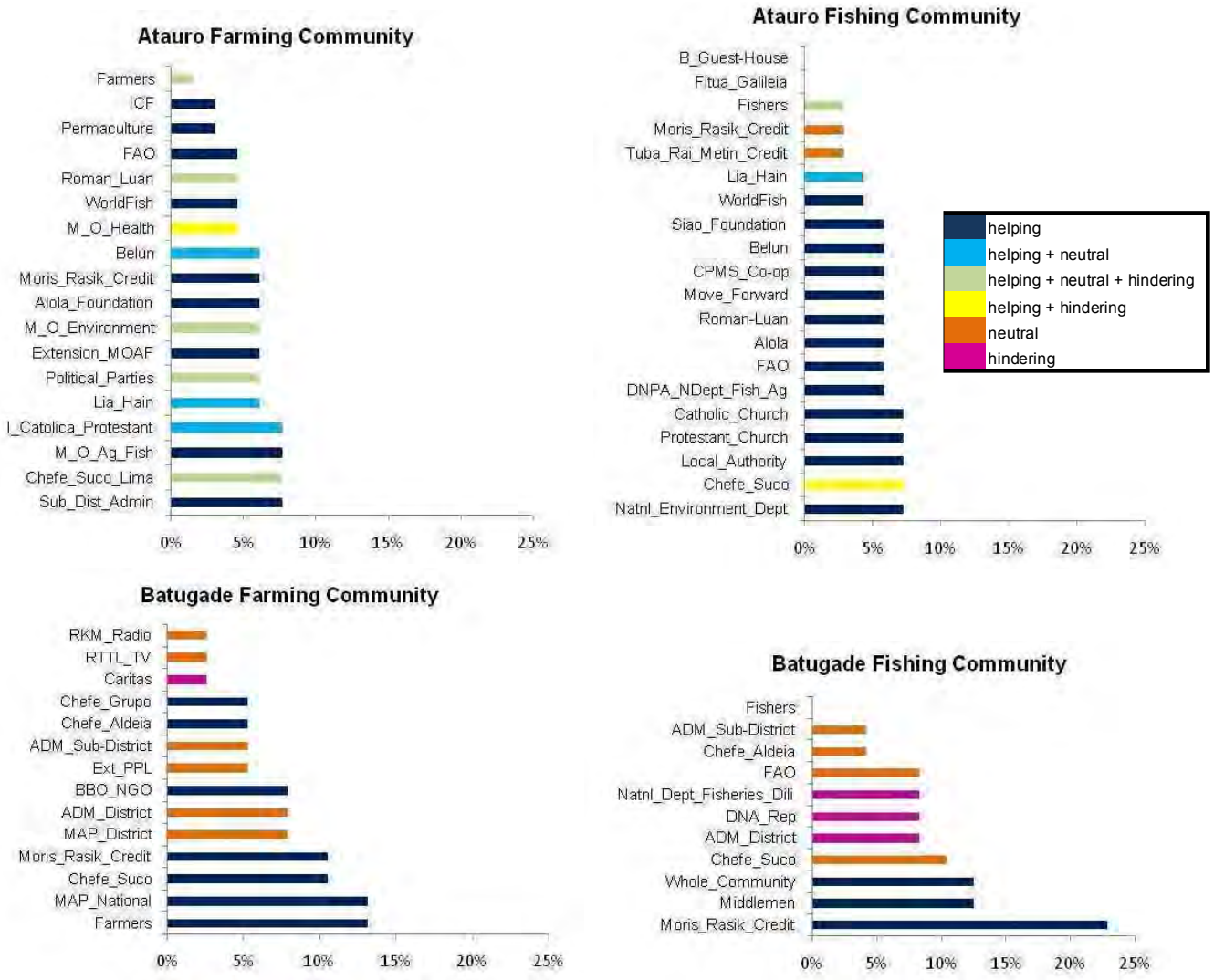
Atauro Farming Community	
Actor Name	**Actor Description**
Sub_Dist_Admin	Administrasaun Sub Distrito (Sub-District Administrator)- based on Atauro
Chefe_Suco_Lima	Chefe Suco Lima- 5 positions, 1 for each Suco
Lia_Hain	Lia Ha'in- traditional culture leaders based on Atauro
Political_Parties	Liderance Politica (Political parties)- 4 parties based on Atauro
M_O_Ag_Fish	Ministerio Agricultura e Pesca (Minstry of Agriculture and Fisheries)- includes Ministry of Forestry, national level
Extension_MOAF	Extention Officer, (Minstry of Agriculture and Fisheries)- 2 on Atauro, paid by M_O_Ag_Fish
M_O_Health	Ministerio Salide (Ministry of Health)- includes Timor Viatie, national level represented by 1 officer in Atauro
Farmers	Farmers- focus group
WorldFish	WorldFish Center
M_O_Environment	Diresaun Ambiente (Ministry of Environment)- national level
Alola_Foundation	Alola Foundation- national level NGO with a base in Atauro
Roman_Luan	Roman Luan, Sião, Move Forward- local NGOs on Atauro
FAO	FAO- international agriculture organisation, Dili-based
Permaculture	Permaculture- Dili-based organisation
Moris_Rasik_Credit	Azensia (Moris Rasik, Tuba Rai Metin)- credit suppliers based in Atauro, provide mostly to women, must be repaid
ICF	ICF- not currently active, possibly an NGO?
Belun	Belun- national level NGO with a base in Atauro
I_Catolica_Protestant	Igreja Catolica e Protestant- Catholic and Protestant Churches on Atauro
Water_Services	Servico Agua e San-Emento (Water Services), new actor

Figure 18: Social network relating to farming activities in Atauro, from the perspective of a focus group of farming-related local authority members in Atauro.



51. In addition to the visual networks and list of actors, we have also provided preliminary analysis of the perceived influence of the actors (Figure 19).

Figure 19: Influence of actors for each community*



*Scores are proportional and presented in percentage of influence across all actors. Color of bars represents the attitude of each actor. See legend for details. Dark blue represents actors who helped Fishers/Farmers achieve their goals, light blue indicates the actors who were identified as both helping and neutral, green indicates the actors who were identified as helping, neutral, and hindering, yellow indicates the actors who were identified as both helping and hindering, orange indicates the actors who were only identified as neutral, and pink indicates actors who were only identified as hindering.

52. From the network analysis (Figure 18) and histograms of influence (Figure 19), the following preliminary conclusions have been drawn regarding the farming networks in Atauro:

- The Sub-District Administrator, Suco Chief, Ministry of Agriculture and Fish, and the Catholic and Protestant Churches are seen as the most influential actors within the Atauro farming network. Each of these actors holds eight per cent of the total influence within the farmer network. All four were identified as helping the farmers to achieve their goals, the Suco Chiefs were reported as helping, neutral, and hindering; the Church was reported as both helping and neutral.

- Described as the center of all information, the Sub-District Administrator receives information from the community and distributes it, and ensures programs are implemented according to the needs of the community. Though he does not have a source of funding to distribute, the Sub-District Administrator can instigate and submit proposals to the National Government. These proposals include requests for the community's seed needs for the forthcoming cropping season.

- The Suco Chiefs provide an important link between the community and Sub-District Administrator, raising information and issues from the community level up to the sub-district and district levels. Though they do not have funds to distribute, they have a role in 'making things happen' and can obtain seeds and equipment for distribution.

- The Ministry of Agriculture and Fisheries provide training and equipment, such as seeds and hand tractors. They also provide technical assistance and support in implementing programs.

- The Catholic and Protestant Churches provide moral guidance on how members of the community should behave. This was considered an important role because of the general lack of education.

- The Farmers of Atauro see themselves as the least influential actor in their network, with only two per cent of network influence. The attitude of the farmers was perceived as being both helpful and hindering.

- The national water services were considered important for planning, implementing and iteratively managing the collection of water (during the wet season), its storage, and delivery to crops and animals (see mid-term report Section 3.3 for how this adaptation was identified as important to the farming communities of Atauro). It will be important to establish links with this national department via their local representative as they are not presently in the farmers' network.

b) Fishing – Atauro

53. Figure 20 shows the social network as perceived by the participating fishing-related local authority representatives from Atauro. Table 11 summarizes the actors in the network. Actors were identified by fishing-related, local authority representatives who are important for decision making and in successfully maintaining/improving income or food production from fishing and gleaning activities.

Table 11: Summary of actors within Atauro fishing community

Atauro Fishing Community	
Actor Name	**Actor Description**
Natnl_Environment_Dept	State Secretariat Environment (National Environment Department)- has the mandate for climate change, communicates with other national departments
Tuba_Rai_Metin_Credit	Tuba Rai Metin- credit lender based in Atauro
Moris_Rasik_Credit	Moris Rasik- credit suppliers, provide only to women, fishers are only male, so they can't access this
Fishers	Fishing communities- also participate in agriculture activities
WorldFish	WorldFish Center
DNPA_NDept_Fish_Ag	National Department of Fisheries and Aquaculture

Atauro Fishing Community	
Actor Name	**Actor Description**
FAO	FAO- international agriculture organisation, Biqueli-based
Lia_Hain	Lia Ha'in Uma Lisan- traditional culture leaders based on Atauro
Chefe_Suco	Lider Komunitariu (Suco chiefs)- community-leaders besed in Atauro, oversee village heads
Local_Authority	Authorida de Lokal (Local Authority)- includes District Administrator, Sub-District Administrator, National Sectors-education, health, police, rural development, fisheries and agriculture
Alola	Alola Foundation- national level NGO with a base in Atauro
Roman-Luan	Roman Luan- local NGOs on Atauro
Move_Forward	Move Forward- local NGOs on Atauro
Fitua_Galileia	Fitua Galileia- shop selling fishing equipment, purely commercial
B_Guest-House	Loja Manutasi (Barry's Guest House)- business based on Atauro, brings tourists to reef
Protestant_Church	Igreja Protestant (Protestant Church)- based on Atauro
Catholic_Church	Catholic Church- based on Atauro
CPMS_Co-op	Koperativa Beata (CPMS)- cooperative baded on Atauro, provides credit to fishers
Belun	Belun- national level NGO with a base in Atauro
Siao_Foundation	Fundasaun Siao- NGO based on Atauro, similar to Rolu
FDTL_Defence_Force	F-FDTL- Timor Defence force, new actor
Maritime_Police	Maritime Police, new actor
International_Orgs	International organisations- new actor, needed to fund and train fishers

54. From the histograms of influence (Figure 19) and network analysis (Figure 20), the following preliminary conclusions have been drawn regarding the fishing network in Atauro:

- The National Environment Department, Suco Chiefs, Local Authority, Catholic Church, and Protestant Church were identified as the most influential actors within the Atauro fishing network. Each actor holds seven per cent of the total influence within the network (thirty-five per cent combined) and each was identified as helping the fishers to achieve their goals. Only the Suco Chiefs received mixed results of being both helpful and neutral in terms of facilitating/iteratively managing fishing activities.

- The National Environment Department has the mandate for climate change and communicates with other national departments, such as the National Department of Fisheries and Aquaculture.

- The Suco Chiefs are the community leaders based in Atauro who oversee the village leaders. They do not have funds of their own to distribute for fishing related adaptation.

- The Local Authority includes a number of positions and departments that the network analysis participants thought were better described as a single actor. This group includes the District Administrator, the Sub-District Administrator, and National Sectors: education, health, police, rural development, fisheries and agriculture. Based locally in Atauro this group of local authority members are sources of information for the community, especially regarding agriculture and fisheries. Though they generally do not distribute money directly, they help in skills training.

- Both the Catholic and Protestant Churches serve as important sources of moral guidance in addition to socializing information; as the community is

predominantly Christian, there is the perception that when the church leaders speak people pay attention. They do not; however, distribute funds.

- The Local Authority group considered the fishers to be the least influential actor in their network, with only three per cent of network influence; their attitude ranged from helping to hindering.

- International organisations, the Maritime Police and the Defence Force were all considered actors needing to be integrated into the fishing network if either special regulations were implemented to enhance the condition of near shore (coral) fisheries, or activities were undertaken to enhance the usage of deep water fisheries.

c) Farming – Batugade

55. Figure 21 shows the social network as perceived by the participating, farming-related, local authority representatives from Batugade. Table 12 summarizes the actors in the network. Actors were identified by farming-related local authority representatives who are important for decision making and in successfully maintaining/improving income or food production from fishing and gleaning activities.

Table 12: Summary of actors within Batugade farming community

Batugade Farming Community	
Actor Name	**Actor Description**
Farmers	Farmers
Ext PPL	Extension Officer Ministry of Agriculture
Caritas	Australian NGO- not currently active
ADM Sub-District	Sub-district Administrator- lives in Macadade
Chefe Suco	Chief of the Suco- talks to everybody
Chefe Aldeia	Chief of the village- has access to the Suco Chief
Chefe Grupo	Head of the Agriculture Group
MAP National	Ministry of Agriculture national level government
MAP District	Ministry of Agriculture district level government
RTTL TV	Television station funded by the National Government
RKM Radio	Maliana-based radio funded by the community and NGOs.
ADM District	District Administrator- in the lint up to the MAP National
BBO NGO	National NGO- have given cows, pigs and money to buy animals to farmers
Moris Rasik Credit	Moris Rasik- credit suppliers, provide only to women, must be repaid

56. From the histograms of influence (Figure 19) and network analysis (Figure 21), the following preliminary conclusions have been drawn regarding the farming network in Batugade:

- The local authority level participants in the network analysis activity identified the Ministry of Agriculture at the national level and the Farmers as the most influential actors within the Batugade farming network. Both of these actors hold thirteen per cent of the total influence within the network (twenty-six per cent combined) and each was identified as being helpful to farmers seeking to achieve their goals.

- Participants identified the national level of the Ministry of Agriculture as having control over making things happen.

Figure 20: Social network relating to fishing activities in Atauro, from the perspective of a focus group of fishing-related local authority members in Atauro

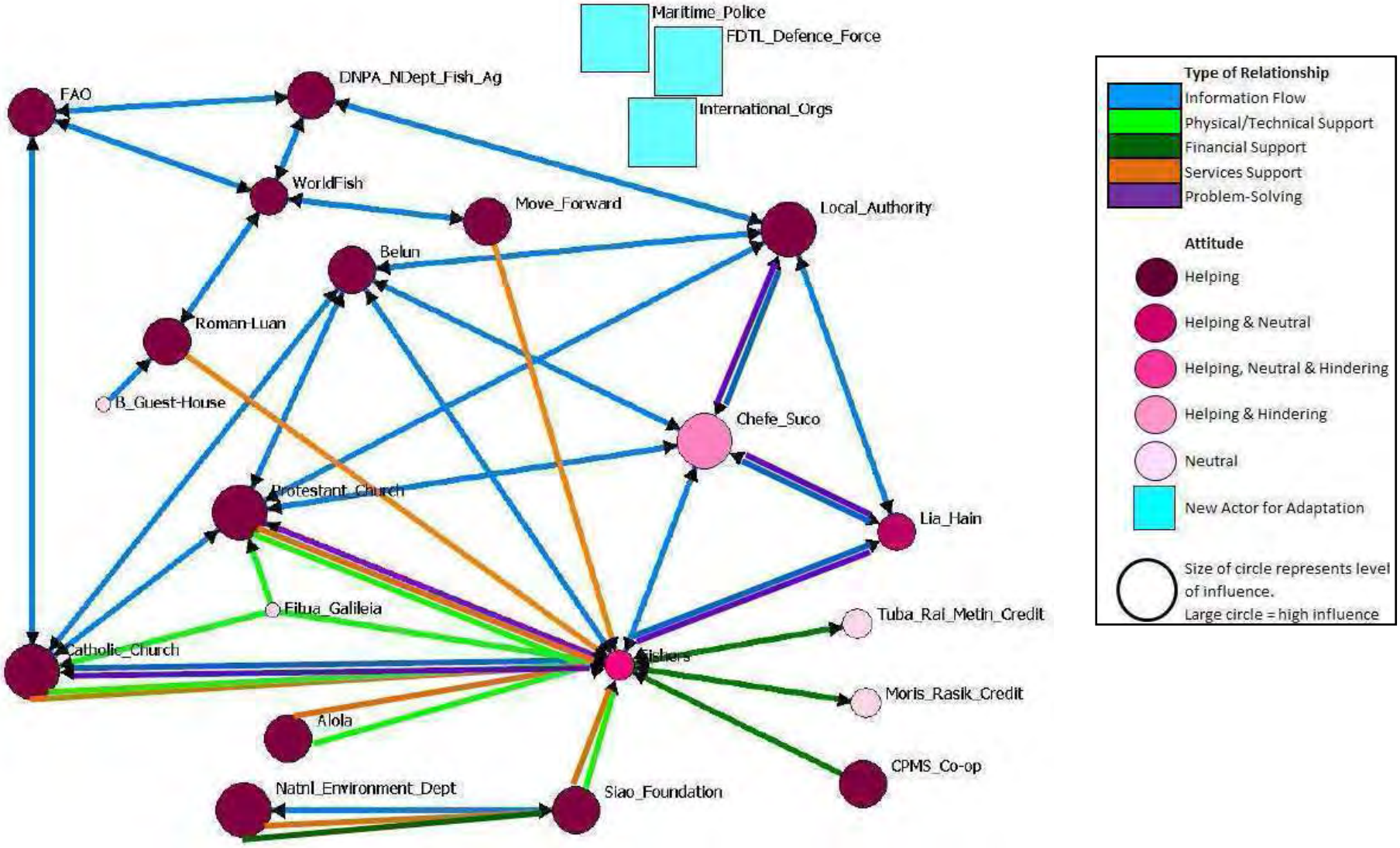
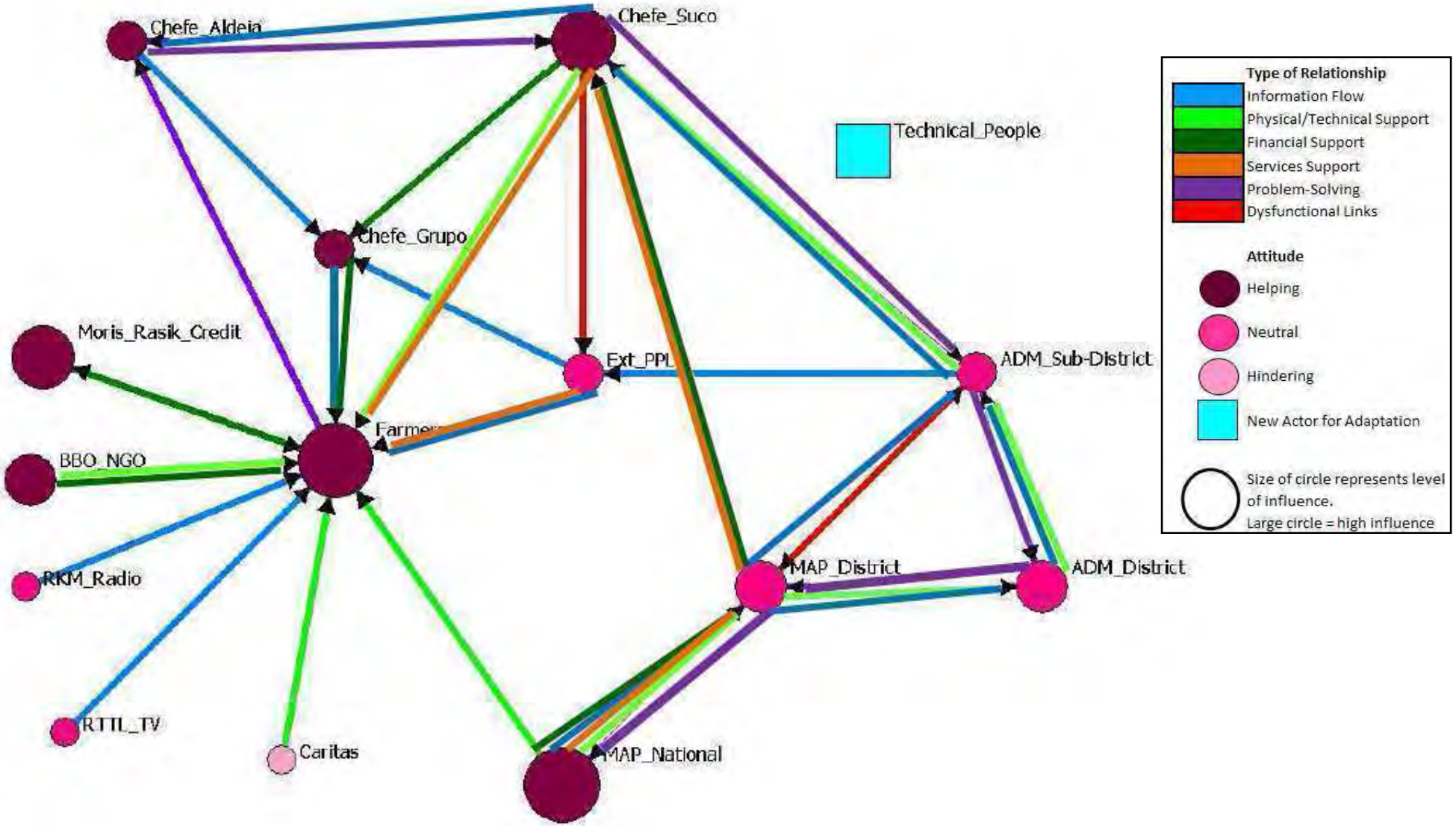


Figure 21: Social network relating to farming activities in Batugade, from the perspective of a focus group of farming-related local authority members in Batugade.



- Farmers were identified as one of the two most influential actors in the network. This, in addition to their description as helpful, is in contrast to the Farmers in Atauro. (They are considered helpful because they produce food for their families and sometimes pass on food to government officials if these officials have not been able to plant crops for themselves.)

- If the farmers wish to implement sustainable farming practices (see the mid-term report, Section 4.3.1 for how this adaptation was identified as important to the farming communities of Batugade), additional actors are considered to be needed within the farming network to provide technical knowledge.

d) Fishing – Batugade

57. Figure 22 shows the social network as perceived by the participating, fishing-related, local authority representatives from Batugade. Table 13 summarizes the actors in the network. Actors were identified by fishing-related local authority representatives from Batugade who are important for decision making and in successfully maintaining/improving income or food production from fishing and gleaning activities.

Table 13: Summary of actors within Batugade fishing community

Batugade Fishing Community	
Actor Name	**Actor Description**
Fishers	Fishers- a sub-set of the Whole_Community
Middlemen	They buy the fish off the fishers and sell it in other locations
Chefe_Suco	Village Chiefs- connected to the community
Chefe_Aldeia	Sub-Village Chiefs- connected to the community
Whole_Community	Describes the whole village, Fishers are a sub-set of this
ADM_Sub-District	Sub-district Administrator- important in link to national level
ADM_District	District Administrator- important in link to national level
DNA_Rep	National Department of Fisheries representative- important link to national level
Natnl_Dept_Fisheries_Dili	National Department of Fisheries, Dili
Moris_Rasik_Credit	Moris Rasik- credit suppliers, provide only to women, fishers are only male, so they can't access this
FAO	FAO- international agriculture organisation, well known in the region

58. From the histograms of influence (Figure 19) and network analysis (Figure 22), the following preliminary conclusions have been drawn regarding the fishing network in Batugade:

- The Moris Rasik credit supplier was listed as the most influential actor within the Batugade fishing network, with twenty-three per cent of total influence. While all fishers are men, the extension of credit is limited to women which means that credit is channelled through the wives of fishers and middlemen. This results in the wives financially facilitating the purchase of supplies and equipment for their fisher husbands or fish from the middlemen.

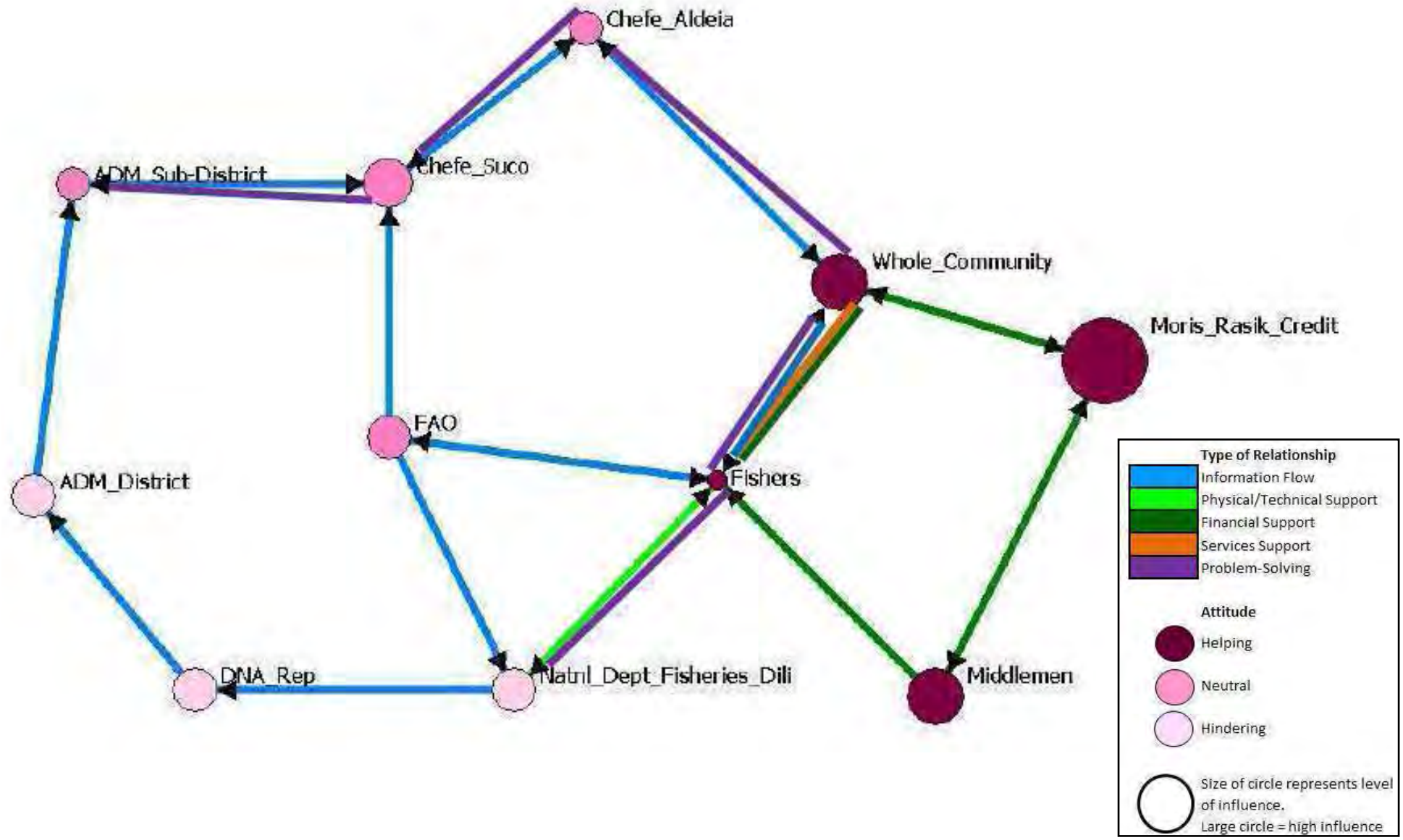
- The next most influential actors within the network are the middlemen and the whole community, with thirteen per cent of total influence each (twenty-six per cent combined) and both identified as helping. The middlemen buy fish from the fishers to sell in other locations. This provides money to the fishers. The community also buys fish, from both the middlemen and directly from the fishers.

Additionally, the community helps to unload the catch when a lot of fish have been caught, so are considered helpful. Fishers give fish to community members who help bring in the catch.

- The participants in Batugade identified the fishers as a separate actor in addition to the whole community. This is unlike the other four networks described above. The fishers (alone) were seen as having zero influence over their fishing decisions; however the whole community is identified as the second most influential actor in the network. Both the fishers and the whole community are identified as helping.

- If the fishers wish to implement either of the adaptations identified in the mid-term report, Section 4.3, no additional actors were considered necessary.

Figure 22: Social network relating to fishing activities from the perspective of a group of fishing-related local authority members in Batugade.



E. Evaluation of adaptation strategies from a social perspective using a governance and institutional effectiveness survey

Activity:	Governance and institutional effectiveness survey
Aim/Key question:	From a community level perspective, what is the present extent and nature of interactions aimed at supporting rural livelihoods, that occur between farmers/fishers and (i) representatives of national level ministries of farming and fishing, and (ii) NGO's?
Brief details of method:	Survey containing ten open-ended and multiple choice questions developed in collaboration with, and conducted by, in-country partners. A total of 150 fishers and farmers were included in the sample group. Data was analysed to produce descriptive statistics.
Key results:	• 55 fishers and 45 farmers in Atauro, and 19 fishers and 31 farmers in Batugade completed the survey. • There was no gender difference apparent in any of the results. <u>Rules and regulations</u> • The most commonly cited rules and regulations relating to agricultural production include not cutting down trees or destroying the forest/woodland, and not burning grass. On average, a greater proportion of farmers credited national government with rules and regulations, than traditional elders. • By far the most commonly cited rules for fishing in both Atauro and Batugade related to the need to limit practices that would deplete fish stocks or the natural resource base in some way. <u>Activities and projects in the community</u> • While a greater proportion of farmers tend to see a regional extension officer more than an NGO representative around their communities, the frequency of visits by the two agents is generally similar. • Nearly two-thirds of the farmers knew of projects or activities that have been brought to their community by the national Agriculture Department. These projects more often related to physical support, but also include the provision of services. • The proportion of farmers that knew of projects or activities brought by an NGO was roughly half of that who knew about national government provided initiatives. NGO projects and activities favour physical support, but they also provide some training (i.e., service). • There were roughly equal proportions of community members seeing a regional fisheries extension officer, as those seeing an NGO representative. The frequency of visits by the two agents was also similar. • There was a wide range in the proportion of fishers (0–90%) that knew of projects or activities brought to their community by the national Fisheries and Aquaculture Department. These projects provide information, physical support and services. • Only fishers in Atauro knew of projects or activities that were brought to their communities by an NGO, (i.e., no fishers in Batugade claimed to have received such projects). <u>Decision-making</u> • Those responsible for making decisions relating to the management of land, soil, sea and rivers for farming activities, differed in the two locations; traditional elders (Lia Nain) were the main decision-makers in Atauro, while local authority (e.g., Chefe Suco and Chefe Aldiea) were the key decision-makers in Batugade. • Those responsible for making decisions relating to the management of land, soil, sea and rivers for fishing activities, differed markedly in the two locations; traditional elders (Lia Nain) were the main decision-makers in Atauro, while the

Activity:	Governance and institutional effectiveness survey
	national Fisheries Department was the key decision-maker in Batugade. • All farmers knew who was on their Suco Council, with the vast majority (91%) considering that they also knew what tasks the council performed. In both Atauro and Batugade, the vast majority of farmers considered the council to be doing a good job. • All fishers knew who was on their Suco Council and knew the tasks that the council performed. In both Atauro and Batugade the majority considered the council to be doing a good job.

1. Results

59. A total of 150 community members completed the survey. These included 55 fishers and 45 farmers in Atauro, and 19 fishers and 31 farmers in Batugade. The distribution of fishers and farmers across the villages is shown in Table 14 and Table 15, respectively. A summary of the responses is shown in the mid-term report (Tables 46–55). The key findings are discussed in the following sections.

Table 14: Villages and number of fishers included in the sample group

Sub-district	Suco	Aldeia	Number of fishers
Atauro	Bikeli	Dotan, Pala, Iliknamu	3, 7, 5
Atauro	Beloi	Usu Bemasu, Il Maker	5, 10
Atauro	Makili	Fatulela, Macelehu	8, 2
Atauro	Vila	Ill Iletekarquia	15
Balibo	Batugade	Batugade	5
Balibo	Batugade	Nuu Badak	14

Table 15: Villages and number of farmers included in the sample group

Sub-district	Suco	Aldeia	Number of farmers
Atauro	Bikeli	Pala	5
Atauro	Beloi	Usu Bemasu, Il Maker	2, 3
Atauro	Makili	Fatulela	10
Atauro	Vila	Ill Iletekarquia	5
Atauro	Macadade	Anartuto, Bite	19, 1
Balibo	Balibo Vila	Fatululi	15
Balibo	Batugade	Lotan	16

a) General findings

60. There was no gender difference apparent in any of the results.

b) Rules and regulations

61. The most commonly cited rules and regulations relating to agricultural production include not cutting down trees or destroying the forest/woodland, and not burning grass. On average, a greater proportion of farmers credited national government with rules and regulations (87%), than traditional elders (63%) (mid-term report, Appendix 14). Traditional elders were credited with a broader range of rules/regulations relating to agricultural production, and Tara Bandu was only cited in connection with traditional rules/regulations (i.e., not rules and regulations emanating from the national government). The proportion of people citing traditional rules is

notably high (i.e., two-thirds of the respondents) as there is no official government strategy to promote Tara Bandu.

62. The lack of female respondents to the fishing survey reflects the general trend for women not to be involved in fishing in Atauro or Batugade, so all respondents in the survey are from male fishers. At least 87% of the fishers interviewed from Bikeli, Beloi and Vila knew of rules or regulations from the national government relating to how they use the land, soil, sea and rivers for fishing activities (mid-term report, Appendix 14). A notably lower proportion (40%) of fishers from Makili knew about national government rules and regulations. All fishers interviewed from the Batugade location (including Balibo Suco) knew of rules and regulations. By far the most commonly cited in both Atauro and Batugade related to the need to limit practices that would deplete fish stocks or the natural resource base in some way. For example, through destructive practices, such as poisoning fish, or bombing coral, or through the use of specific fishing gear, such as spears, or small net mesh sizes.

63. A generally lower percentage of fishers (72%) knew about rules or regulations from Traditional elders (e.g., Lia nain), than from the national government Fisheries Department (88%) (mid-term report, Appendix 14).

64. Tara Bandu was only specifically mentioned by fishers in Batugade and Balibo, in contrast to villages in Atauro where there was no specific mention of the informal governance system.

c) Activities and projects in the community

65. Approximately 87% of the farmers interviewed had seen a regional agricultural extension officer in their community, the frequency being roughly equal between monthly, semi-annually, and annually (mid-term report, Appendix 14). Approximately half (49%) of the farmers had seen an NGO representative in their village, the frequency being roughly equal between monthly, semi-annually, and annually (mid-term report, Appendix 14). The NGOs mentioned included: FAO, Biahula, Belun, Roman Luan, US AID, One Child Fund and Care. While a greater proportion of farmers tend to see a regional extension officer more than an NGO representative, the frequency of visits by the two agents is generally similar.

66. Approximately 80% of fishers from sucos in Atauro and the Balibo Suco in Batugade had seen a regional fisheries extension officer, while only 7% (one fisher) in the Batugade Suco had seen an officer (mid-term report, Appendix 14). In Atauro, visits by extension officers most commonly occur once a year and, somewhat curiously, approximately 25% of those fishers that had originally said they had seen an extension officer, then went on to say they had never seen one. In Batugade visits generally seem to occur more frequently (i.e., every month).

67. Nearly two-thirds (59%) of the farmers knew of projects or activities that have been brought to their community by the national Agriculture Department (data not shown). These projects more often related to physical support (e.g., providing seeds, tree saplings, hand tractors and hoes), but many also provided services (e.g., ploughing the land). There was no difference between men and women's knowledge of projects and activities provided by the government.

68. The proportion of farmers that knew of projects or activities brought by an NGO was roughly half (i.e., 30%) of that who knew about national government provided initiatives (data not shown). Similar to national government support, NGO projects and activities favour physical support (e.g., installing rainwater tanks, providing seeds, tree saplings, and equipment), but also

provide some services (e.g., training for land management, making toilets and feeding primary school children). There was no difference between men and women's knowledge of NGO provided projects and activities.

69. Similar to the results above for extension officer visits, fishers in Batugade (Nu Badak Aldiea) appear to see notably fewer NGO representatives than other sucos and aldieas (14%) (mid-term report, Appendix 14). The majority of visits in all communities are either every six months or once a year. The NGOs mentioned as visiting the communities were cited as including FOA, the Catholic Church Mission, Belun, Roman Luan and WorldFish. There were roughly equal proportions of community members seeing a regional extension officer, as those seeing an NGO representative. The frequency of visits by the two agents was also similar.

70. Across the communities surveyed, there was a wide range in the proportion of fishers (0–90%) that knew of projects or activities brought to their community by the national Fisheries and Aquaculture Department (data not shown). These projects were roughly equally split between those providing information, physical support (i.e., fishing equipment such as fridges, boat motors, lamps, solar panels, nets, and boats) and services (e.g., registering of boats).

71. Only fishers in Atauro knew of projects or activities that were brought to their communities by an NGO, (i.e., no fishers in Batugade had received such projects) (data not shown). The services brought by the NGOs to Atauro was approximately evenly split between physical support (included maps, 'hang up' items, and equipment for farming seaweed) and services (such as training about fisheries, how to 'split' (i.e., gut) fish and farm seaweed).

d) Decision-making

72. Those responsible for making decisions relating to the management of land, soil, sea and rivers for farming activities, differed in the two locations; traditional elders (Lia Nain) were the main decision-makers in Atauro, while local authority(e.g., Chefe Suco and Chefe Aldiea) were the key decision-makers in Batugade (mid-term report, Appendix 14).

73. Those responsible for making decisions relating to the management of land, soil, sea and rivers for fishing activities, differed markedly in the two locations; traditional elders (Lia Nain) were the main decision-makers in Atauro, while the national Fisheries Department was the key decision-maker in Batugade (mid-term report, Appendix 14).

74. All farmers knew who was on their Suco Council, with the vast majority (91%) considering that they also knew what tasks the council performed (data not shown). These tasks included collating information from the community and passing it on to the government (sometimes in the form of proposals or reports), general administration of the village, communication, attending to community needs and promoting development, and working with the church. In both Atauro and Batugade, the vast majority of farmers (78% and 84%, respectively) considered the council to be doing a good job.

75. All fishers knew who was on their Suco Council, with the vast majority (87%) considering that they also knew what tasks the council performed (data not shown). The two key tasks identified by the fishers were collating information from the community and passing it on to the government (sometimes in the form of proposals or reports), and general administration. In both Atauro and Batugade, the vast majority of respondents (85% and 87%, respectively) considered the council to be doing a good job. None of the fishers thought that the council was doing a bad job.

F. Evaluation of adaptation strategies from a social perspective using governance capacity analysis

Activity:	Governance capacity assessment
Aim/Key question:	What is the current governance context (formal and informal) in which farmers and fishers operate? What actions would best support the development of long term capacity to reduce community vulnerability (particularly in respect to managing the natural resource base underpinning fishing and farming livelihood)?
Key stages in method:	• Collect information on the formal and informal governance and institutional environment from: (i) semi-structured interviews with national, regional and community level stakeholders, identified through a snowball sampling strategy; (ii) literature review; (iii) network analyses (see Section 3.5); (iv) survey of fishers and farmers (Section 3.6). • Synthesize the above information using the CORE and modified PROFOR frameworks.
Key results:	<u>Overall and national level</u> • There is relative governance vacuum at the level of National and District government. Inadequate budgets, human resourcing, capacity, communications and logistics means extension functions do not provide much capacity or support to rural fishers and farmers. • Governance is in transition with projected moves towards decentralization and the creation of new municipal structures and the phasing out of the district/sub-district model. The aim is to increase the resources and services available at the local level, but the precise mechanics of this are not yet known. • It is vital for projects to work with existing formal mechanisms for service delivery and representation from national though district, sub-district and suco levels (and the emerging decentralized municipalities), but emphasis will need to be placed on building capacity of government representatives and strengthening mechanisms wherever necessary to ensure that this does not bottleneck services received by communities. • Strengthening local governance and the links to state service delivery needs to be identified as a key strategy to ensure local adaptive capacity. Supporting local agencies to gradually improve and increase service delivery is the best point of entry in order to build long term capacity. • Short term investments in service delivery and reliance on non-state actors should not undermine long term objectives of decentralization and state-building. <u>Aldeia and suco level</u> • Governance at the aldeia and suco level has considerable legitimacy, and supporting decision-making at this level is key to community adaptation. • The suco council includes chefe aldeia, women and youth representatives and a traditional elder and is clearly the essential body to engage with for adaptation

Activity:	Governance capacity assessment
	interventions. • Consideration needs to be given to the long term context in which communities will need to adapt, requiring improved services and delivery mechanisms at sub-district and national levels. • It is important to consolidate a core of long-term community-development planning and monitoring (as initiated in this project) which builds ownership, increases transparency and community understanding of prioritization and budgeting processes, as well as building relations with central government. • Information provision is a relatively straightforward service that state authorities could improve with support from adaptation projects.

1. Results

76. Table 16 contains analysis of available legislation and secondary sources of information relevant to governance as considered using the framework of Ratner and Smith (2012).

Table 16: Characteristics of formal and informal governance mechanisms relating to community vulnerability based on desk study*

Mechanisms	Stakeholder representation	Distribution of authority	Accountability mechanisms
Formal	National parliamentary system apportions seats to parties according to number of votes won and leads to a national rather than local constituency for elected representatives[1] **Suco council and chefe elected by list and relatively representative of local communities.[1,2]** ***Representation of Suco Councils through Sub-District, District and National level is cumbersome and impedes community representation.[1]*** **Women are guaranteed at least 2 representatives in the suco council[3] nearly 30% of parliamentary seats are occupied by women partly owing to**	District- and sub-district-level civil servants are the closest formal state authority to the population while suco- and aldeia-level authorities are the most visible and accessible form of governance for the majority of the citizenry.[4] ***Formal authority for governance of natural resources is (de facto) centralized*** and isolated at national level owing to lack of resources and support at and below district / sub-district levels.[7,8,9] National laws on resource management exist but there is a large gap between government policy and enforcement or implementation on the ground.[8,9] ***NDFA has low budget and capacity with little staff capacity at district level.[7,8,9]***.	Appointed district and sub-district administrators communicate directly with suco chiefs. ***The former are not clearly accountable to suco chiefs and these are not appropriately involved in the state authority.[4]*** There is potential for lack of accountability between State and communities/population at large owing to the cumbersome and inadequate links between national, district, sub-district, suco and village levels.[1] Decentralization could increase accountability but may not do so if suco councils are not firmly integrated into proposed municipal structures.[4]

Mechanisms	Stakeholder representation	Distribution of authority	Accountability mechanisms
	a decree which requires one in every three candidates to be female.[3]	**Decentralization is in progress and aims to improve the distribution of authority and increase means at a municipal level** but the way forward has yet to be adequately defined.[4] Land tenure is unclear and unsupported in policy, lacking institutionalized dispute resolution mechanisms at local level.[5,6] Coastal marine tenure is vested in the state but de fact customary tenure still exists.[13] **Traditional mechanisms of resource management (e.g., tara bandu) are supported under the constitution and contemplated as a government strategy**[10] but this has not been practically tested yet.[11]	
Informal	**Community institutions are strong, locally respected and provide the basic mechanisms for community participation and decision making.**[4] Power and representation is defined to a great extent through traditional mechanisms relating to lineage and history and this determines to a great extent the leaders, elders and other stakeholders who are represented both informally and formally.[4] ***Customary power relations and authority structures at the community level may limit consultation / representation of certain groups including women.***[3,4]	Land and other dispute resolution mechanisms exist at local level and are recognized in the constitution. Nonstate institutions including traditional elders and chefes suco/aldeia are utilized as much if not more than police and state institutions, particularly in rural areas.[12] **Non-state dispute resolution mechanisms appear to function for fisheries conflicts**[11] but in the case of ***land these are unable to always avoid violence.***[5,6] The role of the church is important in development and has much potential in resolving disputes for instance.[4] There are relatively high levels of trust in and between communities though disputes are not uncommon.[12]	Possibly the strongest accountability occurs at village level where the chefe aldeia is readily accessible to the community.[1] The chefe suco is recognized by law but not included in the Public Administration and their decisions are not binding on the State.[1,2] Customary authority system based on lineages may leave accountability gaps for some sectors of communities.[3,4] Accountability mechanisms exist at the local level such as customary and community enforcement, conflict resolution and sanctions as well as civil society mediation – church, NGOs, networks.[4]

Mechanisms	Stakeholder representation	Distribution of authority	Accountability mechanisms
		Existence of respected traditional mechanisms for resource management such as the tara bandu.[11]	

*Possible bottlenecks are highlighted in *bold italics* and strength and opportunities in bold.

1. Asia Foundation 2012. 2. LAW 3/2009, of 8 July 2009. 3. UN Women 2012. 4. Butterworth and Dale 2010. 5. Wright 2012. 6. ETLJB 2012. 7. Hanich and Tsamenyi 2011. 8.MAF 2012. 9.Fernandez et al. 2011. 10 MAF (draft). 11. AMSAT International 2011. 12 Dale et al 2010. 13 McWilliam 2003

77. The results of the semi-structured interviews, local authority level social network analyses (mid-term report, Section 4.5) and community level social network analysis (Abernethy et al., 2012), and a governance and institutional support survey (mid-term report, Section 4.6), assessed using the modified PROFOR framework, are presented in Table 17 and Table 18.

Table 17: Analysis of natural resource governance issues arising at the local and informal community level using a modified PROFOR (2011) framework

	Policy, regulatory, institutional and legal frameworks	Planning and decision-making processes	Implementation, enforcement and compliance
Community level (Suco and Aldeia) [largely informal]	+Persistence of locally recognized customary land and sea tenure, rules or rights [IA,IB] and examples of local rule setting (e.g., tara bandu)[IB] +Traditional and community leadership institutions strongly recognized(suco council)[IA,IB] -Tenure undocumented and potential for disputes [ref 2,3] -Suco council and aldeias do not have budget (this is projected to change [KI1]) and limited capacity [IA,IB] -Community influence on district or national policy and decision-making depends on a cumbersome chain village-suco-sub-district-district [IB,ref 1]	+Strong village and suco processes for planning, decision making[IA,IB,KI1] and dispute resolution [ref4]. Communities are clear on the role of the council and supportive. +Traditional and local knowledge is relied on [IA,IB] +/- Provision of information from higher levels relies on effectiveness of government bodies and levels of administration as well as the chefe suco. This works better in Atauro [IA] but is deficient in Batugade [IB] -Community influence on district or national policy, decision-making and information flows susceptible to poor links between chefe suco and sub-district [IB] -Inadequate tenure system creates potential for disputes and these currently resolved locally putting pressure on local systems [ref]	+Customary and community implementation, enforcement, conflict resolution and sanctions are carried out. Traditional elders are key in Atauro while Chefes (suco/aldeia) were more important in Batugade [IA,IB, ref 2,4] -Inadequate or uncoordinated support from national or sub-national agencies demotivates attempts to introduce local resource management [IA,IB,KI2] -Suco councils and villages do not receive funds of their own and generally lack capacity [KI3] +Suco councils are projected to receive a yearly budget of US$50,000 or above starting in 2013 [KI1].

	Policy, regulatory, institutional and legal frameworks	Planning and decision-making processes	Implementation, enforcement and compliance
		[2,3] +Churches provide information and guidance and have potential for networking in Atauro [IA] but not in Batugade [IB]	

Features and issues raised by interviewees (IA or IB) in Atauro and Batugade, respectively; or key informants (KI); or identified in the literature (ref). Symbols: strengths (+),weaknesses (-) and Priority Issues for action.

1. Asia Foundation 2012, 2. Wright 2012, 3. ETLJB 2012. 4. AMSAT International. KI1 - MS, KI2 - MB

Table 18: Analysis of natural resource governance issues arising at the subnational and national level using a modified PROFOR (2011) framework*

	Policy, regulatory, institutional and legal frameworks	Planning and decision-making processes	Implementation, enforcement and compliance
Sub-district, district and national scale [State administration]	-Land laws are unclear and lack institutionalized dispute resolution mechanisms at the local level [ref1,2]. +/-Coastal marine tenure is vested in the state but communities do exercise de facto customary rights [ref3, IA,IB] +National rules on fishing and agriculture exist and are known at the community level [IA, IB]. -Current budgets and resourcing are not adequate at national, district or sub-district needs [KI5,KI7, KI8, ref9] -Inadequate coordination mechanisms for government, NGO and donor support	+NDFA has the intention to increase support in aquaculture and coastal fisheries management (building on traditional bodies and mechanisms) [KI5, ref7] -NDFA does not currently have appropriate mechanisms or capacity to support community based management [KI4, ref6] +Agriculture extension services theoretically make provision for one officer per suco nationwide [KI7] -Inadequate flow of information from government to communities [IA,IB] +Some civil society organizations (NGOs) exist that can provide support and oversight though their engagement with government varies [IA,IB, KI7] +/- Planned decentralization moves are an opportunity but	+Agriculture extension officers are active in distributing information and supervising projects, NGOs are also active but considerably less [IA,IB]. +/-Fisheries extension officer in Atauro is relatively active while in Batugade he is not perceived to be active [IA,IB]. -Effective fisheries extension is challenged by lack of rurally based staff, finance, logistics and low capacity [IA,ref4, 5] as well as low salaries and lack of direct support to state staff KI7 -Despite knowledge of national laws communities do not necessarily comply [IA,IB,KI3], this may be because the basis or intent of the laws is not understood [KI2] and/or they are not integrated into community or customary processes [ref4]. -Challenges for district or sub-district coordination or

	Policy, regulatory, institutional and legal frameworks	Planning and decision-making processes	Implementation, enforcement and compliance
		much remains to be defined [KI1] and if suco councils are not adequately included then communities may not be any better engaged in decision-making [ref7] -Challenges in handling of land disputes at the institutional level [ref1,2]	support for resource management, land use planning, extension services include financial resources, communications and staffing [KI1] +National departments of fisheries and agriculture are undergoing institutional strengthening and capacity building to provide better local services [KI7,KI6,ref5,6]

*Features and issues raised by interviewees (IA or IB) in Atauro and Batugade, respectively; or key informants (KI); or identified in the literature (ref). Symbols: strengths (+),weaknesses (-) and Priority Issues for action.

1. Wright 2012. 2. ETLJB 2012. 3. McWilliam 2003 4. AMSAT International 2011. 5. MAF 2012. 6. Fernandez et al. 2011. 7. Butterworth and Dale 2010. 8. MAF (draft) Strategic Plan. 9. GOTL.2010. Budget 2010

2. Discussion

78. The assessment recognizes the distinct differences in governance at various levels, namely local community, sub-district/district and national. In addition, the long timeframe over which adaptation is developed and supported suggests that potential adaptation strategies need to consider not only the current governance context but also its evolution and how to build or sustain appropriate supportive governance into the future. Thus the identification of issues includes consideration of the temporal as well as the spatial dimensions.

3. Overall and national level

79. There is relative governance vacuum at the level of national and district governments. This is particularly visible in the fisheries sector, but also to some extent in the agriculture extension services - extension functions are poorly resourced and limited in their scope and do not provide much capacity or support to rural fishers and farmers. Inadequate budgets, human resourcing, capacity, communications and logistics are at the heart of this obstacle.

80. The aldeia and suco level has considerable legitimacy and supporting decision-making at this level and is key to community adaptation. There is a large body of project implementation experience to draw on at this level, however the long term processes implied by climate change will require building long term support, particularly from government service providers, which is not usually contemplated under project modalities. Thus, though the short term actions will be carried out by communities, an appropriate long term context in which these evolve and are improved or spread will require improved services and delivery mechanisms at sub-district and national levels.

81. Governance is in transition with the projected moves towards decentralization and the creation of new municipal structures and the phasing out of the district/sub-district model. The aim is to increase the resources and services available at the local level but the precise

mechanics of this are not yet known. This process will be both a challenge and an opportunity and may increase the burden on district governance processes overall while potentially allowing an opportunity for municipal governance to include elements essential to adaptation, resource management and extension services.

a) Immediate strategic considerations

82. It is vital for projects to work with existing formal mechanisms for service delivery and representation from national through district, sub-district and suco levels (and the emerging decentralized municipalities) but emphasis will need to be placed on building capacity of government representatives and strengthening mechanisms wherever necessary to ensure that this does not bottleneck services received by communities.

b) Long term strategic considerations

83. The long term adaptive capacity of communities will require timely and responsive inputs from government service deliverers over the long term and far beyond the life of projects. The capacity building and institutional strengthening that is required to ensure short term success must be placed in the context of developing institutions and mechanisms that can fulfill these roles into the future.

84. The process of institutional strengthening and human resource development that the NDFA is embarking on and, more broadly, the national policy of decentralization to the municipal level are examples of two long term governance initiatives that need to be considered and integrated into project strategies.

85. Strengthening local governance and the links to state service delivery need to be identified as a key strategy to ensure local adaptive capacity. A careful balance needs to be achieved as ignoring informal non-state authorities can considerably undermine any effort to reform local governance, whereas exclusive reliance on non-state authorities in service delivery can undermine efforts to strengthen state capacity and legitimacy in local arenas (Kyed and Engberg 2008).

86. Supporting local agencies to gradually improve and increase service delivery is the best point of entry in order to build long term capacity, these services could be those the adaptation initiative envisages, providing they are relatively modest and within the expected future scope of work of such agencies. Short term investments in service delivery and reliance on non-state actors should not undermine long term objectives of decentralization and state-building (Kyed and Engberg 2008).

4. Aldeia and suco level

87. The suco council and in particular the chief suco is considered to be the most important stakeholder for the various governance functions including decision-making, representation and communication. The potential role of the chief suco in liaising with government and ensuring a flow of information to communities is so vital that a poorly performing chief suco can be a major impediment to community adaptation.

88. Chief aldeia have high accountability to, and communication with, hamlet inhabitants and this would be vital to the successful planning and enforcement of community based natural resource management but alone may be insufficiently connected to higher levels of governance.

89. Customary power relations and authority structures at the community level may limit consultation, representation and information flow concerning certain groups (including women) which may disadvantage these or reduce cohesiveness for joint implementation or enforcement. In addition, inadequate composition of and engagement with local project committees in past interventions was cited as a major impediment.

90. Traditional elders have important roles including traditional knowledge and authority, many of their functions may not be explicit to outsiders[1] but nonetheless vital to successful adaptation or project implementation. Traditional elders will be vital to the imposition and enforcement of custom based management rules and potentially in the resolution of conflicts arising.

a) Strategic considerations

91. The suco council includes chefe aldeia, women and youth representatives and a traditional elder and is clearly the essential body to engage with for adaptation interventions. Though chefe suco would frequently be the only contact with interventions, close care is needed to ensure that the council is functioning and that information is flowing between aldeia inhabitants, their chefe, women, elders and the chefe suco. This may require engaging directly with the council and/or building the chefe and council members' capacity to perform their expected functions. The capacity and performance of the chefe suco needs to be carefully assessed and monitored.

92. Where separate project committees are formed it will be essential to ensure that the appropriate representatives are chosen and that these match the aldeia and suco structure as well as including the key representatives from other stakeholders. Agriculture and related interventions may be able to build directly on the existing system of agricultural extension that delivers directly to suco level.

93. Community based management of common resources such as fisheries or water will need careful attention to interactions between villagers, chefe aldeia and chefe suco/suco council. Probably this will require careful inclusion and empowerment of the local community along with the appropriate traditional elders as well in addition to the suco council and chefe. Though the chefe is a key figure, enforcement and implementation will be highly reliant on the local community having ownership of the intervention as they will be the most affected.

94. It is important to consolidate a core of long-term community-development planning and monitoring (as initiated in this project) which builds ownership, increases transparency and community understanding of prioritization and budgeting processes as well as builds relations with central government (cf. Butterworth and Dale 2010).

[1] This might explain the fact that the LiaNain are not mentioned consistently between network mappings eg Abernethy in Batugade but not Atauro and the more recent mapping the reverse.

b) Balibo[2]

95. Results from Balibo indicate that there will need to be a particularly high degree of attention placed on building linkages between the suco council and the aldeias represented and also between the suco and the sub-district administrator as there appears to be little interaction with national and district levels. Increased capacity may well be vital at all these levels.

5. Sub-district and district level

96. The district and sub-district administration are the formal state authority connection with communities. This conduit and its evolution into a decentralized municipal structure are vital for the provision and coordination of services and other governance aspects like representation and accountability.

97. Communities consistently emphasized the importance of ensuring access to information. Provision of information would appear to be a basic function of the sub-district administration and the other government services that should coordinate with the sub-district administrator.

a) Strategic considerations

98. The evolving institutions are an opportunity to ensure that adaptation and natural resource management are better integrated into the sub-district strategies. Integrating customary rules developed at the aldeia and suco levels into sub-district regulations may be a first opportunity and marine resource management / MPAs were considered a good place to start given community interest (AMSAT International, Sub-district administrator Atauro).

99. Information provision is a relatively straightforward service that state authorities could improve with support from adaptation projects. This could include an active sub-district information office using a range of communication techniques (Butterworth and Dale 2010) and would allow staff and institutions to improve capacity for planning and service delivery while supporting the adaptation activities. Related to this would be a slightly more challenging initiative exploring how to ensure that sub-districts improve their communications with district and national government ensuring community information does filter back up.

b) Balibo

100. Notable differences in results between Balibo and Atauro suggest that in the former the apparently lower reliance on sub-district administrator, suco chefes and traditional elders may need closer examination.

[2] Abernethy et al 2012 report: Table 2–3—Important stakeholders to include in decisions related to water and fisheries in Atauro and Balibo suggests that the emphasis placed in network mapping on suco/aldeia chefes in Atauro is not matched in Balibo. Network maps (Fig 16 et seq.) suggest that the representative of the fishers has more of a role in Batugade than chefe suco and this latter has similar status to the chefe aldeia. The sub-district administrator is not mentioned in Batugade.

G. Evaluation of adaptation strategies from an environmental perspective using Landscape Function Analysis

Activity:	Landscape Function Analysis (LFA)
Aim/Key question:	What is the current status of the natural resources underpinning agricultural production? From this baseline, identifying a range of simple management options which communities can use to increase the sustainability of their farming systems, and looking at how ecological function may change as a result of implementing these.
Brief details of method:	Identify the various types of home gardens that occur commonly throughout the focal regions (four were identified each for Batugade and Atauro—the four types in each location representing a point along a gradient of management intensification/modification). Soil function (i.e., soil structure stability, nutrient cycling and water infiltration/run-off) was assessed using Landscape Function Analysis (LFA). LFA uses a range of simple visual assessment methods in order to assess the function of a land use or natural system. Replicate transects were established in each garden type and the following data were collected: • Landscape arrangement of each land use element along the transect—this was used to examine the question of which garden type had the greatest structural and compositional diversity, and is related to resistant and resilience to threats; • Land use (garden) function from the perspectives of soil stability, nutrients and infiltration—this examines the question of which garden type functions more effectively, and which are most vulnerable to threats or reduced function, and therefore require adaptive intervention; • The contribution to function of each element within a garden type—this examines the question of which specific components of the gardens contribute to, or detract from, each function (soil stability, nutrients, infiltration), thus indicating which should be further adopted, modified or reduced as part of adaptation actions.
Key results:	<u>Batugade:</u> • Landscape arrangement—perennial gardens and native woodland were more structurally and compositionally diverse than the plantation and the annual garden. • Landscape function—nutrient cycling and water infiltration greatest in plantation and perennial gardens and low in annual garden; soil stability highest in plantation and woodland, perennial garden consistently higher function index score than annual gardens. • Landscape element function—leaf litter and crop trash contributed greatly to all functions, bare ground detracted from all functions, perennial crops very effective at maintaining soil structure (e.g., through root architecture). <u>Atauro:</u> • Landscape arrangement—perennial village gardens and perennial hills gardens both exhibited similar diversity of composition and structure (hills garden had more bare ground), and both appeared more diverse than the fallow gardens. • Landscape function—All three land use types appear to function well, fallow garden exhibits marginally more function than other garden types, village gardens show marginally better function than hills perennial garden. • Landscape element function—bare soil detracts from function; leaf litter,

Activity:	Landscape Function Analysis (LFA)
	crop trash, dead wood all contribute to function, banana leaves (as litter), in particular, contribute to function .
Recommen-dations	<u>Batugade:</u> Landscape arrangement: • Continue to manage perennial gardens as a resilient food source and potential source of natural pest control; • Improve spatial juxtaposition of perennial and annual gardens in order to increase natural pest control in annual gardens; • Introduce greater complexity (e.g., more plant types, intercrops, tree cover) into annual gardens. Landscape function: • Introduce elements of perennial garden (e.g., less bare ground cover, greater diversity, litter cover) into annual gardens; • Plantation under-utilised, trial shade-tolerant perennial crops as an understorey component in plantations. Landscape element function: • Increase ground cover in annual gardens, through introducing leaf litter, canopy cover, mulching with leaf litter, composting leaf litter (e.g., from plantations); • Reduce bare ground in annual gardens; • Better integrate livestock management into cropping (e.g., chickens for manure and pest removal); • Improve water harvesting (during wet season), storage and distribution, especially in annual gardens; • Retain leaf litter and crop trash; • Do not burn off ground cover post-harvest; • Increase maize use, as may be more drought tolerant; • Avoid overgrazing with livestock in native vegetation; • Use coarse woody debris to intercept resources flowing out of production systems. <u>Atauro:</u> Landscape arrangement: • Continue to manage perennial gardens as a resilient food source and potential source of natural pest control, pollination, etc; • Avoid the loss of perennial gardens from the production system. Landscape function: • Reduce bare ground, increase litter cover, better integrate livestock (e.g., for manure, pest control, weed removal), cease garden burning post-harvest, determine optimum period for cropping and fallow, improve water harvesting storage and distribution. Landscape element function: • Reduce bare ground cover, increase leaf litter, crop trash cover, use banana leaves as cover, mulch and compost, use woody debris to intercept resource flows.

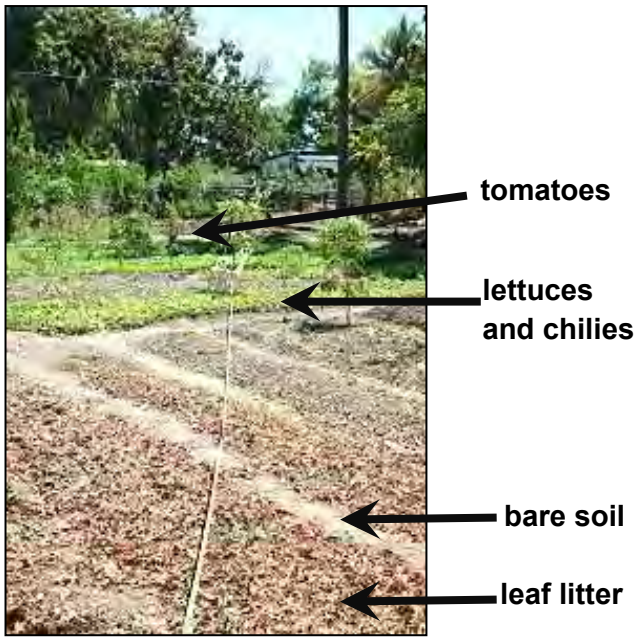
1. Results

a) Land use types—Batugade

101. In Batugade, four landscape/land use types were sampled, representing a gradient of land use intensification from native vegetation (woodland) to frequently tended gardens consisting of annual crops (e.g., vegetables). The four landscape/land use types sampled were:

i. *Annual crop garden (Figure 23)*—an actively and frequently managed garden of annual crops such as lettuces, tomatoes and chillies. Crop species planted in rows, generally segregated, but also paired as intercrops. There are considerable areas of bare soil between vegetable beds. Tree cover is very sparse, with leaf litter from trees adjoining the garden. Garden is management intensive with frequent watering of plants. This land use type provides a year round food supply of annual vegetables and fruit and is situated only a few metres from the family house.

Figure 23: Transect #1 of annual crop garden in Batugade



ii. *Perennial crop garden (Figure 24)*—an actively planted and managed garden of perennial crops such as cassava, tunis beans and mangos, as well as annual crops (e.g., maize). Different species intermixed with bare soil occurring sporadically and non-uniformly, hence far greater ground cover than annual gardens. Woody vegetation cover dense, but largely consisting of perennial tree crop plants (e.g., cassava) or volunteer acacias. All trees were below 2.5 m in height and with breast height diameter less than 12 cm. High level of leaf litter/crop trash were present. This land use type provides a food supply of perennial vegetables and fruit, as well as maize. Volunteer native acacias provide nitrogen for the soil. The garden is situated only a few metres from the family house and adjoining the annual garden.

Figure 24: Transect #2 of perennial crop garden in Batugade

iii. *Old plantation* (Figure 25)—timber plantation, dominated by tree species for building construction. Palm wine trees also present. Very high density of leaf litter and moderate degree of coarse woody debris. Relatively high tree stem density and accordingly high canopy cover. Tree diameter at breast height often > 70 cm. Low heterogeneity in vegetation composition and structure. Presence of domestic pigs is likely to lead to soil disturbance, vegetation breakdown and nutrient enrichment. This land use type provides hardwoods (growing to 10+ m in height in 30 years) for building construction. It also provides firewood and foraging for domestic pigs. The garden is situated about 70 m from the family house.

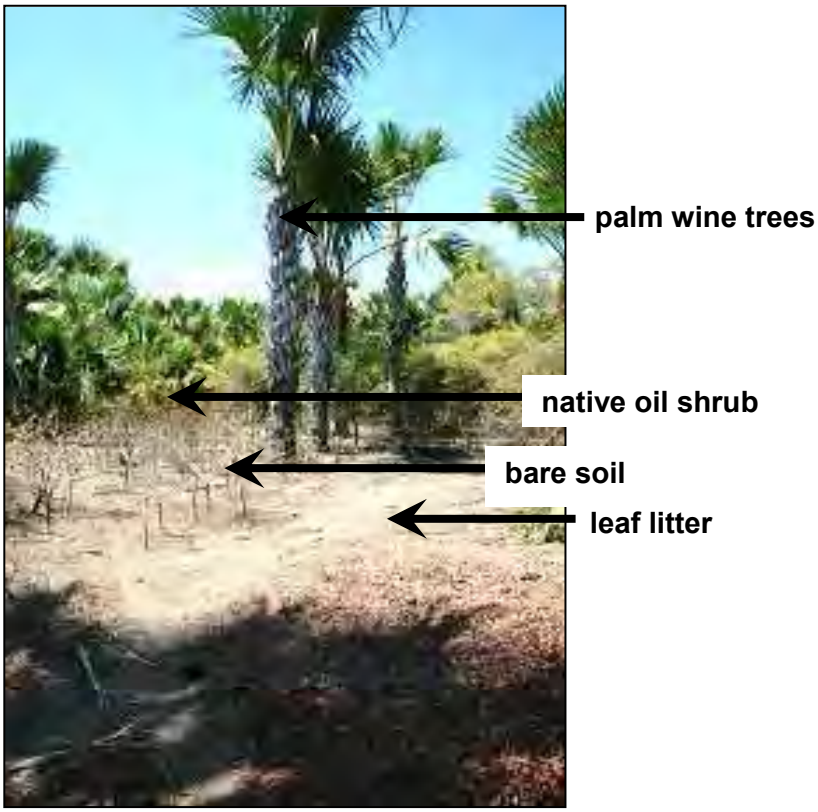
Figure 25: Transect #1 of old plantation in Batugade

iv. Native vegetation—open woodland with scattered tree cover or groves of trees with open areas of grass and/or low shrubs. Dominant tree species is palm wine tree (**Figure 26** and **Figure 27**). Dominant shrub species is native castor oil shrub with extremely high vegetation structural heterogeneity. Bare soil is present in areas that are used as human tracks and areas that are heavily grazed by domestic goats.

Domestic pigs are also present, tree DBH ('diameter at breast height') is generally high. This land use type provides firewood and foraging for domestic pigs and goats.

Figure 26: Transect #1 of native vegetation in Batugade

Figure 27: Transect #2 of native vegetation in Batugade

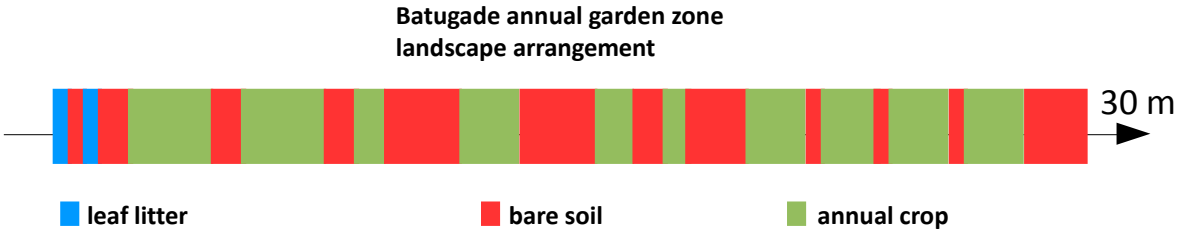


a.1 Landscape arrangement

102. The structure and composition of each land use type is very different in terms of: (a) the number of different landscape elements that are contained in the land use type, and (b) the uniformity with which they are arranged. Figure 28–**Figure 37** depict the diversity of one transect of each land use type, with the spatial arrangement of landscape elements within a transect depicted to relative scale.

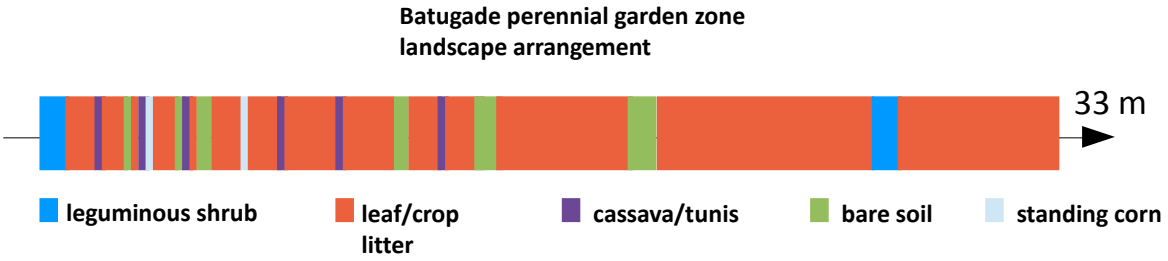
103. The landscape arrangement of the annual garden (Figure 28) is relatively simple (few landscape elements, arranged in a relatively uniform pattern).

Figure 28: Landscape arrangement of annual crop garden (transect #1) in Batugade



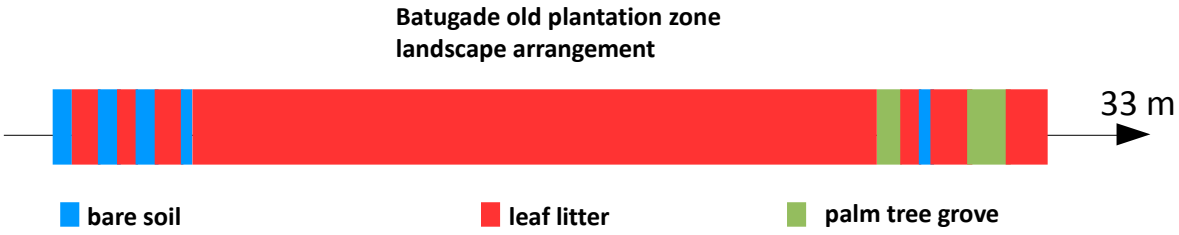
104. The landscape arrangement of the perennial garden is relatively complex (Figure 29) compared to the landscape arrangement of the annual garden (six landscape elements as compared to three, arranged in a non-uniform pattern). It shows similarities with the native vegetation landscape arrangement in terms of several landscape elements and rapidly changing element spatial arrangement over a relatively short distance.

Figure 29: Landscape arrangement of perennial crop garden (transect #2) in Batugade



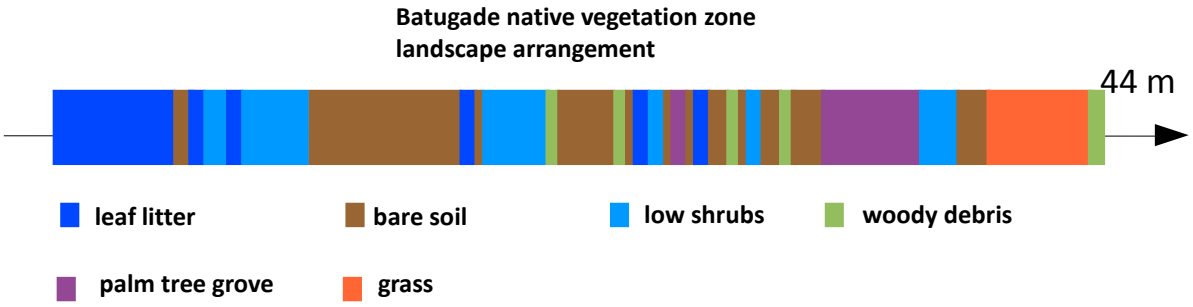
105. The landscape arrangement of the old plantation (Figure 30) is relatively simple with few landscape elements, arranged in a relatively non-uniform pattern.

Figure 30: Landscape arrangement of old plantation garden (transect #1) in Batugade



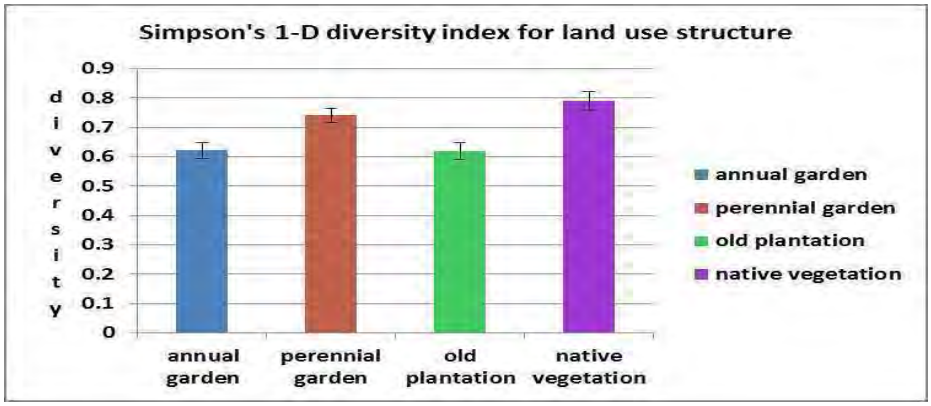
106. The landscape arrangement of the native vegetation (Figure 31) is highly complex and heterogeneous with many landscape elements, arranged in a highly non-uniform pattern.

Figure 31: Landscape arrangement of old plantation garden (transect #2) in Batugade



107. The compositional and structural diversity (Simpson's 1-D) was calculated for each land use type (**Figure 32**). Both the native vegetation and perennial garden land uses appear to show greater diversity than the old plantation and annual garden. No statistical analyses were conducted due to insufficient replication.

Figure 32: Land use diversity measured using Simpson's 1-D index for each land use in Batugade*



*Annual garden, perennial garden and old plantation are mean of two transects at each site; native vegetation is mean of three transects at site. Error bars are SE of mean and combined transects.

a.2 Landscape arrangement—Key results

108. Although statistical analysis was not undertaken (due to n=1 for each land use type), Figure 28–**Figure 32** indicate the compositional and structural diversity of both the native vegetation and the perennial garden are greater than the annual garden and the old plantation. This is not surprising given that land use intensification often results in, and/or is attributable to, vegetation homogenisation (Benton et al. 2003).

109. Perhaps the most telling result is that the spatial and compositional structure of the perennial garden is most similar to that of the native vegetation. This has two significant implications:

- The greater compositional complexity (expressed as diversity of crops and other components) of the perennial garden renders it more resistant to negative impacts such as pests, drought and invasive plants (Lu et al. 2005; Kreyling et al. 2008; although see Munro et al. 2009) and more resilient post disturbance (e.g., greater number of species to maintain ecosystem functions in event of disturbance/change) (Walker et al. 1999; Hooper et al. 2005);

- More complex habitat types harbour greater numbers and increased diversity of beneficial insects and other arthropods (Langellotto and Denno, 2004). There is also a general global trend, that as agricultural land use becomes simplified and management becomes more intense, the diversity and abundance of predatory and decomposer insects and other arthropods is reduced (Attwood et al. 2008). This translates into the perennial garden being less vulnerable to pest insect attack and having better soil nutrient status due to more decomposer soil fauna. It is also feasible (depending on spatial juxtaposition, landscape permeability and species mobility) that this land use type could provide a source for populations of beneficial insects that could reduce insect pests in annual crops (see for instance Pearce and Zalucki, 2005 in relation to sources and movement of spiders in agricultural systems).

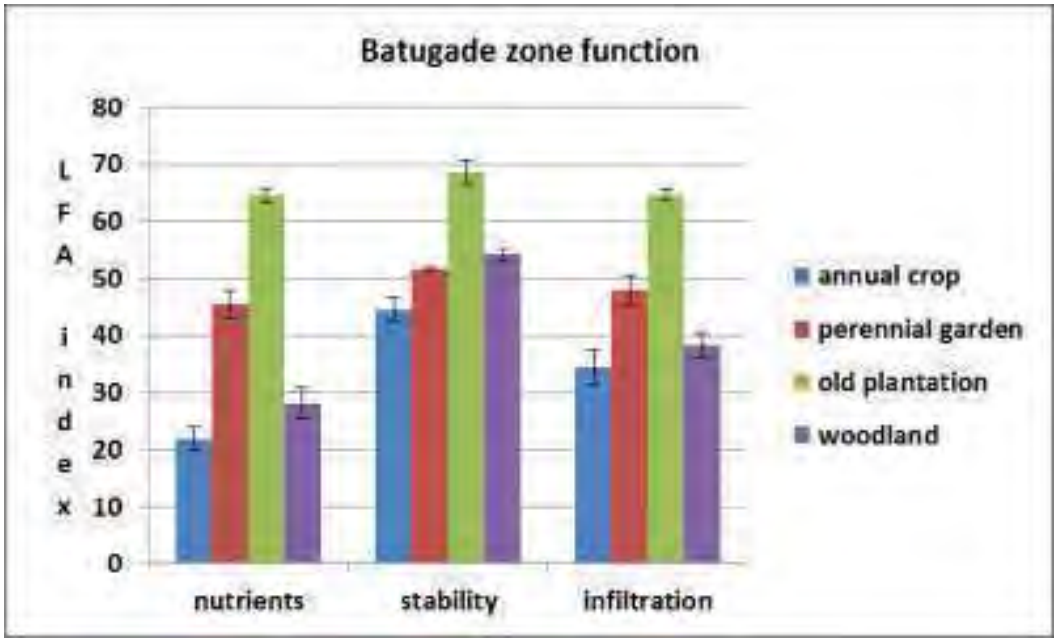
110. The key findings and recommendations relating to adaptation are the following:

- Promoting perennial gardens as a robust and resilient source of food and (potentially) ecosystem services through natural pest control.
- Considering spatial juxtaposition of perennial and annual crop gardens.
- Introducing greater compositional/structural complexity into annual gardens (e.g., more crop species, intercrops, trap crops, tree cover).

a.3 Landscape function

111. **Comparison 1** – Overall function of each garden type in terms of nutrient cycling, soil stability, water infiltration (Figure 33), where N = 2 transects each for annual crop, perennial garden, old plantation and 3 transects for native woodland. Error bars are SE of mean. No statistics done due to insufficient replication.

Figure 33: Results of garden type function in terms of nutrient cycling, soil stability and water infiltration in Batugade*



i. **Key results.**

- Nutrient cycling was greatest in the old plantation, but also relatively high in the perennial garden. By comparison, nutrient cycling in the annual crop and the native woodland was very low. This latter finding may be due to the often naturally poor nutrient status of open structured native woodland.

- Soil stability was greatest in the old plantation and the native woodland. Soil stability was slightly lower in the perennial and annual gardens. However, it was not especially low in these treatments, indicating that soil stability was generally high. Very little evidence of major erosion was found in any of the sites, so this finding is supported through observation.

- Water infiltration was greatest in the old plantation, but also relatively high in the perennial garden. Water infiltration was lower in the native woodland and lowest in the annual garden. In the latter treatment, water management was very time and labour intensive, with hand watering of crops being conducted 2–3 times per day.

- The greater functional performance for nutrient cycling, soil stability and water infiltration of the perennial garden over the annual garden (due in part to more bare soil in annual garden and more canopy cover, less bare soil and more leaf litter/crop trash cover in perennial garden) is highly consistent with a review by Kumar and Nair (2004, see Table 3, p. 145). The review indicates that diverse gardens function more effectively than adjacent open areas in terms of litter decay, soil water holding capacity, soil porosity, soil bulk density, soil pH, soil organic carbon, C:N ratio, total soil N, soil P, soil microbiological properties.

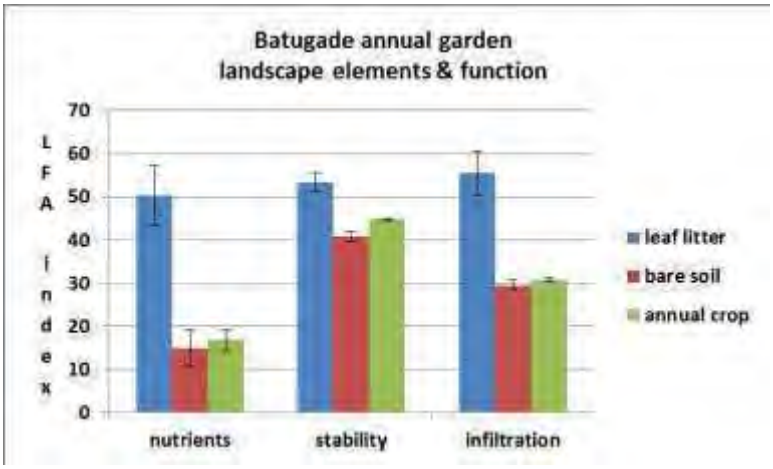
ii. **Key findings and recommendations relating to adaptation:**

- Land use function appears to be highly correlated with perennial vegetation, canopy and leaf litter cover (see landscape element sections for more detail). This indicates that increasing the cover of these elements may increase function in a number of areas in land uses where they are scarce or absent (i.e., annual crop garden). This is particularly evident in the comparison between the annual and perennial gardens.

- The old plantation had very high levels of function in comparison to the other land use types. However, the areas (often considerable in size) between timber stems appear largely underutilised. There may be opportunities to take advantage of the high levels of nutrient cycling, water infiltration and soil stability by planting perennial crops into the inter-stem spaces. This may be potentially suitable for crops that are more tolerant of low light levels (due to high canopy cover), such as cacao (although likely to be water limited), passion fruit, ginger, cardamom and turmeric.

112. **Comparison 2** – function of each landscape element in annual garden in terms of nutrient cycling, soil stability, water infiltration (Figure 34), where N = 1, (each data point on graph is mean of 2 transects). Error bars are SE of mean. No statistics done due to insufficient replication.

Figure 34: Results of landscape element function in annual crop garden in terms of nutrient cycling, soil stability and water infiltration in Batugade



i. **Key results**

- Leaf litter was by far the greatest contributor to all assessed functions in the annual crop garden. Leaf litter is a very important feature of tropical production gardens (Das and Das, 2010), as it confers on the garden a functional similarity to native forest systems (Kumar and Nair, 2004). In particular, the litter

accumulation, decomposition and subsequent nutrient release are functionally reminiscent to forest system processes (Lavelle et al. 1993; Heal et al. 1997).

- Bare soil performed poorly, particularly in terms of nutrient cycling and water infiltration. However, having a cover of annual crops (e.g., tomatoes, lettuce), did not appear to increase functional status to any great extent. This is probably due to the actual cover of bare soil below the canopy of the crop being very similar in spatial cover to bare soil without an annual crop. This is likely due to the very low basal area cover of annual crops.

ii. **Key findings and recommendations relating to adaptation**

- The findings that a) leaf litter performs very well functionally (particularly in relation to nutrient status) and b) both bare soil and annual crops with a low basal area (and therefore high bare soil cover below the canopy) indicate that increasing leaf litter/vegetation ground cover is important in maintaining good nutrient cycling and water infiltration status. Leaf litter and other forms of low vegetation cover can reduce soil temperature, aid soil moisture retention and increase abundance and diversity of soil fauna and bacteria that drive ecosystem processes and functions. Leaf litter can also reduce the impact of rain on soil structure and reduce erosion (Kumar and Nair, 2004). In terms of adaptation, farmers could increase their vegetative ground cover through a number of approaches:

    - Redistributing leaf litter from the periphery of annual gardens (where tree canopy cover tends to be greater) to the areas where crops are grown (mulching in essence);
    - Transporting leaf litter (again, as mulch) from surrounding land uses (for instance, leaf litter cover/depth in old plantation extremely high and only 50–100 m from the annual crop garden) to areas of annual crops.
    - Setting up composting (e.g., discrete areas of compost of different ages in order to maintain a continual supply) areas where leaf litter is placed/accumulated and allowed to break down (would require watering, covering, augmentation with other vegetation matter (e.g., crop trash, household organic waste).

- Minimise bare ground cover. At present, bare soil is performing poorly in terms of the measured functions, but also presents a physical barrier (e.g., in terms of high insolation and temperature) to carnivorous arthropods (e.g., spiders from the family Lycosidae, beetles from the family Carabidae and Staphylinidae) that are likely to inhabit surrounding perennial land uses and have the potential to remove pests (e.g., butterfly/moth larva) from annual crops. Increasing litter and other vegetative ground cover would increase habitat complexity at fine scales, and create conditions and a resource base more suitable for predatory arthropods to persist and migrate.

- More effective use of animal husbandry and animal manure. e.g., manure from chickens/pigs could be composted or applied directly to crops; chickens could be corralled and rotated around areas to be planted with crops in order to a) turn over soil, b) remove soil pests and c) nitrify soil with manure. Manure from

animals would enable nitrogen to be incorporated with carbon from leaf litter in order to maintain productive C:N ratio.

- Increase tree cover as means of a) protecting annual crops from heavy rain events (projected to increase in the region due to climate change), b) maintaining soil structure, providing leaf litter cover.

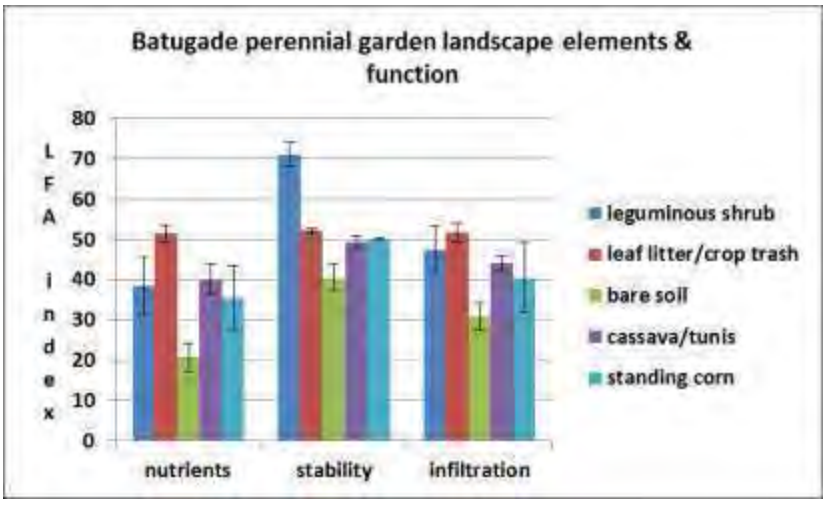
- Need to maintain tree cover (in addition to leaf cover) to enhance soil stability (one of key impacts of increase in intensity of rainfall). Manage erosion.

- Even with increased water infiltration (through increased ground cover/improved ground cover management), there will still be a need for intensive water management of annual crops. This could potentially be achieved through:

    - Improved water harvesting and storage in wet season (projected to become wetter with more intense rainfall events). This could be achieved through the provision of water tanks to collect and store rain water from tins roofs. Many dwellings and larger public buildings have tin roofs amenable to guttering, downpipes and water collection, but very few buildings have this feature installed.
    - More efficient, less labour intensive distribution of water, via a reticulation/irrigation system from stored water (in tanks).

113. **Comparison 3** – function of each landscape element in perennial garden in terms of nutrient cycling, soil stability, water infiltration (Figure 35). No statistics conducted due to insufficient replication.

Figure 35: Results of landscape element function in perennial crop garden in terms of nutrient cycling, soil stability and water infiltration in Batugade*



*N = 1 but each data point on graph is mean of 2 transects. Error bars are SE of mean.

i. **Key results**

- Leguminous shrub (unidentified sp.) very effective at maintaining soil stability. This is probably due to deep root system and fine filamentous roots binding soil.

- Leaf litter/crop trash contributed consistently highly to all assessed functions.

- Bare soil performed poorly, particularly in terms of nutrient cycling and water infiltration. However, nutrient cycling in bare soil in perennial garden appears to function slightly more effectively than bare soil in annual garden. This may be due to increased canopy cover and leaf litter/crop trash cover that protects the soil more effectively from rain events, and hence reduces the risk of erosion.

- Cassava, tunis beans and corn (maize) all contributed relatively well (higher scoring than bare soil, lower scoring than leaf litter/crop trash) to all functions. This is quite possibly due to the complex root system that develops from having several crop species intermingling and in close proximity to one another (i.e., often only a few cm between stems). This high density of roots may increase soil stability (ref) and reduce nutrient loss (Kumar and Nair, 2004) and increase nutrient uptake (Kumar and Divakara, 2001) from the soil.

ii. **Key findings and recommendations relating to adaptation**

- Leave leaf litter and crop trash in situ; do not burn leaf litter/crop trash, but allow it to break down through natural decomposition. Fire will remove the leaf letter layer and other forms of ground cover, thus eliminating the nutrient cycling and other ecosystem services that it provides (Hochegger, 1998).

- Consider using chickens (corralled into discrete areas if necessary) to reduce pests and weeds after harvest and prior to next replanting (e.g., in case of maize). Chickens will also introduce nitrogen into soil, improving soil fertility.

- Consider introducing more leaf litter from old plantation sites or fallen litter from trees at boundary of gardens.

- Produce compost from leaf litter, domestic animal manure and household organic waste; use this to augment leaf litter and reduce bare ground cover.

- Minimise bare soil through leaf litter retention and maintenance of canopy cover from shrubs, trees and woody crops (e.g., cassava).

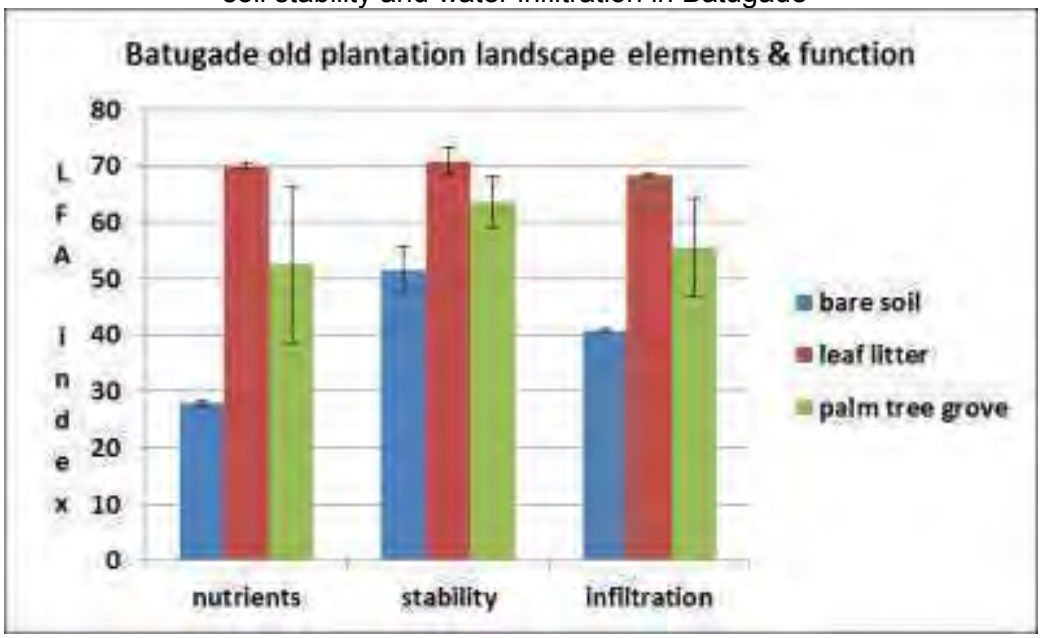
- Consider improved water capture (e.g., rain tanks from roofs in wet season) and improved water distribution through irrigation/reticulation systems.

- Consider increasing (or at least maintaining) the cover of corn (maize) in the long term. Standing corn performed creditably in terms of function, but is also one of the few productive plants that use a C4 photosynthetic pathway, which renders them more efficient at photosynthesising at current C02 levels (Zhu et al. 2008). C4 plants are also generally more able to tolerate dry conditions and high temperatures (Crafts-Brander et al. 2002; Lopes et al. 2011), which, given

climate change projections for the region, may enable them to grow in future projected drier conditions.

114. **Comparison 4** – function of each landscape element in old plantation in terms of nutrient cycling, soil stability, water infiltration (Figure 36). No statistics done due to insufficient replication.

Figure 36: Results of landscape element function in old plantation in terms of nutrient cycling, soil stability and water infiltration in Batugade*



*N = 1 but each data point on graph is mean of 2 transects. Error bars are SE of mean.

i. **Key results**

- Leaf litter contributed very highly to all assessed functions. The Landscape Functional Analysis (LFA) function scores for leaf litter in the old plantation were greater than the scores for leaf litter in the other land use types (e.g., nutrient cycling in: old plantation = 69.95, annual garden = 50.23, perennial garden = 51.55, native woodland = 46.46). The data indicate that this is due to a) much greater depth of leaf litter (often >100 mm) and b) advanced state of decomposition (self-composting in essence) of older/lower layers of leaf litter.

- Bare soil performed poorly compared to other landscape elements, but much better than bare soil in other land use types. This may be attributable to high levels of canopy cover, and relatively higher levels of leaf litter on bare ground.

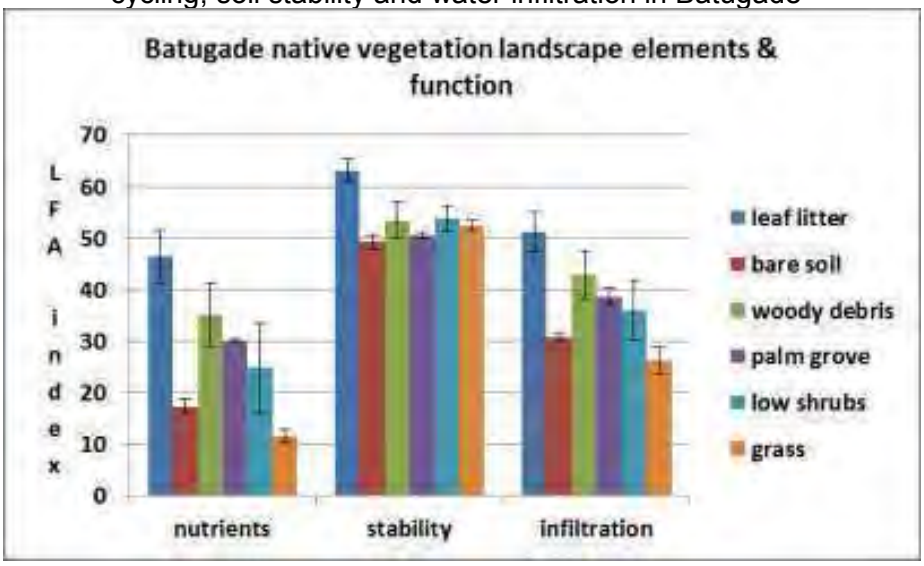
- Samples taken amongst palm trees also scored highly for all functions, potentially benefiting from the increased canopy cover and leaf litter fall.

ii. **Key finding and recommendation relating to adaptation**

- This land use appears to be very effective at maintaining function with (and perhaps, in part, because of) minimal management intervention. There are probably opportunities for using the ground layer to experiment with growing shade tolerant perennial crops in this land use and therefore increasing its productivity and output.

115. **Comparison 5** – function of each landscape element in native vegetation in terms of nutrient cycling, soil stability, water infiltration (Figure 37). No statistics done due to insufficient replication.

Figure 37: Results of landscape element function in native vegetation in terms of nutrient cycling, soil stability and water infiltration in Batugade*



*N = 1 but each data point on graph is mean of 3 transects. Error bars are SE of mean.

i. **Key results**

- Leaf litter made the greatest contribution to all assessed functions. The lower scores associated with the leaf litter in woodland compared to other land uses may be due to the sparse canopy cover of trees, leading to sparse and shallow (often <20 mm depth) litter cover on the ground.

- Bare soil and sparse grass cover performed poorly compared to other landscape elements, for nutrient cycling and water infiltration. It may be that the sparseness of grass cover did not greatly differentiate it from bare soil in terms of function.

- All land uses (excepting leaf litter) performed consistently well for soil stability. This may well reflect the fact that being native woodland (and hence never subject to cultivation), soil disturbance has been kept to a minimum regardless of the dominant landscape element in a given area of the woodland.

- Coarse woody debris (fallen trees, logs, sticks) contributed consistently well to all functions. This may be due to woody debris providing a 'trap' for nutrients and

water, particularly those associated with overland flow across relatively impervious landscape elements (e.g., sun-baked bare soil with a hard soil crust).

ii. **Key findings and recommendations relating to adaptation**

- Principally not an agricultural land use type, but a number of recommendations are:

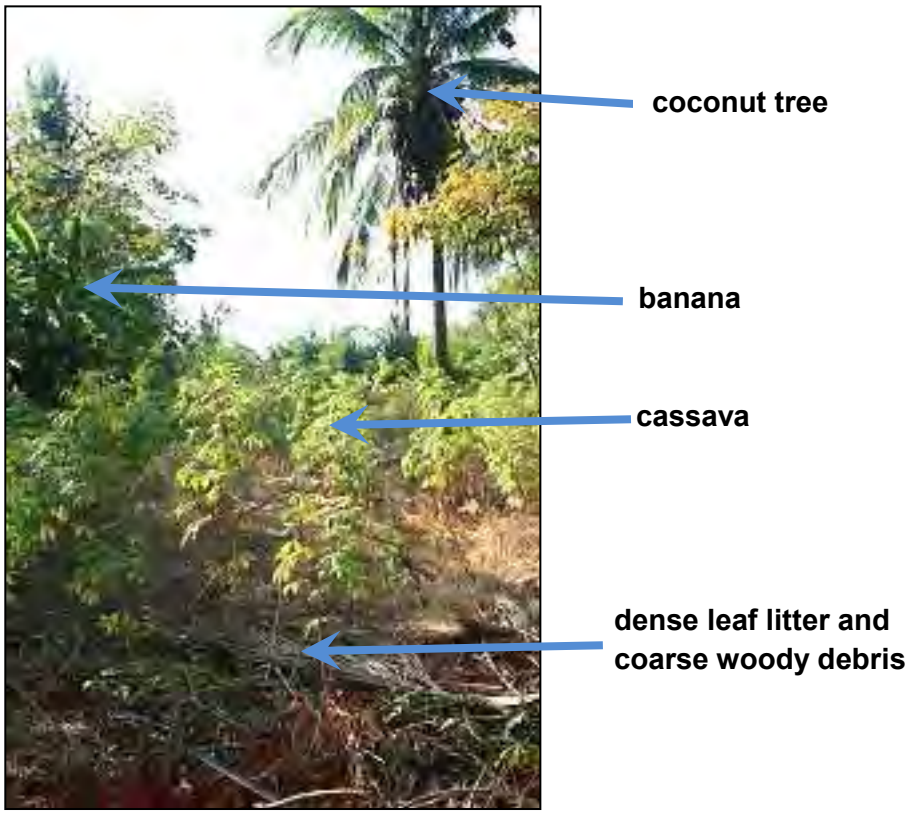
  - Better management of livestock grazing in order to reduce risk of overgrazing. Grass cover was very sparse and grassy areas performed at least as poorly as bare ground in all functions measured. While site was assessed during dry season, and therefore post-rain recovery was not assessed, there may be opportunities for sequentially grazing areas using temporary fencing as opposed to allowing pigs and goats to roam freely.
  - Coarse woody debris contributed well to all functions. Therefore, it may be worthwhile trialling the introduction of coarse woody debris in the perennial and annual gardens to intercept the flow of water and nutrients (woody debris should be placed at 90^0 to predominant flow direction. Woody debris is also known to provide habitat for beneficial insects, and therefore may be able to contribute to natural pest control.

b) Land use types—Atauro

116. In Atauro, three landscape/land use types were sampled, representing a gradient of land use intensification from fallow gardens (temporarily taken out of production in order to recover nutrient status) to frequently tended gardens consisting of perennial crops in the village of Beloi (e.g., cassava). The three landscape/land use types sampled were:

117. *Perennial crop garden in Beloi village (*Figure 38*)*—an actively and frequently managed garden of perennial tree and shrub crops such as coconuts, bananas and cassava; non-uniform spatial arrangement of crops in most cases. There are considerable areas of leaf litter with smaller areas of bare soil. Tree cover moderate. Garden management is relatively intensive due to close proximity to dwellings in village.

Figure 38: Site 2, Transect #1 of perennial garden in Beloi village, Atauro



118. *Perennial crop garden in foothills above Beloi village* (Figure 39)—an actively managed garden of perennial tree and shrub crops such as palm wine trees, tunis beans and cassava and annual crops such as maize. Also nitrifying leguminous native acacias present; non-uniform spatial arrangement of crops. Smaller areas of leaf litter than village garden, with smaller areas of bare soil. Tree cover is moderate. Garden management is less intensive than village garden due to distance from village. There is considerable grazing by goats.

Figure 39: Site 3, Transect #1 of perennial garden in foothills of Beloi, Atauro

119. *Fallow garden in foothills above Beloi village ()*—deliberately abandoned (rested) fallow garden consisting of palm wine trees, other palms, perennial grass species used for roofing, and volunteer native acacias; highly non-uniform spatial arrangement of plants. There are considerable areas of leaf litter; bare soil is not present. Tree cover is moderate to high. There is sporadic grazing by goats.

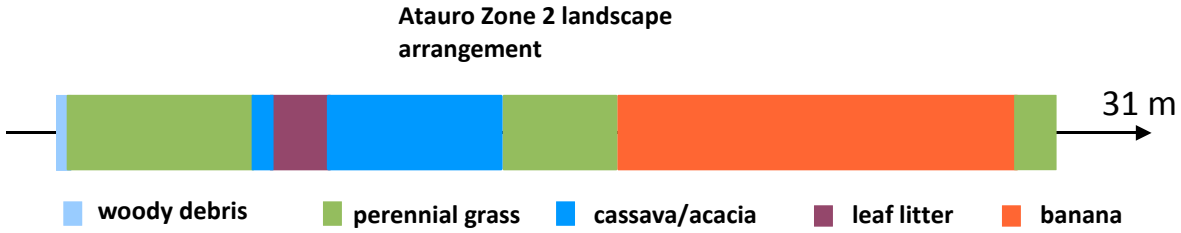
Figure 40: Site 2, Transect # 2 and site 1, transect 1 of fallow plantation in foothills of Beloi, Atauro.

b.1 Landscape arrangement

120. *The* structure and composition of each land use type is very different in terms of) the number of different landscape elements that are contained in the land use type, and b) the uniformity with which they are arranged. Figure 41–Figure 43 depict the diversity of one transect of each land use type, with the spatial arrangement of landscape elements within a transect depicted to relative scale.

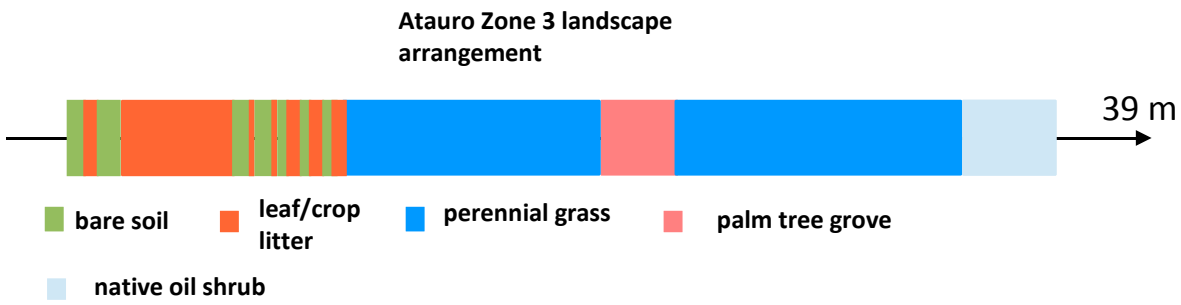
121. The landscape arrangement of the perennial village garden (Figure 41), is moderately complex with several landscape elements present along the transect.

Figure 41: Landscape arrangement of village perennial crop garden in Beloi, Atauro



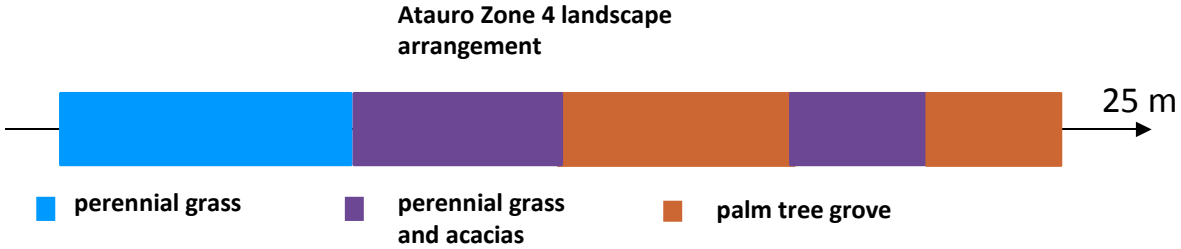
122. The landscape arrangement of the perennial foothills garden (Figure 42), is moderately complex with several landscape elements present along the transect, although more bare soil was present than was generally found in the village perennial garden.

Figure 42: Landscape arrangement of foothills perennial crop garden in Beloi, Atauro



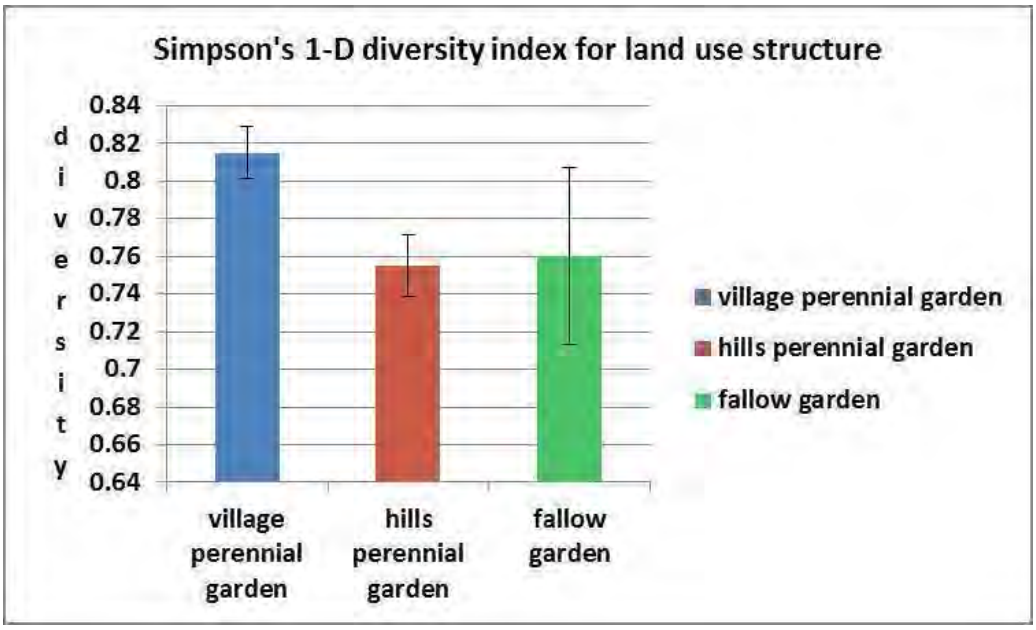
123. The landscape arrangement of the fallow garden (Figure 43), is rather simple, with fewer landscape elements present along the transect.

Figure 43: Landscape arrangement of fallow garden in Beloi, Atauro



124. The compositional and structural diversity (Simpson's 1-D) was calculated for each land use type (Figure 44). Both the native vegetation and perennial garden land uses appear to show greater diversity than the old plantation and annual garden.

Figure 44: Land use diversity measured using Simpson's 1-D index for each land use in Atauro: perennial garden in village, perennial garden in hills and fallow garden in hills*



*N = 3 replicates, with each replicate being composed of two transects. Error bars are SE mean of combined transects.

Statistics:
One-way ANOVA, Simpson's 1-D diversity: $F = 1.225_{2,6}$ P = 0.358. NS
No difference was found in the overall structural diversity of the garden types.

i. Key result

- Although Figure 41–**Figure 44** indicate that there may be some difference in compositional and structural diversity among the three garden types, no difference was apparent. This is probably due to a) the overall compositional similarity of the village and hills active perennial gardens, and b) the biases of the Simpson's index in how it incorporates richness (number of landscape elements) and abundance (number of times each element occurs along the transect) into the calculation of the index. There are other measures of diversity and evenness that could be used to examine these relationships, but a thorough examination of measuring spatial heterogeneity with various diversity indices is beyond the scope of this report.

ii. Key findings and recommendations relating to adaptation

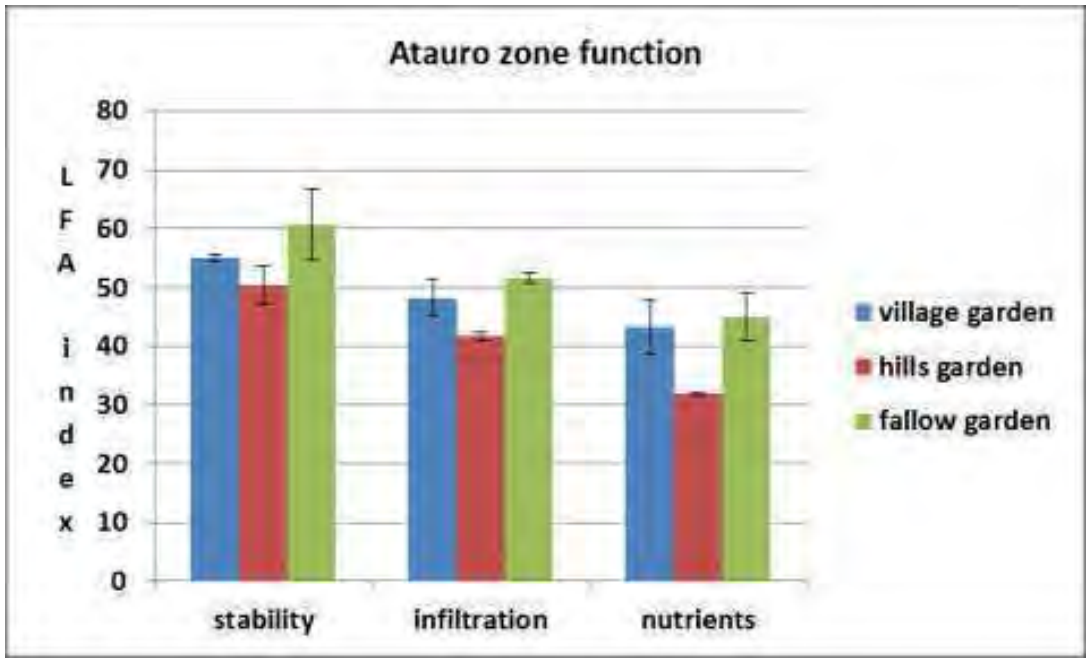
- Both village and perennial gardens seem to exhibit levels of heterogeneity/diversity that are comparable with the perennial garden in Batugade, and are therefore likely to be robust in the event of threats/disturbance and resilient post-disturbance.

- Diverse home gardens of this nature are known to be in decline in some parts of the world. For instance, market changes and government policies have led to a decrease in the number of home gardens (e.g., to coconut and rubber plantations) in Kerala (Ashokan and Kumar, 1997), and a loss of structure and function of gardens due to commercialisation of production, has been noted in Indonesia (Abdoellah et al., 2001). Consequently, these diverse gardens in Timor-Leste need to be encouraged and supported. Means of support could include research to determine how gardens can be productively improved without reducing diversity or function, and extension and outreach of any research findings and lessons learned to growers within and among regions. Another important action is to ensure that government policies do not undermine diverse gardens and that opportunities are explored to support diverse gardens through payments for ecosystem services (PES). However, there are recognised obstacles and impediments to locally managed/utilised ecosystem services (which are by definition decentralised) and PES which are often part of a centralised governmental process or initiative (Janzen, 1998). Such potential conflicts require carefully navigation and management.

b.2 Landscape function

125. **Comparison 1** – overall function of each garden type in terms of nutrient cycling, soil stability, water infiltration (Figure 45).

Figure 45: Results of garden function in terms of nutrient cycling, soil stability and water infiltration in Atauro (Beloi)*



*N = 3 replicates of 2 transects each for perennial garden in Beloi village, perennial garden in Beloi foot hills and fallow garden in Beloi foot hills, Error bars are SE of mean.

Statistics:
1) One-way ANOVA, Soil stability: $F = 1.656_{2,6}$ P = 0.267. NS
2) One-way ANOVA, Infiltration: $F = 6.778_{2,6}$ P = 0.029.Significant difference

T-test comparisons:
Village garden compared to hills garden P = 0.171 NS
Village garden compared to fallow garden P = 0.397 NS
Hills garden compared to fallow garden P = 0.00077 Significant difference

3) One-way ANOVA, Nutrient cycling: F = 4.1672,6 P = 0.073. NS

i. Key results

- All three land use types appear to perform reasonably well in relation to all three measured functions.

- The only statistically significant difference found among land use types was for water infiltration, where the fallow garden scored higher for this function on the LFA index than the perennial hills garden. This may be due to a) the length of time that vegetation in the fallow garden has remained relatively undisturbed, thus allowing for advanced root development, and thus aiding infiltration, and b) the complete absence of bare soil (which contributes to surface run-off and lateral water movement) in the fallow gardens, whereas bare soil occurred frequently in the perennial hills garden. The bare soil in the perennial hill gardens may be due to a combination of livestock grazing and post-harvest burning.

- Although not statistically significant, the village perennial garden averaged higher LFA index scores than the perennial hills garden and fallow garden for soil stability, nutrient cycling and water infiltration. This is an interesting finding in that one might reasonably anticipate environmental function to decline with management intensity (the proximity of the village gardens to dwellings renders frequent management more feasible). There are a number of reasons why the annual gardens may function well:

    - More frequent watering may promote greater, and deeper, root growth, increasing water infiltration into a more porous and well-structured soil;
    - Livestock were present in greater densities than was seen in the hill gardens; this may lead to higher quantities of animal manure, which in turn increases nutrient status of the soil (e.g., nitrogen) and can lead to enhanced primary production;
    - The presence of bananas in this land use which appear to contribute to increased soil function in a number of ways (see comparison # 2, below);
    - The hills perennial gardens are often burnt after harvest (and prior to onset of the wet season when new plantings occur). This is due to a) a desire to manage pests and weeds in the garden and b) a cultural association with burning gardens.

ii. Key findings and recommendations relating to adaptation

- While there are recommendations for each individual land use (discussed for each garden type, below), it appears that each garden type is functioning effectively in respect of all the measured landscape functions. This said, there are a few generalisations that can be made that lead to recommendations.

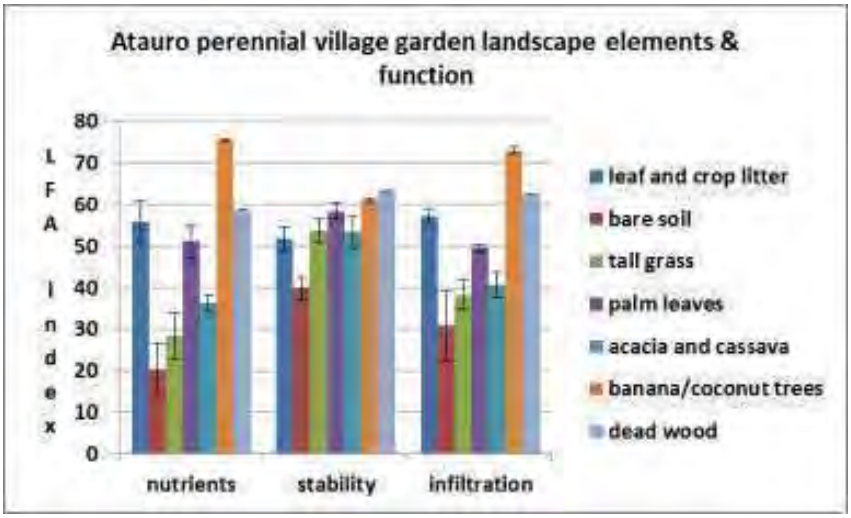
    - Bare earth leads to a reduction in function in the two active garden types (and as seen in all land uses in Batugade); therefore, strategies need to be

adopted to reduce the incidence of bare earth. Four main strategies are a) retention/collection/distribution of leaf litter that is high in nutrients and is likely to lead to a broader and deeper ground cover (e.g., leaf litter), b) composting of leaf litter/crop trash and subsequent distribution, in order to create ground over, increase nutrients in the soil (e.g., C:N ratios), reduce soil surface temperature, increase soil moisture retention, c) strategic distribution of coarse woody debris in gardens in order to reduce bare ground cover or intercept flow of resources (e.g., water, nutrients) across bare ground (i.e., woody debris placed at 90^0 to flow direction), d) cessation of burning of crop aftermath.

- At present, livestock are not managed in gardens. This can lead to a) overgrazing/excessive browsing in certain areas, and b) a missed opportunity in terms of pest control, weed control and manure composting. Therefore, recommendations in relation to animal husbandry include improved maintenance of fences around gardens, collection of manure for composting or immediate distribution on gardens and use of chickens to remove weeds/pests from harvested gardens.

126. **Comparison 2** – function of each landscape element in perennial garden in village in terms of nutrient cycling, soil stability, water infiltration (Figure 46). No statistics done due to insufficient replication of each landscape element.

Figure 46: Results of landscape element function in village perennial garden in terms of nutrient cycling, soil stability and water infiltration in Atauro*



*N variable depending on frequency of occurrence in this garden type, but each reading is mean of two transects in each garden replicate. Error bars are SE of mean.

i. Key results

- Bare soil contributes poorly to all three measured functions.
- Leaf litter, crop trash, dead wood and palm leaves all contribute well to the measured functions.

- The presence of coconut and (in particular) banana trees greatly increases nutrient cycling and infiltration. The litter below banana trees was extremely deep (>120 mm) and highly decomposed in parts, indicating that the soil immediately below the banana trees has a very active soil fauna (e.g., bacteria, collembolan, other micro-, meso- and macro-arthropods), that drive nutrient cycling and the maintenance of soil porosity. Such litter volume observations are consistent with the studies that have found greater litter volumes in some tropical production gardens than in native forest systems (Gajaseni and Gajaseni, 1999).

ii. **Key findings and recommendations relating to adaptation**

- Minimisation of bare soil cover (see recommendations in comparison 1, above).

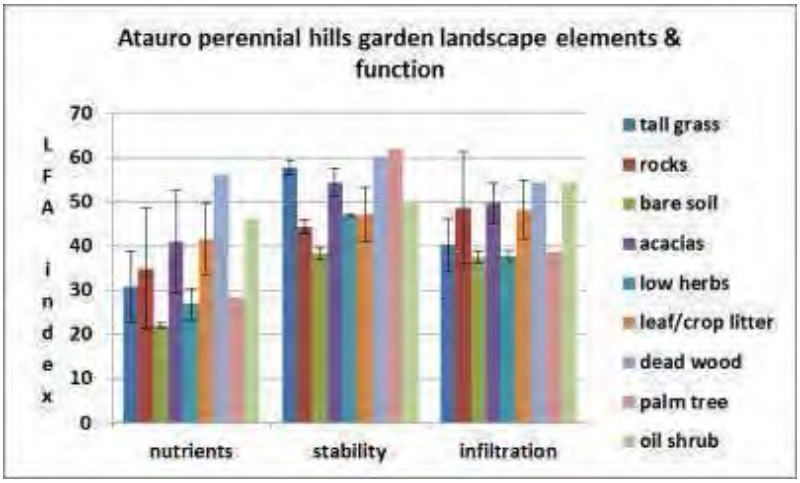
- Increase in leaf litter and crop trash as ground cover (see recommendations in comparison 1, above).

- Placement of woody debris in strategic locations to intercept overland flow of resources (see recommendations in comparison 1, above).

- Increase in production of bananas, or more proactive and strategic harvesting of banana leaves and distribution around garden. This could be done by directly placing banana leaves in areas of garden where they are absent (e.g., amongst cassava or tunis beans), or by experimenting with composting approaches and subsequent distribution of leaves. Such approaches have been used in (for instance) banana/intercropped systems in Uganda, where banana leaves have the potential to recycle up to 25 kg ha^{-1} yr^{-1} of nitrogen, and banana leaves and pseudostems have the potential to recycle up to 43 kg ha^{-1} yr^{-1} of potassium (Lekasi et al. 1999).

127. **Comparison 3** – function of each landscape element in perennial garden in hills in terms of nutrient cycling, soil stability, water infiltration (Figure 47). No statistics done due to insufficient replication of each landscape element.

Figure 47: Results of landscape element function in foothills perennial garden in terms of nutrient cycling, soil stability and water infiltration in Atauro*



*N variable depending on frequency of occurrence in this garden type, but each reading is mean of two transects in each garden replicate. Error bars are SE of mean.

i. **Key results**

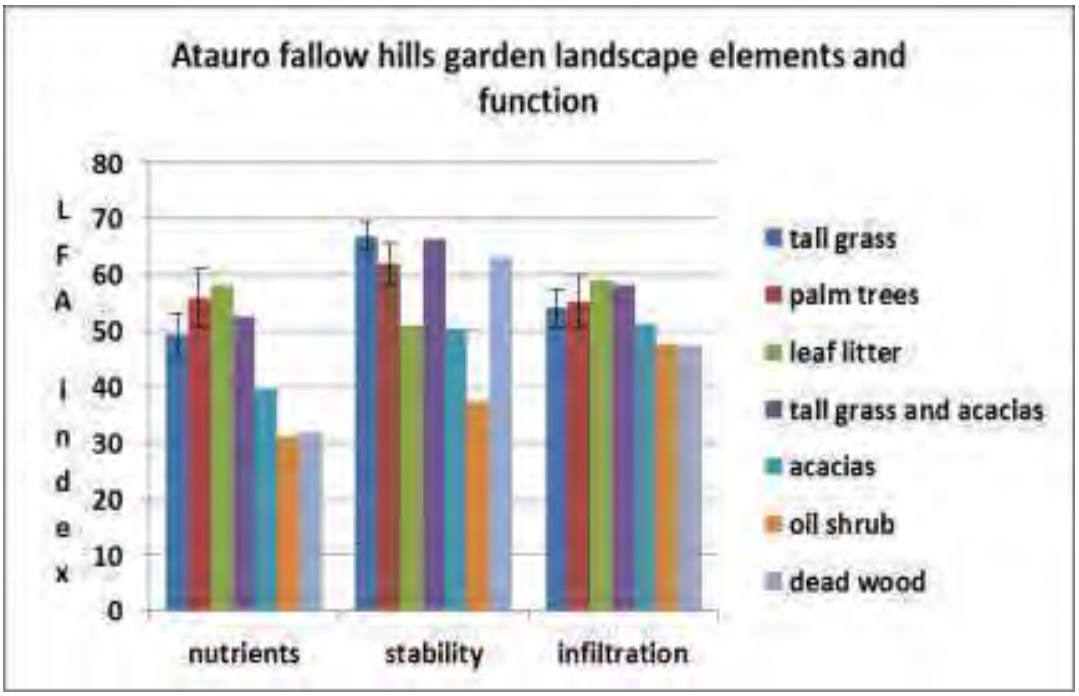
- Bare soil contributes poorly to all three measured functions.
- Leaf litter contributes well to the measured functions.
- While tall perennial grasses (generally used for roofing thatch) contribute well to soil stability, they are poor for nutrient cycling and less effective than some other landscape elements (e.g., leaf litter/crop trash).
- Coarse woody debris appears effective at maintaining all measured functions.

ii. **Key findings and recommendations relating to adaptation**

- Minimisation of bare soil cover (see recommendations in comparison 1, above).
- Increase in leaf litter and crop trash as ground cover (see recommendations in comparison 1, above).
- Placement of woody debris in strategic locations to intercept overland flow of resources and aid infiltration of water (see recommendations in comparison 1, above).
- Explore opportunities to reduce the cover of perennial grasses and replace with more perennial crops planted into leaf litter. This could be conducted in small discrete areas of a garden as a test prior to broad scale application. See comparison 1 recommendations for information on collecting, processing and distributing leaf litter and crop trash.

128. **Comparison 4** – function of each landscape element in fallow garden in hills in terms of nutrient cycling, soil stability, water infiltration (Figure 48). No statistics done due to insufficient replication of each landscape element.

Figure 48 :Results of landscape element function in fallow garden in terms of nutrient cycling, soil stability and water infiltration in Atauro*



*N variable depending on frequency of occurrence in this garden type, but each reading is mean of two transects in each garden replicate. Error bars are SE of mean.

i. **Key result**

- Leaf litter, perennial thatching grass and palm trees contribute well to the measured functions.

ii. **Key findings and recommendations relating to adaptation**

- Fallow gardens might be an effective source of litter to distribute on active garden types.
- It is not known how rapidly fallow gardens recover their function after being used as perennial gardens in the hills. Farmers could experiment with taking land out of fallow after a shorter period than the 5–6 years that is presently the norm.
- Given that a) the fallow gardens are unmanaged, and b) no landscape elements performed exceptionally well or exceptionally poorly in maintaining function, no other recommendations are made with regard to fallow management.

2. Conclusion

129. The different forms of land use in Batugade and Atauro, as represented by the home gardens, provide a wide range of crops for both subsistence and commerce at local markets. They also provide a variety of other materials such as timber for construction and thatch for roofing. That the home garden is a traditional feature of these communities is a testament to: a) their ability to provide a wide range of produce, and b) their resistance and resilience to long term environmental changes and short term climatic events. Perennial gardens in particular appear to function very effectively in terms of nutrient cycling, soil stability and water retention. This is likely due to a combination of factors (e.g., diverse range of plants, complex spatial structure, deep rooted plants, continual ground cover), but is, in a broader sense, potentially attributable to the structural, compositional and functional resemblance to native systems in which environmental function tends to be high.

130. The diversity of the perennial systems may also confer other desirable functional attributes on the system such as invertebrate mediated pest population control and pollination. This in turn is likely to confer such functional traits at scales greater than that of the individual garden, thus conferring improved environmental function on the wider landscape. As well as the active perennial gardens, it appears that the measured functions may be slightly greater in the areas rested from production (fallow gardens). This indicates that the practice of periodically resting gardens may give them an opportunity to recover.

131. While we have found that the perennial gardens function well, there are a number of recommendations that we can make based on this research:

- Annual gardens do not appear to function as well as perennial gardens. This appears to be largely attributable to the large areas of bare soil present in these gardens. Growers should consider utilising leaf litter to reduce bare ground cover, or begin producing compost or mulch from leaf litter in order to distribute around the annual gardens;

- Perennial gardens function well, but some elements function better than others. Efforts should be taken to reduce any bare ground cover, increase litter cover and in particular use leaf litter from banana trees to increase ground cover;

- Plantations function well, due in part to high levels of canopy and ground cover; however they appear under-utilised. We recommend that communities experiment with planting shade-tolerant perennial crops into inter-stem spaces in plantations as another means of production;

- Any activity that increases bare ground should be reduced. In particular, the burning off of crop trash at the end of the harvest should be discouraged as this a) increases bare ground, b) reduces certain soil nutrients, c) eliminates beneficial soil fauna;

- Fallow areas appear to recover effectively from cropping activities. However, a research priority should be to determine if there is an optimum cropping period where function begins to fall off, but does not become significantly depleted, and conversely whether there is an optimum resting period, whereby functional attributes recover, thus allowing cropping to resume.

132. Overall, the Landscape Function Analysis approach worked well in a) determining relative function of different land use types and b) establishing which specific components contributed to, or detracted from, system function. From this, some clear and relatively straightforward management recommendations have been made. While we have provided a snapshot of the land use condition and function of the various types of home garden, it was apparent that the LFA approach is relatively easy to conduct, analyse and interpret. Consequently, it could be used by local NRM officers to a) establish baseline function, b) track function over time in response to climate change (e.g., altered rainfall, increased temperatures) and c) track function over time in response to specific adaptation actions, such as those suggested in this report.

H. Evaluation of adaptation strategies from an environmental perspective using marine and coastal ecosystem service analysis

Activity:	Ecosystem service assessment using InVEST
Aim/Key question:	• Presently, what and where are the most important natural assets in terms of utility to the community in question (i.e., which natural assets contribute the most to ecosystem services that the community relies on)? • Under the various adaptation strategy/management portfolio scenarios, how may the presence, extent and distribution of those priority natural assets change? • How may the services provided by those natural assets change under the various adaptation strategy/management portfolio scenarios? • Is it possible to: a) determine which are natural assets that most require protection/retention b) determine whether a management or adaptation action move the community towards/away from their desired future?
Brief details of method:	Using data for Atauro only (i.e., Batugade) as a pilot study: • Fisheries mapped and ranked for the entire island; • Fisheries and other resource bases mapped for the entire island; • Recreation mapped and ranked for the entire island; • Fisheries and other resource bases mapped for each focal community (five in total); • Natural habitats and resource use mapped for each focal community; • Foreshore structure and vegetation ground-truthed and mapped for Beloi (approx. 3 km of coastline). All data to be analysed using InVEST software to determine: a) ecosystem services baseline, and b) potential changes to natural assets and ecosystem service delivery as a consequence of adaptation actions being implemented.
Key results:	• All data collected from two or more community sources, or mapped on-ground. • All other data required for InVEST (e.g., bathymetric data) has been collected or in the process of acquisition. • Analysis is on-going.

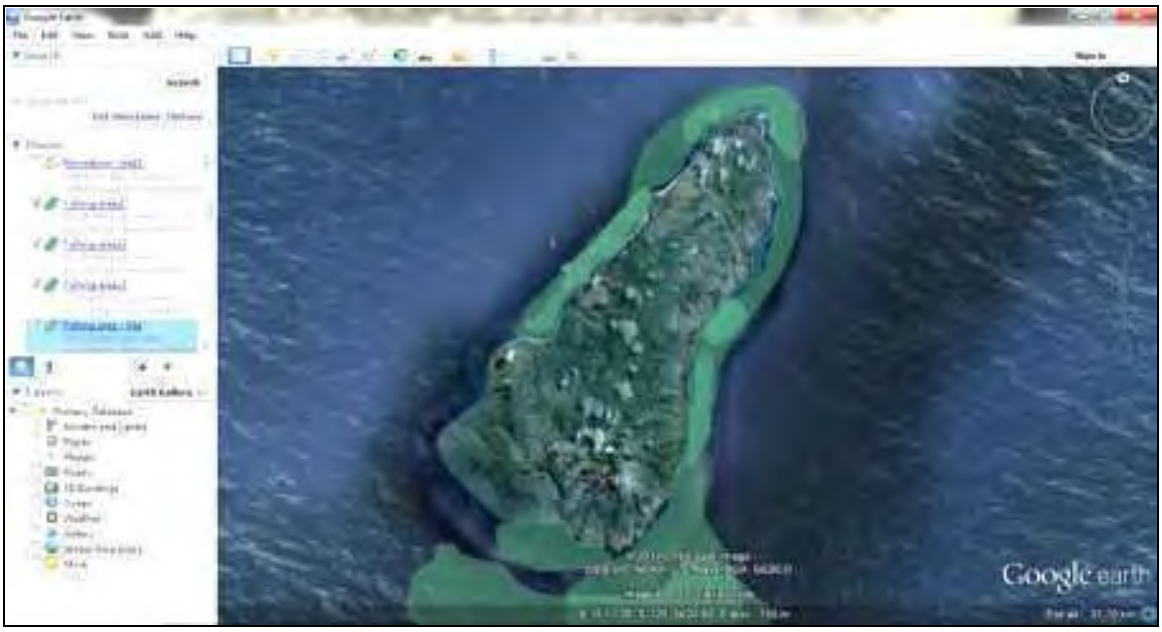
1. Results (preliminary)

133. The interim results are able to provide a detailed assessment of natural asset locations.

a) Fishery locations

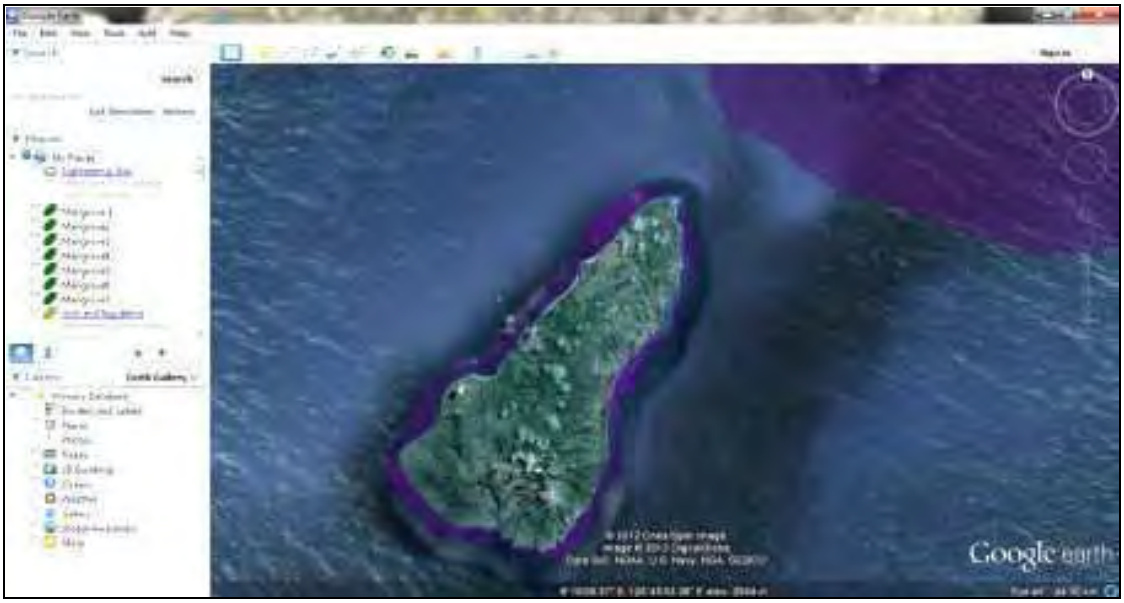
134. Figure 49 depicts the location of fisheries as indicated by Barry and Mario (order of importance not annotated). Each Suco has its own areas of fishing emphasis (e.g., Beloi fishers tend to patrol middle sections of island on both east and west coastlines), but there is a great deal of crossover into neighbouring areas (e.g., Biqueli and Beloi coincide a great deal). They also indicated a good deal of pelagic fishing (for tuna) in the waters to the south of the island.

Figure 49: Atauro Island fisheries (in relation to suko) as depicted by Barry and Mario of Barry's Place



135. Figure 50 meanwhile, depicts the location of fisheries as indicated by Marcello of local NGO Roman Luan. Marcello's interpretation of priority fishing grounds also indicated that each Suco tends to patrol certain areas, with similar patterns of crossover among neighbouring areas as reported by Barry and Mario. The main differences, however, are that a) Marcello depicts the entire coast of the island (including the far south-western corner) being utilised for fishing, b) the southern part of the island not being used for pelagic fishing (as reported by Barry and Mario), and c) pelagic fishing from Biqueli village occurring to the far north east of the island, including the waters of the south-western coast of Pulau Wetar.

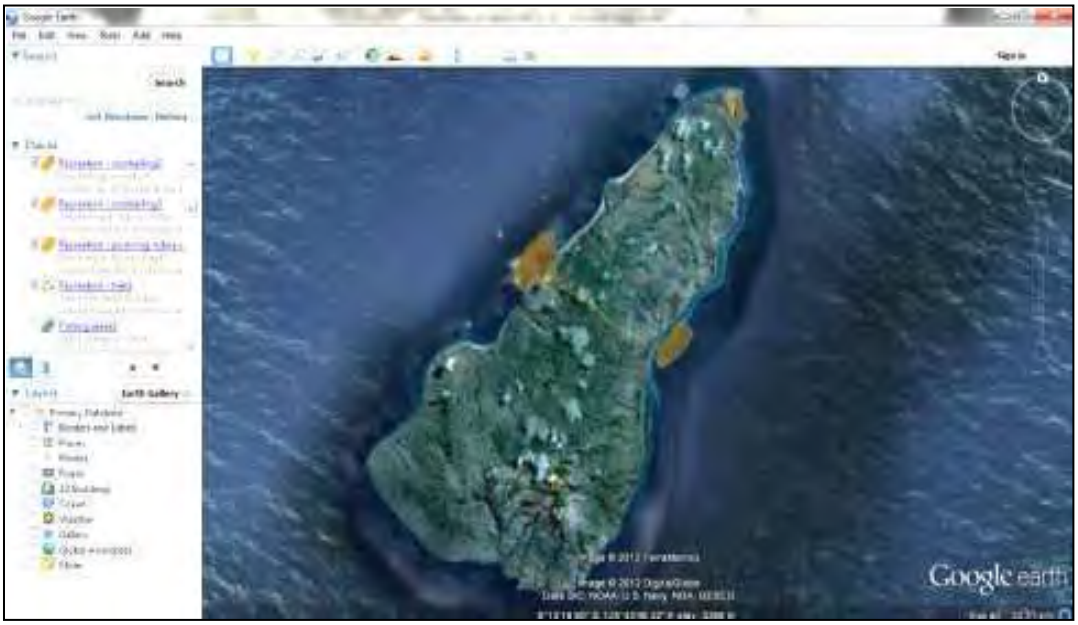
Figure 50: Atauro Island fisheries (in relation to suko) as depicted by Marcello of local NGO Roman Luan



b) Eco-tourism/recreation locations

136. Figure 51 illustrates the localities of major sources of recreation and eco-tourism as annotated by Barry of Barry's Place. The recreation activities, which include snorkelling, trekking and picnicking areas, were ranked in terms of importance (not illustrated), as required by the InVEST modelling software. The most prominent nature-based recreation activities were related to the Beloi Suco, namely snorkelling off the Beloi coastline, trekking to Adara on the western coastline and snorkelling off the Adara coast.

Figure 51: Atauro Island eco-tourism and recreation areas as selected (and ranked, not illustrated) by Barry of Barry's Place eco-lodge



c) Natural habitats and utilisation

137. The main marine and coastal natural habitats (i.e., sea grass beds, mangroves and coral reef) in the region of Beloi village as annotated by Barry of Barry's Place eco-lodge are illustrated in Figure 52. The main community uses of each habitat type were also notated and included in the data set. For instance, the sea grass beds were principally used for spear fishing, net fishing and seaweed farming, whereas the reefs are used more for line fishing and sea cucumber harvesting, as well as snorkelling and recreational fishing (for visitors).

Figure 52: Natural habitats around Beloi village and how utilized by local community as reported by Barry of Barry's Place eco-lodge

138. Marcello (of Roman Luan, and having a broad knowledge of the island's habitats) was able to provide mapping and utilisation of natural habitats (mangroves, sea grass beds and coral reefs) of the entire island. These are depicted in Figure 53 to Figure 56, showing Beloi, Biqueli, Vila and Makili, respectively. Utilisation of each habitat type appears to be very uniform across the island, with sea grass beds generally utilised for spear and net fishing and seaweed farming, coral reefs used for spear, net and line fishing, snorkelling, recreational fishing and sea cucumber harvesting, and mangroves utilised for firewood and crab harvesting.

Figure 53: Natural habitats around Beloi village and how utilized by local community as reported by Marcello of Roman Luan

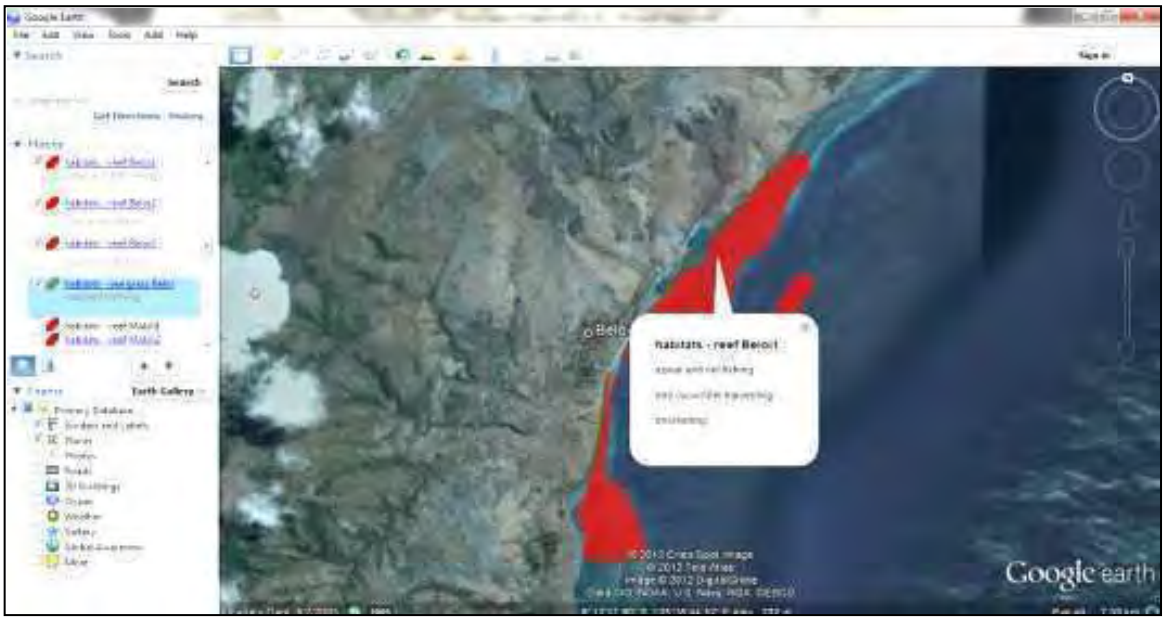


Figure 54: Natural habitats around Biqueli village and how utilized by local community as reported by Marcello of Roman Luan

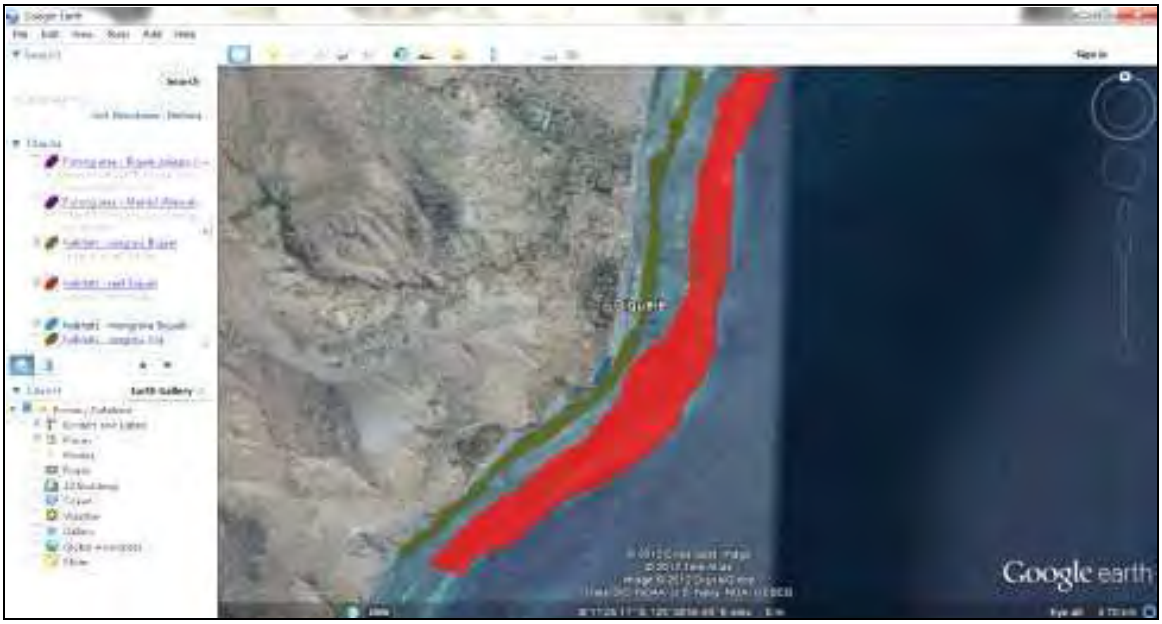


Figure 55: Natural habitats around Vila village and how utilized by local community as reported by Marcello of Roman Luan

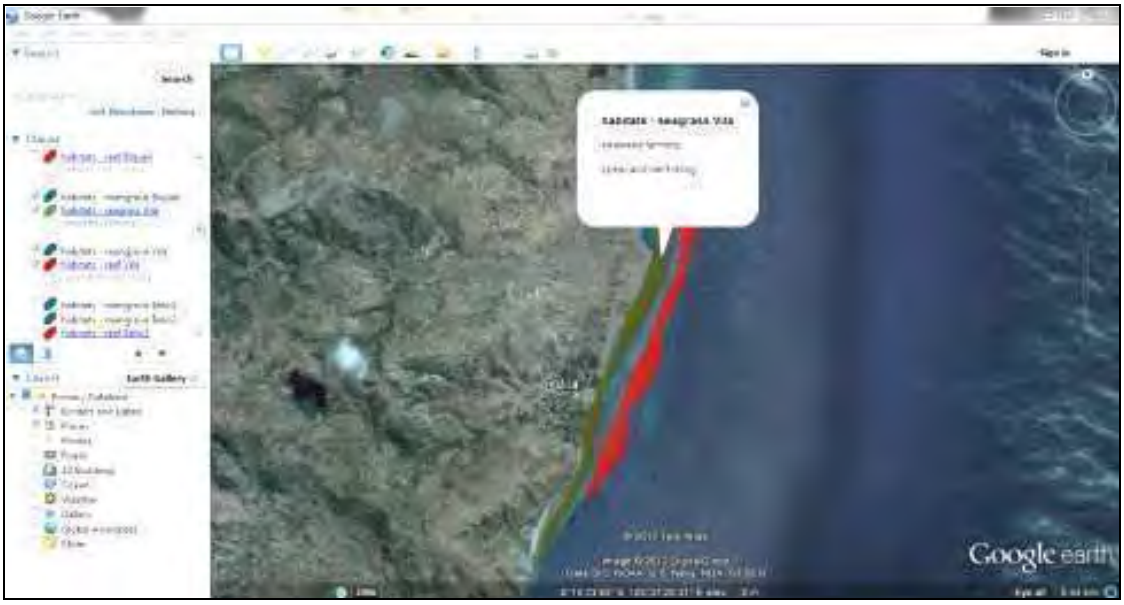


Figure 56: Natural habitats around Makili village and how utilized by local community as reported by Marcello of Roman Luan

d) Beloi foreshore structure

139. The structure of the foreshore in the vicinity of Beloi village, when inspected on-ground, is highly variable, with areas of mangrove, woody native vegetation (generally shrubs <2 m in height), and fallen trees and rocks deliberately placed along between the road and the shore. There are also areas that appear to have very little protection from the sea, with low foreshore height coupled with no natural or constructed features to obstruct sea incursions should they

occur. Figure 57 depicts an overview of the foreshore composition and structure along the Beloi village coastline (extending approximately 1.5–2 km along the coast north and south of the village). Figure 58 to Figure 61 illustrate a selection of individually mapped features with photographs of each feature.

Figure 57: Foreshore features within 1.5–2km of Beloi village, as mapped on-ground

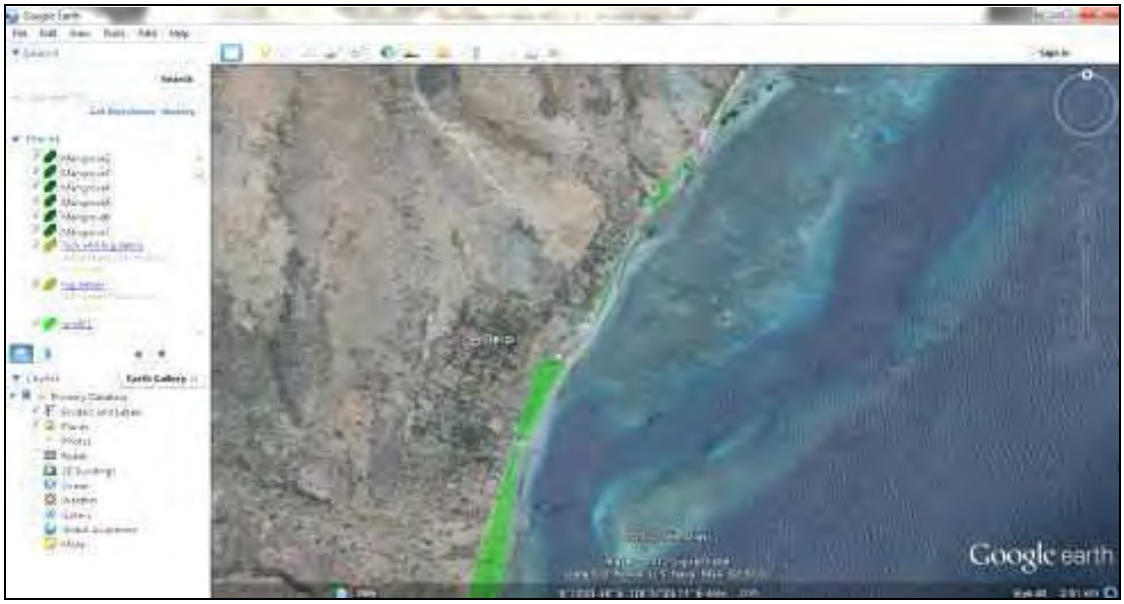


Figure 58: Foreshore 1.5 km north of Beloi village, illustrating mangroves and foreshore protection (rocks and woody debris)

Figure 59: Foreshore 1 km north of Beloi village, illustrating high sea wall and native vegetation growing on foreshore

Figure 60: Foreshore immediately adjacent to Beloi village, illustrating native vegetation growing on foreshore

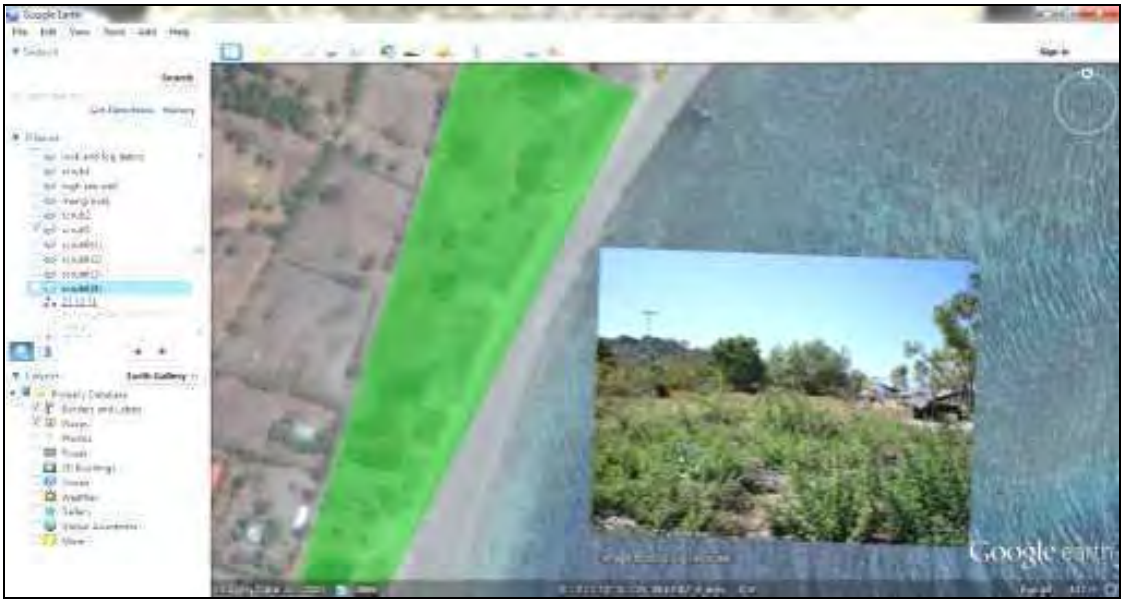


Figure 61: Foreshore south of Beloi village, illustrating native vegetation growing on foreshore

I. Stakeholder participatory workshops in Timor-Leste, March 2013

Activity:	Stakeholder participatory workshop
Aim/Key questions:	• How useful is the material produced in respect to supporting the community members to make decisions about how to adapt? • How can community members in Batugade and Atauro use this information to develop a plan for implementing adaptation actions?
Brief details of method:	• Presentation of social, economic and environmental evaluations conducted on a selection of adaptation actions selected by the community as potentially useful. • Participatory activity focused on community members considering if and how they would implement each adaptation, including a discussion on thresholds (tipping points) likely to prompt implementation. • Participatory activity focused on community members providing feedback on the usefulness of the outputs produced during the project.
Key results:	• The posters produced to summarize the case study findings were considered by the communities to provide useful information (particularly because it incorporated the fishers' contribution of their own information) • Some adaptation actions can be taken immediately, however others require specific technical training. • Farmers expressed much interest in using leaf litter for making compost. • Participants appreciated the visual aspect of the social networks, how it shows relationships, and the potential for increasing knowledge transfer along important relationship pathways.

1. Method - community workshop

140. In March 2013 community workshops were held in Batugade and Atauro, in addition to a meeting held with national level decision makers in Dili. The purpose of the workshops was to present the results of the analysis on the social, economic, and environmental evaluations conducted on adaptation options selected by the community as being potentially useful.

141. The same format for the workshops was used in Batugade and Atauro with the overall structure aiming to discuss with community members: (a) the details of the analysis conducted on a small number of adaptation actions; (b) if and how the analysis and the materials produced might be for implementing adaptations; (c) the likelihood of participants using the results of the analyses and how they might use them; (e) if there were new (external) actors needing to be brought into their social network to help implement adaptations; and (f) what events need to happen or what thresholds need to be breached to trigger implementation of an adaptation. These activities were undertaken during a half-day workshop in each community (see 0 for full details of the workshop agenda). The workshops were conducted in the local language, Tetum, and in-country partners provided translation between the community members and the English-speaking Project Team.

142. Slight modifications were made to the agenda in both Atauro and Batugade to reflect location-specific differences, such as the number and gender mix of attending participants and the number and experience of in-country facilitators and translators that were assisting. The following section provides more specific details of the methods used to facilitate key participatory activities in the Atauro and Batugade workshops. The agenda for the Dili workshop can be found in mid-term report, Appendix 2.

143. The workshop in Dili was attended by government staff, NGOs and development programs. The workshop focused on updating participants on research conducted to date, reviewing the framework used for the project, and disseminating the results posters (mid-term report, Appendix 3).

a) Presentation of adaptation analysis / results posters

144. The aim of this activity was to present back the analysis conducted on the selected adaptations. At the outset of all workshops (and all subsequent data collection activities), the participants were provided with details (in Tetum) of the nature of the data to be collected from them, and how the information would be used and stored. Participants were also informed about their right to refuse or end participation in the study, issues of confidentially that the Project Team would adhere to, and any risks or benefits that would likely flow from their participation. Those community members agreeing to consent to these terms were asked to provide their signature. Table 19 details the number of men and women attending the community workshops in Atauro and Batugade, and the workshop in Dili.

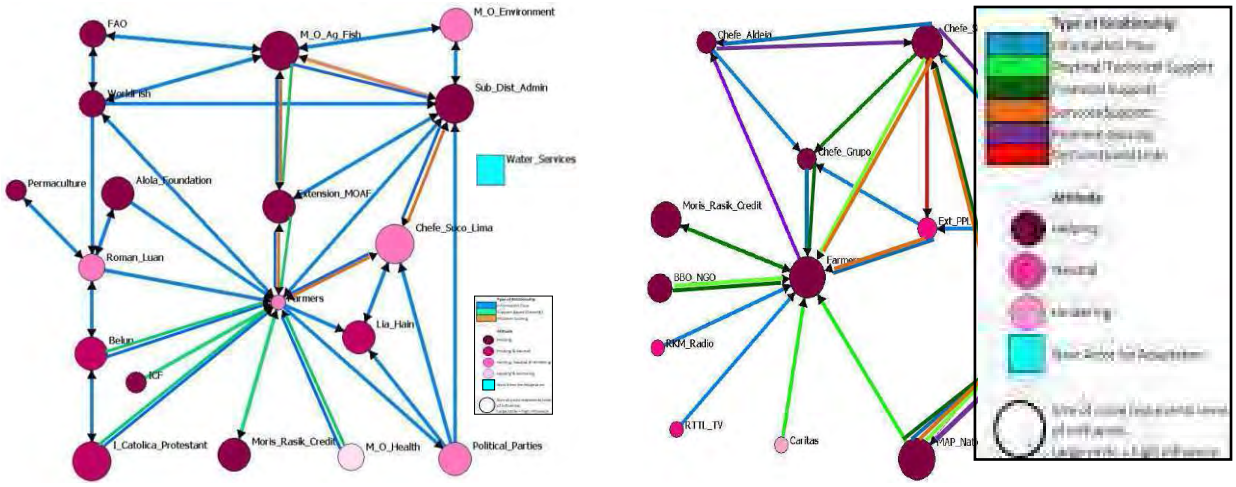
Table 19: Number of men and women attending the March 2013 workshops

Location	Men	Women
Atauro	26	4
Batugade	15	2
Dili	27	4

145. To start the workshop each community was given a full set of posters to review; this enabled results from each community case study to be shared (see 0 for English versions of all the results posters). The posters detailed the steps and activities that had been undertaken in Timor-Leste since the project began. This included a review of past climate trends and estimates of future projections considered in light of seasonal fishing and farming activities (the latter being material created as part of a projected included in the Australian Government Coral Triangle Initiative on Coral Reefs, Fisheries and Food Security (Mills et al., 2013).

146. Other posters detailed sustainable agricultural practices that may help farmers respond to the challenges of a changing climate. They also showed social network maps produced by the community to illustrate how actors within the farming and fishing networks are connected, their influence, and the types of relationships they share. The maps helped visualize who is necessary to help farmers and fishers plan, implement and maintain sustainable livelihood adaptations (**Figure 62**). The posters also included results of a partial cost benefit analysis of different methods of fishing that may be useful as an adaptive response to climate change.

Figure 62: Example of social network maps produced for Atauro (left) and Batugade (right)*



*The size of the circles show how important each person or group is. The different colored lines show how the people and groups are linked and what resources and services flow between them. (More detailed social network maps for Atauro and Batugade can be viewed in the project mid-term report (Park et al., 2013).

147. After reviewing the posters, the community participants separated into fisher and farmer groups, with the farmers focused on the sustainable agriculture practices posters (poster 8 focusing on the environmental analysis and poster 9 focusing on the farming social network analysis), and the fishers focused on the fishing activities posters (poster 11 focusing on the economic analysis and poster 12 focusing on the fishing social network analysis). In these groups, participants discussed how useful the information provided was in supporting them to plan adaptations and what social, economic, or environmental triggers might indicate when it is the appropriate time to implement an adaptation. Participants recorded their feedback in Tetum onto evaluation posters (see mid-term report, Section 3.1.2). This involved the participants using colored stickers to indicate how useful the information was on a scale of 1 to 10 (where 1 sticker indicated the information was not useful and 10 stickers indicated it was very useful). The participants were also asked to write down who they needed to liaise with in order to implement their desired adaptations, and what would trigger the participants into taking action.

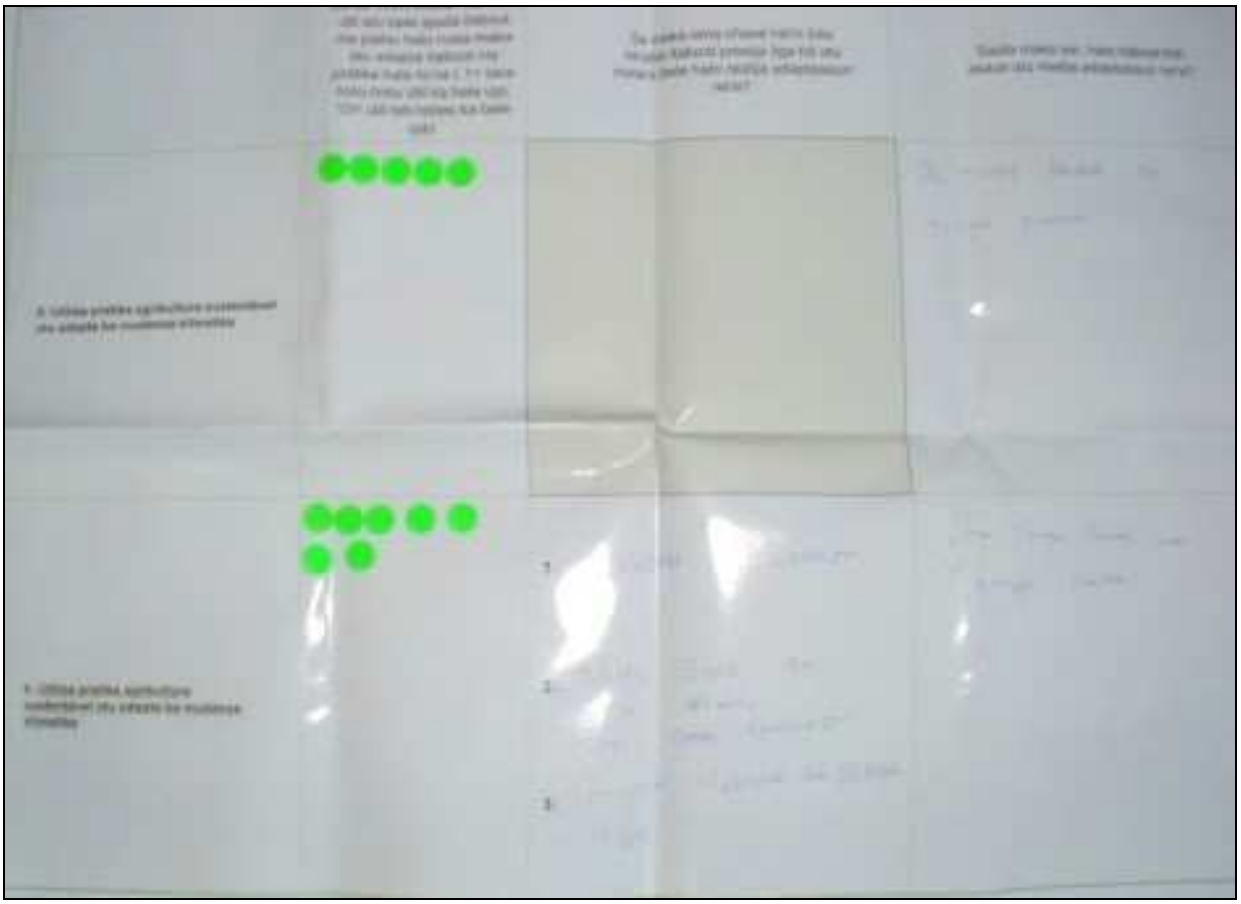
148. In Atauro each livelihood focus group presented their findings to the whole workshop once the exercise was complete, and plenary discussions were facilitated with the aim of allowing all community members' views to be expressed. This additional discussion was not conducted in the Batugade workshop due to time constraints.

2. Results - responses to the evaluation of selected adaptations

149. Reactions from farmers in Batugade. Farmers in Batugade provided positive feedback on the sustainable agriculture practice posters as the information was considered useful and the pictures very good (Figure 63). Linking their daily activities to the information provided, indicated the following:

- Sometimes the results are helpful, but some results will have no impact on their daily activities;
- Farmers are already practicing some of the recommendations so the information was not new to them. They said they would continue with these practices;
- Using leaf litter for compost is new information as they usually burn this to control pests.

Figure 63: Batugade Farmers' feedback on Sustainable Agricultural Practices posters*



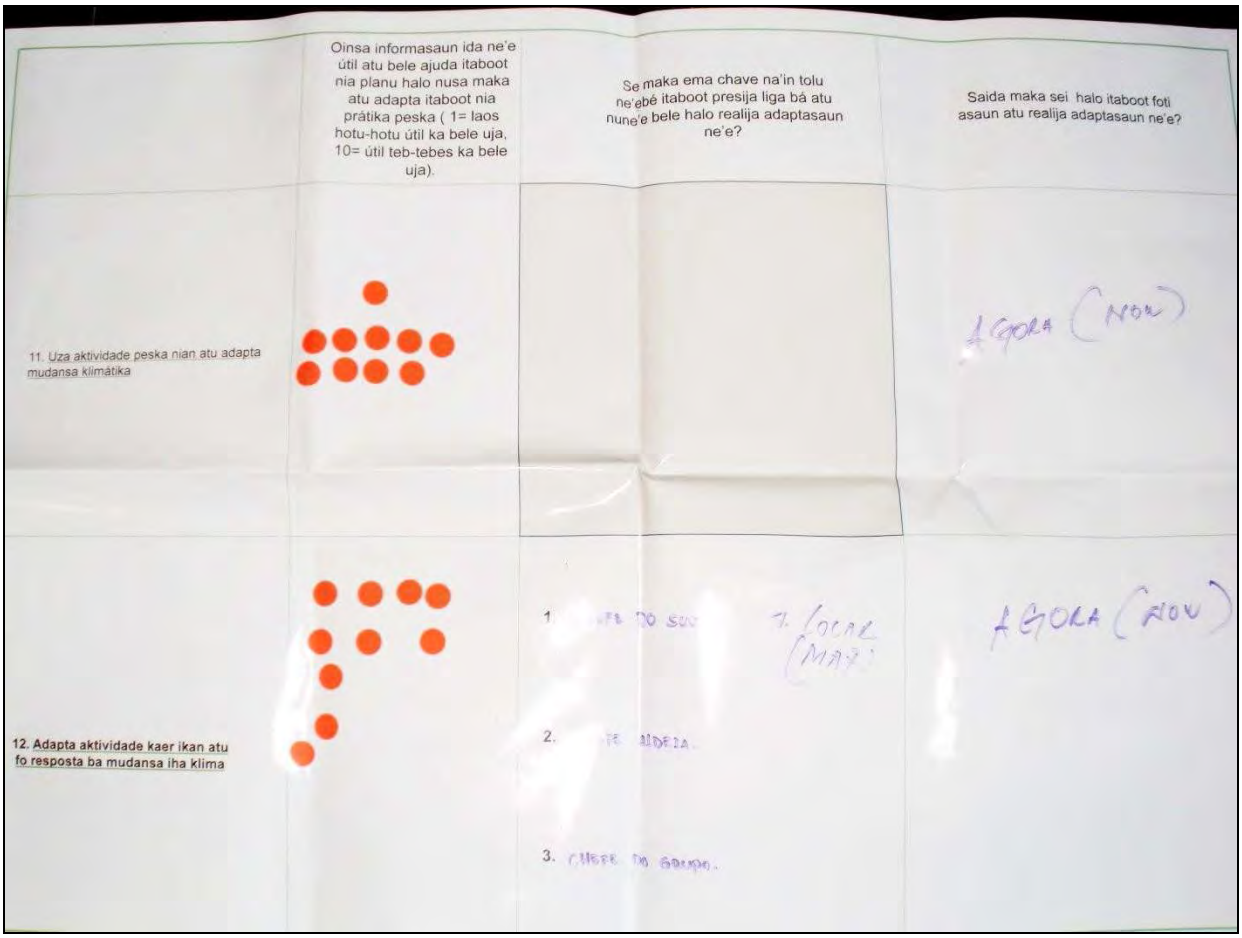
*English translations of the questions and responses from the above poster are shown in Table 20.

Table 20: Questions and responses from farmers in Batugade

	How useful is this information in helping you plan how you will adapt your farming practices (1 = not useful, 10 = very useful).	Who are the first 3 key people you will need to liaise with to make this adaptation happen?	What will trigger you taking action to make this adaptation happen?
Poster 8	5	N/A	Farmers need supplies (e.g., hand tractor) before being able to undertake certain practices. If they have the supplies and the crops are not good, then they will plant vegetables/horticulture. They will also talk to the extension officer immediately (who was present in this group). Farmers need more technical support to show them how to do different activities. They would start implementing these practices immediately if they had someone who could train them. Money is an obstacle to implementing some of the adaptations.
Poster 9	7	1. Extension officers (to get the information and take it to the National level) 2. Chefe de Suco 3. National and District government 4. NGOs/ WorldFish	

150. Reactions from fishers in Batugade. Fishers in Batugade provided feedback on fishing activities posters (Figure 64, Table 21). The fishers rated the poster as being very useful because they were based on information that they had provided, so the results were highly relevant. The participants saw particular value in the economic analyses of fishing practices and aquaculture. Poster 12 was considered very useful as the network map was a good mechanism for showing relationships and pathways, and for increasing their understanding of how knowledge is transferred. In explaining what would need to happen before acting on these adaptations, participants felt that they needed an immediate transition from information and talking to implementation, with the involvement of the four key people listed on the evaluation poster (see Table 21).

Figure 64: Batugade fishers' feedback on fishing posters*



*English translations for the questions and responses from the above poster are shown in Table 21

Table 21: Questions and responses from fishers in Batugade

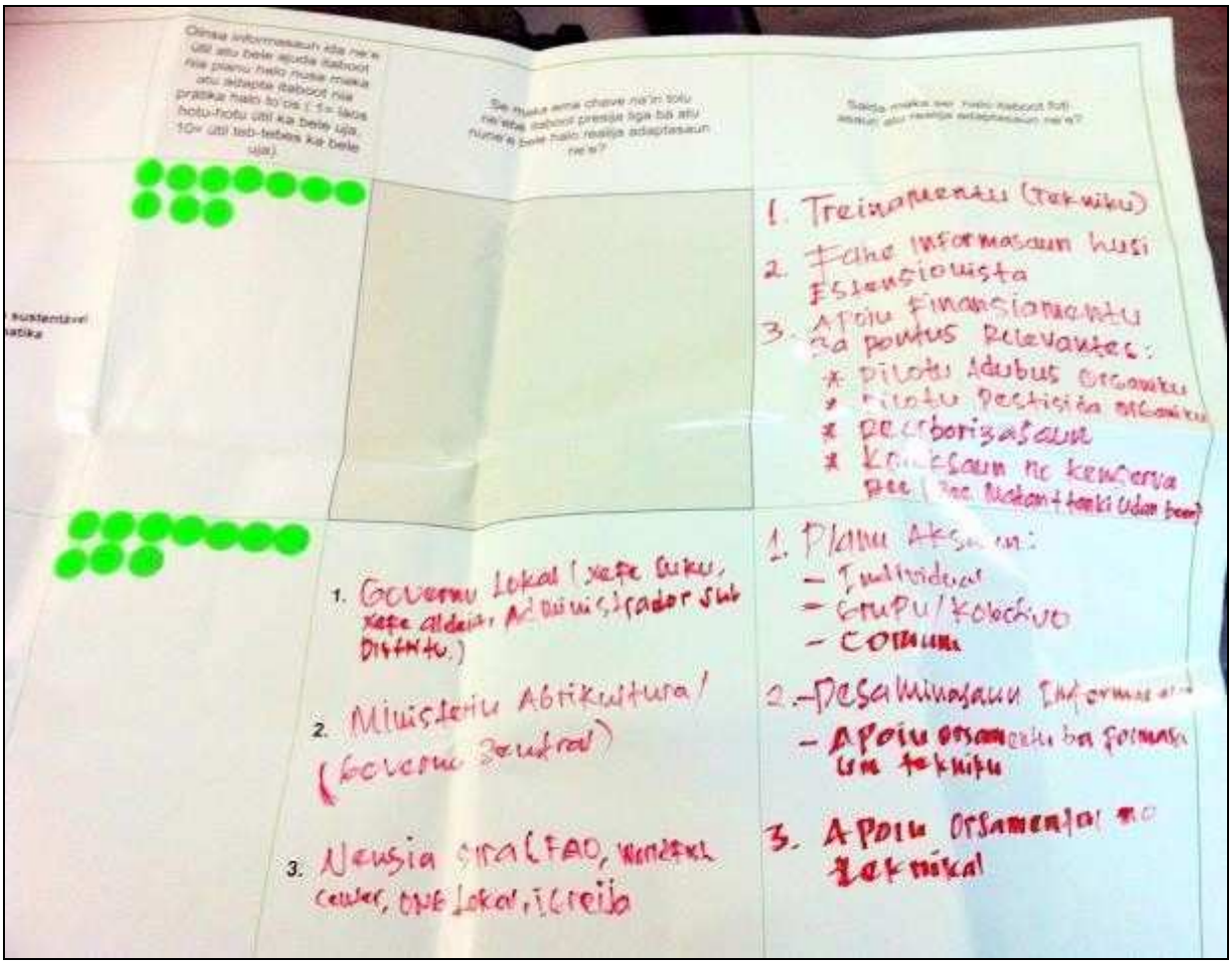
	How useful is this information in helping you plan how you will adapt your fishing practices (1 = not useful, 10 = very useful).	**Who are the first 3 key people you will need to liaise with to make this adaptation happen?**	**What will trigger you taking action to make this adaptation happen?**
Poster 11	10	N/A	"Action needs to be taken now and all four [of the key people] need to be involved, not just one person."
Poster 12	10	1. Chefe de Suco 2. Chefe Aldeia 3. Chefe fishing group 4. Local MAP person (Ministry of Agriculture and Fisheries).	

151. Reactions from farmers in Atauro. Farmers in Atauro provided feedback on sustainable agriculture practice posters (Figure 65, Table 22). The farmers rated the information in the

posters as very useful; however they were less interested in the results from Batugade. Like the other groups, farmers in Atauro felt the posters were more useful because the information provide for the analysis had been supplied from them. They described the adaptations as important but stressed that they needed ample time to discuss how they would use it. Two actions to be taken were agreed on by the farmers: i.e., talk with people about the information on the posters (i.e., further socialize the information); and actually do the actions on the posters.

152. Although farmers recognized that the information on the posters is part of a step-by-step process, they were fatigued by the wealth of information and a lack of action. They said they did not need to organize large groups to request government support, but rather could approach the local government as individuals or as small groups. They explained they would need to develop an action plan, disseminate information, and gain more technical skills. Though a lack of money and equipment is an obstacle to implementing some adaptations, it was not needed for all of them.

Figure 65: Atauro Farmers' feedback on Sustainable Agricultural Practices posters*



*English translations of the questions and responses from the above poster are shown in the Table 22.

Table 22: Questions and responses from farmers in Atauro

	How useful is this information in helping you plan how you will adapt your farming practices (1 = not useful, 10 = very useful).	**Who are the first 3 key people you will need to liaise with to make this adaptation happen?**	**What will trigger you taking action to make this adaptation happen?**
Poster 8	10	N/A	Local government can support small-group/individual action. It does not have to be a big group project. 1. Action Plan (Individual, group/collective/community) 2. Disseminate information. Organize more technical trainings 3. Gain more technical skills
Poster 9	10	1. Local government (Chefe de Suco, Chefe Aldeia, Sub-district Administrator) 2. National level Ministry of Agriculture (central government) 3. NGOs/other organizations (FAO, WorldFish, Local NGOs, the Church	

153. Reactions from fishers in Atauro. Fishers in Atauro provided feedback on fishing activities posters (Figure 66, Table 23). As with the fishers in Batugade, the Atauro fishers rated the posters as very useful because they were based on information that they themselves had supplied for the analysis. The participants saw particular value in comparing the prices for different fishing methods. They thought the network maps were a valuable and new way of thinking about their relationships.

154. After looking at the posters, the participants expressed a desire for more information regarding:

- Where to locate a rumpong, along with the technical knowledge to manage and fish it;
- Night fishing with lines;
- Access to echo-sounders;
- Using sport GPS for reporting illegal fishing.

Figure 66: An Atauro fisher presenting feedback on the fishing results posters*

*English translations of the questions and responses from the above poster are shown in Table 23.

Table 23: Questions and responses from fishers in Atauro

	How useful is this information in helping you plan how you will adapt your fishing practices (1 = not useful, 10 = very useful).	**Who are the first 3 key people you will need to liaise with to make this adaptation happen?**	**What will trigger you taking action to make this adaptation happen?**
Poster 11	9	N/A	Implementation is needed now. (NB: The concept of social, environmental and economic thresholds was difficult to communicate. As a result, most participants responded that they needed to adapt now).
Poster 12	10	1. FAO – Eco-sounders, GPS and technical knowledge (training) to use this equipment. FAO were identified in particular because the present FAO eco-sounder project ends soon. Jose asked to add MPA to FAO list – "they must help. 2. Ministry of Fisheries – need to socialize knowledge to enforce and better manage the marine protected area. They also need to provide training for fishing deep water, and everybody needs to know the	

	How useful is this information in helping you plan how you will adapt your fishing practices (1 = not useful, 10 = very useful).	Who are the first 3 key people you will need to liaise with to make this adaptation happen?	What will trigger you taking action to make this adaptation happen?
		'rules'. 3. NGOs to 'facilitate' the rumpong. 4. Government – to provide electricity so that ice can be made (to help storage of fish). Q. Who will make contact with these people? A. The local Fisheries Officer.	

3. November 2013 Timor-Leste trip 4

155. The fourth trip to Timor-Leste was made in November 2013. The trip consisted of filming interviews with community members, local and national level NDFA representatives and NGO staff when discussing the challenges faced by fishers and farmers in respect to climate change. They also commented on their participation in the project workshops and the utility of the information produced to supporting planning for implementing adaptation actions. Filming was also conducted at a workshop lead by the WorldFish project team in Dili and attended by local and national NGO representatives. The workshop was aimed at socializing the series of method manual brochures produced to provide step-by-step guidance on conducting the assessment process.

a) Audio-Visual Production

Activity:	Audio visual project
Aim/Key question:	Collate footage for use in a single 8 minute video aimed at NGOs, development partners, and Government officials and ministries in Timor-Leste, Solomon Islands, Fiji, Vanuatu and PNG that are considering how to support communities in adapting to climate change.
Brief details of method:	Individual interviews were conducted with fishers, farmers, NGO staff and government representatives that had been involved in the previous workshops. The interviewer asked questions regarding the assessment process conducted by the WorldFish project team over the past 18 months.
Key results:	The eight interviews were filmed (amounting to over 8 hours of video footage) and subsequently translated into English in readiness for a video production team to assemble them into a coherent discussion on the utility of the assessment process. The video clip will be made publically available for download via the web.

156. WorldFish has produced a single 8 to 10 minute video for use by NGOs, development partners, and Government officials and ministries in Timor-Leste, Solomon Islands, Fiji, Vanuatu and PNG that are considering how to support communities' adaptation in response to climate change. The video includes interviews with fishers, farmers, a government official, and an in-country NGO staff member. The aim of the video is to have the audience review or adopt the community engagement process developed by WorldFish. They may simultaneously consult with the eight brochures produced as a step-by-step guide (methods manual) to conducting the

participatory engagement activities. The video refers to the four stages used in the assessment process (scoping, identifying options, evaluation, planning implementation). In the film, fishers and farmers describe the process they went through with WorldFish, and talk about their perspectives on the utility of the assessment.

b) Workshop to socialise the eight brochures (methods manual)

Activity:	NGO workshop
Aim/Key question:	To share with local and national NGO and government representatives the project findings/results, review the eight brochures (methods manual), and engage in a participatory activity as a means to demonstrating use of the brochures.
Brief details of method:	A facilitated workshop including the following: • Review of the project aim and activities conducted to date; • Introduce eight brochures (methods manual) and review their structure; • Participatory activity to demonstrate the use of the brochures; • Video footage taken of individual interviews undertaken with a selection of workshop participants
Key results:	The workshop was attended by fifteen organisations operating in Timor-Leste; The eight brochures were presented and an example brochure (Social Network Analysis (SNA)) worked through in detail with the participants; Participants voiced a request for additional SNA mapping to be conducted at the NGO and government level, to compliment community produced maps.

c) Method

157. A workshop was held in Dili, Timor-Leste in November 2013. The purpose of the workshop was to bring together a number of local and national NGO representatives and government stakeholders interested in exploring methods to address the issue of climate change adaptation and broader NRM issues in Timor-Leste. More specifically, the workshop aimed to:

a. provide a summary of the project activities conducted in Timor-Leste and Solomon Islands;
b. use the eight brochures (methods manual) (see Appendix 8) as a guide to understanding why and how to conduct an assessment, explore the linkages between the WorldFish project findings and other relevant in-country climate change and natural resource management projects, initiatives or activities currently in operation or being planned;
c. work through an example brochure to trial out the method.

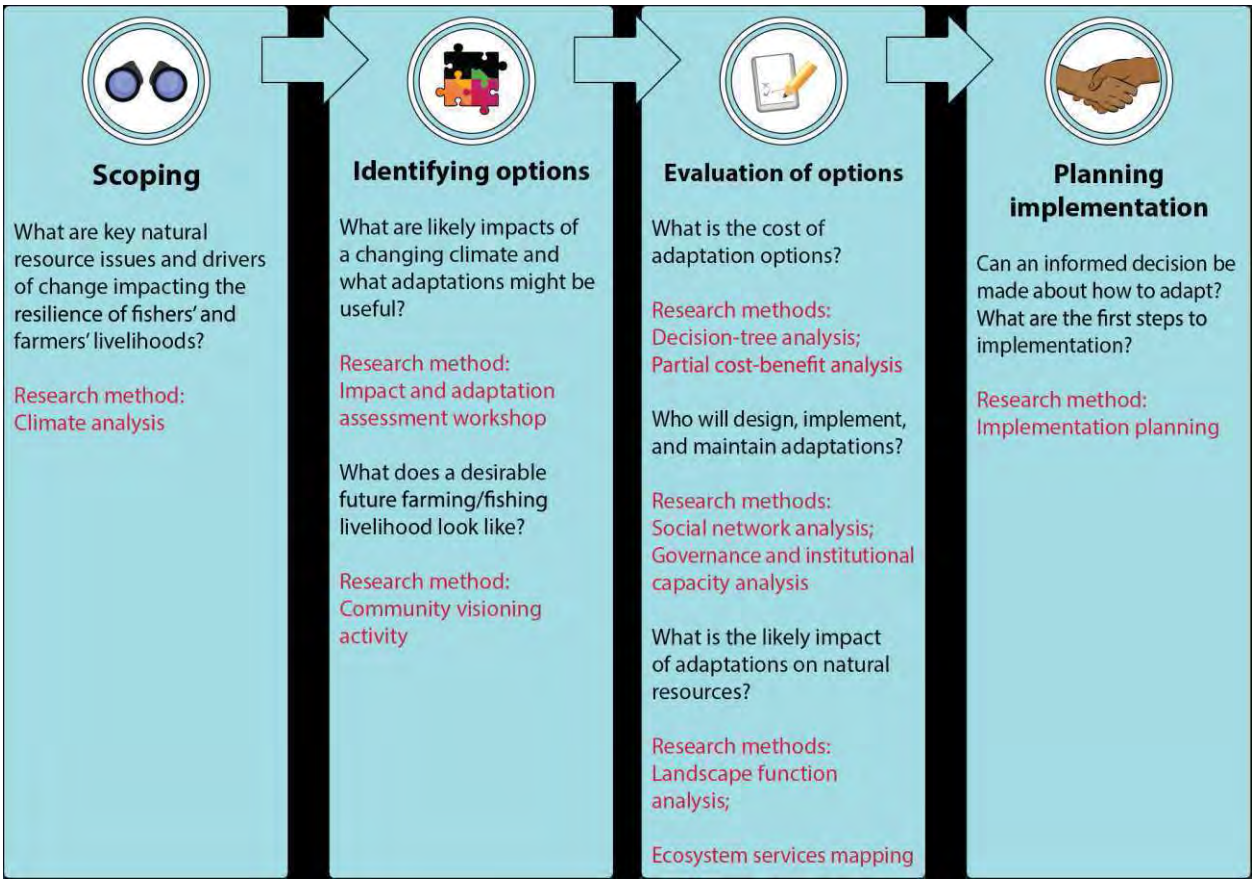
158. Organizations working in the area of climate change adaptation and fishing and farming livelihoods, which included both government and NGO representatives, were invited to participate in the half-day workshop. Table 24 lists the workshop attendees.

Table 24: Organizations in attendance at Timor-Leste NGO workshop, November 2013

Organizations		
NGO Rolu-Atauro	NDFA	CT Pacific
MICE-SEMA	SoL	Conservation International
Move Forward	WorldFish	GSEP
Hivos	UNDP	FAO
Roman Luan	CARE	ChildFund TL
MercyCorps		

159. Project summary. The Director of the NDFA opened the workshop by describing the importance of climate change adaptation for fishing and farming communities in Timor-Leste. Review was made of the project aims and process used to assess options for adaptation in both Timor-Leste and Solomon Islands. Framing the four-step process as a sequence of questions (**Figure 67**), participants discussed how each of the activities detailed in the methods manual addressed these questions. Each step addresses specific questions likely to be asked by community members needing to adapt and research methods that can be used to answer these.

Figure 67: The four steps taken by community and national government representatives in developing a plan to respond to climate change



160. The Introduction and Climate Analysis brochures (Brochures 1 and 2, see 0) fall into the scoping stage, while activities to identify options are captured in the Community Workshops brochure (Brochure 3, see 0). Economic analysis (Brochure 4, see 0), social network analysis (Brochure 5, see 0), landscape function analysis (Brochure 6, see 0) and ecosystem service mapping (Brochure 7, see 0) provide several means of evaluating adaptation options. Planning and implementation is detailed in the Community Feedback and Planning for Implementation brochure (Brochure 8, see 0).

161. Review of Methods Manual. The series of eight brochures were designed to be an accessible tool for national and local level partners/practitioners to understand the process used in this participatory assessment of climate change adaptation; present the methods used for individual activities in the process, and be guided to further material for additional instructions and information about the methods.

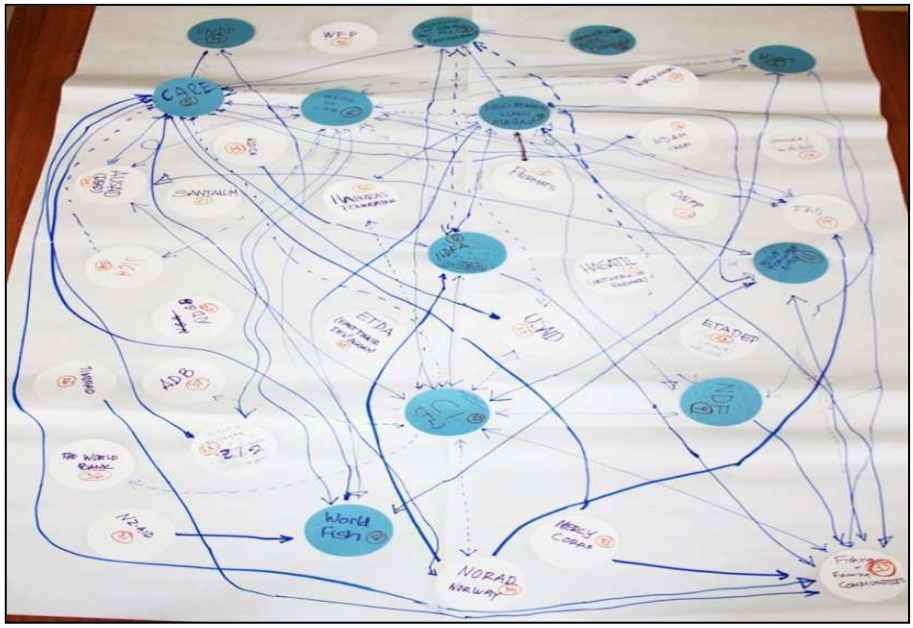
162. Using the landscape function analysis brochure as an example, participants reviewed the format and structure of the brochures, focusing on how they might help them to use/lead/implement similar activities in their own work.

163. Participatory activity. Using the social network analysis (SNA) brochure, workshop participants discussed the process for producing network maps in communities. They reflected on the maps previously created by fishers and farmers during community workshops in Atauro and Batugade (see mid-term report) as a means of understanding: the perspective of the community participants; the value of creating social networks for planning the implementation of adaptation actions, and how to conduct the activity.

d) Results

164. The plan for the participatory activity (described above) was to work through the SNA brochure and to reflect on the maps created by fishers and farmers in the communities, as a means of understanding how the activity could be run and the value of creating social networks for planning the implementation of adaptation actions. As the participants reflected on the social networks maps created by fishers and farmers, they expressed their desire to map their own networks, focusing on how their various groups connected to each other and how these connections then extend to fishing and farming communities. The workshop activity was quickly reorganized to accommodate this request. Using the brochures and the resources available at the workshop, the participants began to identify the actors they engage with in relation to their work on fishing, farming, and climate change, writing their names on circles and affixing them to butcher paper (Figure 68). Participants then began to draw lines representing flows of information between these actors. As this additional activity had not been previously planned in the workshop schedule, there was insufficient time for the participants to complete mapping their social network. They therefore proposed for a follow-up workshop to be conducted with the participants to facilitate this activity. A proposal for this has been detailed in 0.

Figure 68: Participants begin to map their social network



II. Solomon Islands Case Study

165. This chapter details the application of the assessment process in the Solomon Islands and the two field trips undertaken in 2013. The first field trip was undertaken in May 2013 and the follow up field trip in July 2013. Prior to the field trips and engagement with the community members, a review of existing information and vulnerability studies conducted in Solomon Islands was undertaken. The purpose of this was to avoid duplication of activities and to draw on the local knowledge of the WorldFish Solomon Islands team and their partners. The review revealed that Solomon Islands, unlike Timor-Leste, has been the focus of a number of climate change and vulnerability studies. As such, several activities included in the assessment process developed for this project (and detailed in Park et al., 2013) had already been conducted in one form or another. Duplicating activities was avoided, where data produced by past studies was suitable for the purposes of our study, and where the data was freely available for use. Adopting this strategy in developing a work plan for engaging in Solomon Islands was to avoid unnecessary research fatigue amongst community members. This is especially important the outputs are diagnostic in nature (i.e., knowledge products will be delivered rather than engaging in an ongoing project of providing interventions and technologies to communities). Table 25 summarizes the changes made to activities conducted in the Solomon Islands.

Table 25: Activities undertaken in Solomon Islands case study

Secondary data collection from a range of activities identified through literature searches and interviews with in-country WorldFish colleagues and partners.	This data was reviewed. Through this process it was highlighted that aquaculture had been identified as a possible adaptation activity for a changing future by farmer / fishers in Central Malaita, the focal area for the Solomon Islands study.
Stakeholder analysis.	As part of a workshop organized by WorldFish-Solomon Islands on 22 April 2013 (ACIAR bilateral funded project: Developing inland aquaculture in the Solomon Islands. Project number FIS/2010/057), fish farmers in the Auki area of Malaita expressed interest in participating in this assessment of climate change adaptation.
Analysis of historic climate data for the region.	Use of existing data and prior studies. Further analysis undertaken where existing secondary data insufficient for determining the impact of climate on fishing activities.
Community engagement workshop including: (a) impact assessment; (b) visioning of desired future community; (c) adaptation assessment.	Facilitate a workshop with stakeholders that included activities to: (a) explore climate change in the context of Solomon Islands; (b) explore the link between climate sensitive activities for livelihoods and past trends and future potential changes in climate; (c) discuss proposed evaluation methods; agree on the format of material produced.

(d) Decision tree analysis and partial cost-benefit analysis	(d) Develop scenarios of the social, economic and environmental cost and benefit of aquaculture in the Solomon Islands, with consideration of climate change. Scenario development drew on existing literature and expert opinion from aquaculture experts within WorldFish, as well as primary and secondary data obtained from interviews.
Social network analysis	Conducted via stakeholder engagement activities during and after the workshop.
Governance and institutional effectiveness survey	Integration of useful questions from the Timor-Leste survey into the Social Network Analysis proposed for Solomon Islands. Aim to understand provincial level perspectives on the laws, rules, institutions and implementation activities in existence that may relate to the use of natural resources and in particular, integration of pond aquaculture production into livelihoods.
Governance capacity assessment	Review data in the context of our study, and conduct additional research only where necessary.
Landscape function analysis	As the adaptation action being focused on in this case study is aquaculture, landscape function analysis is not an appropriate evaluation method and was not conducted in Solomon Islands case study.
Ecosystem service assessment	Conducted in respect to aquaculture as an adaptation action in the area of the focal farmers and the wider Province. Most data sourced from experts and secondary data repositories. Any additional data requirements collected from provincial and national level stakeholders and data sources.
Monitoring and evaluation	Adopting a similar approach to that used in Timor-Leste, i.e., during the final workshop, asking stakeholders to comment on the usefulness of the material.
Threshold analysis	Adopting a similar approach to that used in Timor-Leste, i.e., during final workshop, asking stakeholders to consider what would prompt them to improve their farming techniques or if relevant start planning and implementing pond aquaculture.

A. Malaita Community Workshop, May 2013

Activity:	Stakeholder participatory workshop
Aim/Key question:	What are the likely impacts of a change in future climate on fishing and farming livelihoods in general, and more specifically on pond aquaculture in Malaita, Solomon Islands, and what are the key considerations for the development and ongoing management of ponds to reduce negative impacts of climate change and capitalize on opportunities?
Brief details of method:	Using a stakeholder participatory engagement process: • Identify the expectations of farmers and fishers in exploring aquaculture as a technology to help in development in general, and in response to climate change more specifically Identify climate-sensitive livelihood activities in response to

Activity:	Stakeholder participatory workshop
	changing temperature and rainfall. • Identify climate-sensitive aspects of establishing and maintaining an aquaculture pond. • Consider the above in terms of past trends and projections of future changes in climate (i.e., identify impacts of climate change on livelihoods and aquaculture activities). • Identify appropriate adaptations to current recommendations regarding how to build and maintain an aquaculture pond.

1. Method

166. The initial workshop held in Auki, Malaita Province was attended by a community of practice interested in pond aquaculture as a means to address climate, and other drivers of change (Table 26). Twenty-seven fishers and farmers attended the workshop. At the outset of the workshop (and all subsequent data collection activities), the participants were provided with details of the nature of the data to be collected, and how the information would be used and stored. Participants were also informed about their right to refuse or end participation in the study, issues of confidentially that the Project Team would adhere to, and any risks or benefits that would likely flow from their participation. Those community members agreeing to consent to these terms were asked to provide their signature.

Table 26: Attendees at community workshop in Malaita, May 2013

	Total number	Farmer only		Fisher only	Fisher & Farmer	No identification
	Male/Female	Men	Women	Men	Men	Men
1st workshop	25 m / 2 f	13	2	6	3	3

167. The participants were familiarized with the scope and nature of the ADB project. The aim of the workshop was stated, i.e., to provide information about past climate trends and future projections of climate change and understanding these in the context of fishing and farming livelihoods in Malaita, particularly in relation to assessing the potential benefits of pond aquaculture as an adaptation response. The research team and participants discussed the most appropriate format in which results and information would be delivered back to the workshop participants. The project engagement process was described to the participants, and it was explained that there would be two workshops held (one in May 2013 and the other in July 2013).

168. The workshop then explored climate change in the context of Solomon Islands using existing materials and making reference to a similar climate change assessment project previously conducted in the country (i.e., LEAP, Abernethy et al., 2012). An overview of past trends in local climate and the level of consistency with projections of future climate were explored by the workshop participants.

169. Having established an understanding of climate change, the participants were presented with a review of climate sensitive aquaculture activities/tasks. The social, economic, and environmental implications of aquaculture were then considered and facilitated discussions and activities undertaken to explore the following questions:

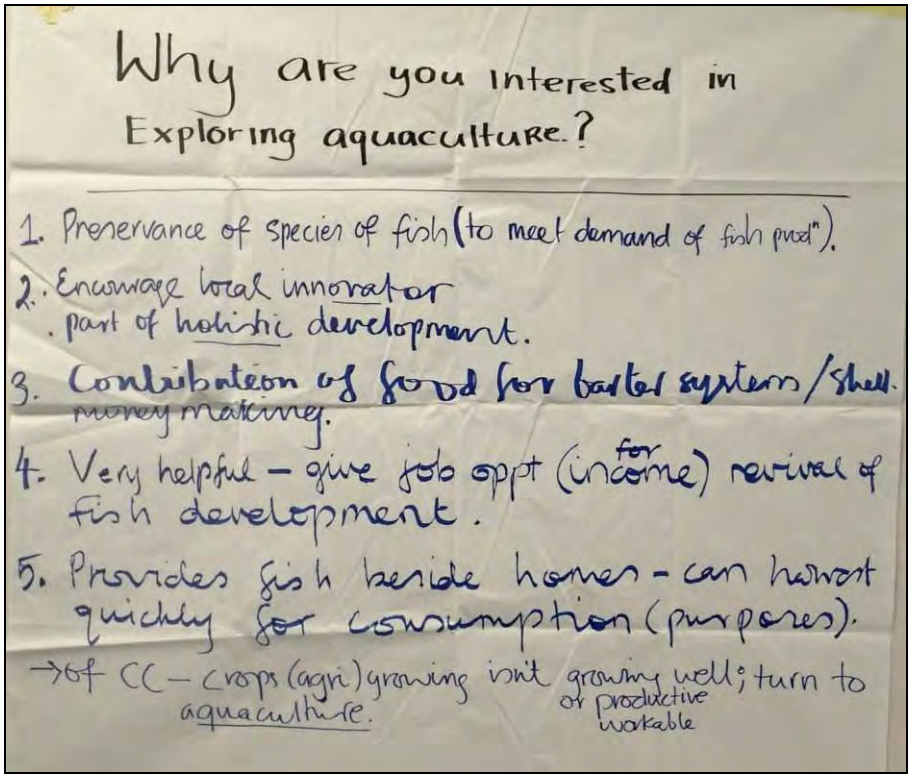
a. Is aquaculture a viable option for diversifying farmer livelihoods in the light of climate change?

b. What are possible scenarios for aquaculture development in the Malaita province?
c. What are the motivations for undertaking pond aquaculture?
d. What are local stakeholders' perceptions on the social, economic and environmental costs and benefits of aquaculture development?
e. What people, organizations and institutions are needed to help facilitate the design, implementation and ongoing practice of aquaculture in the Malaita province?
f. What is the likely impact of aquaculture on the natural resource base and the ecosystem services that underpin livelihoods in Malaita?

2. Results

170. The workshop participants expressed a range of reasons for being interested in exploring pond aquaculture as an adaptation to climate, and other drivers of change (Figure 69). These included household food security (the ponds would provide a food source in close proximity and a supplement to other agricultural activities) and economic benefits. It was identified that aquaculture may be a cheaper alternative to buying fish, boats, and petrol. The participants considered that selling extra fish from household ponds could provide an additional source of household income. Participants felt that if coastal marine fishing continues at its current rate, then there will not be enough fish to meet future needs. They also stated that aquaculture would permit people to consume fish without taking them from the sea.Aquaculture was seen as a way of making up for declining fish catches and agricultural yields, both of which they identified as being driven by the changing climate. The participants also discussed how aquaculture aligns with their culture and livelihoods, through its use of local knowledge, skills and resources, in addition to encouraging innovation. Interest in aquaculture was also driven by its use of natural resources that are accessible. For those who do not have access to the sea, aquaculture may be a way of providing better access to aquatic food sources.

Figure 69: Participants' reasons for exploring aquaculture in Malaita

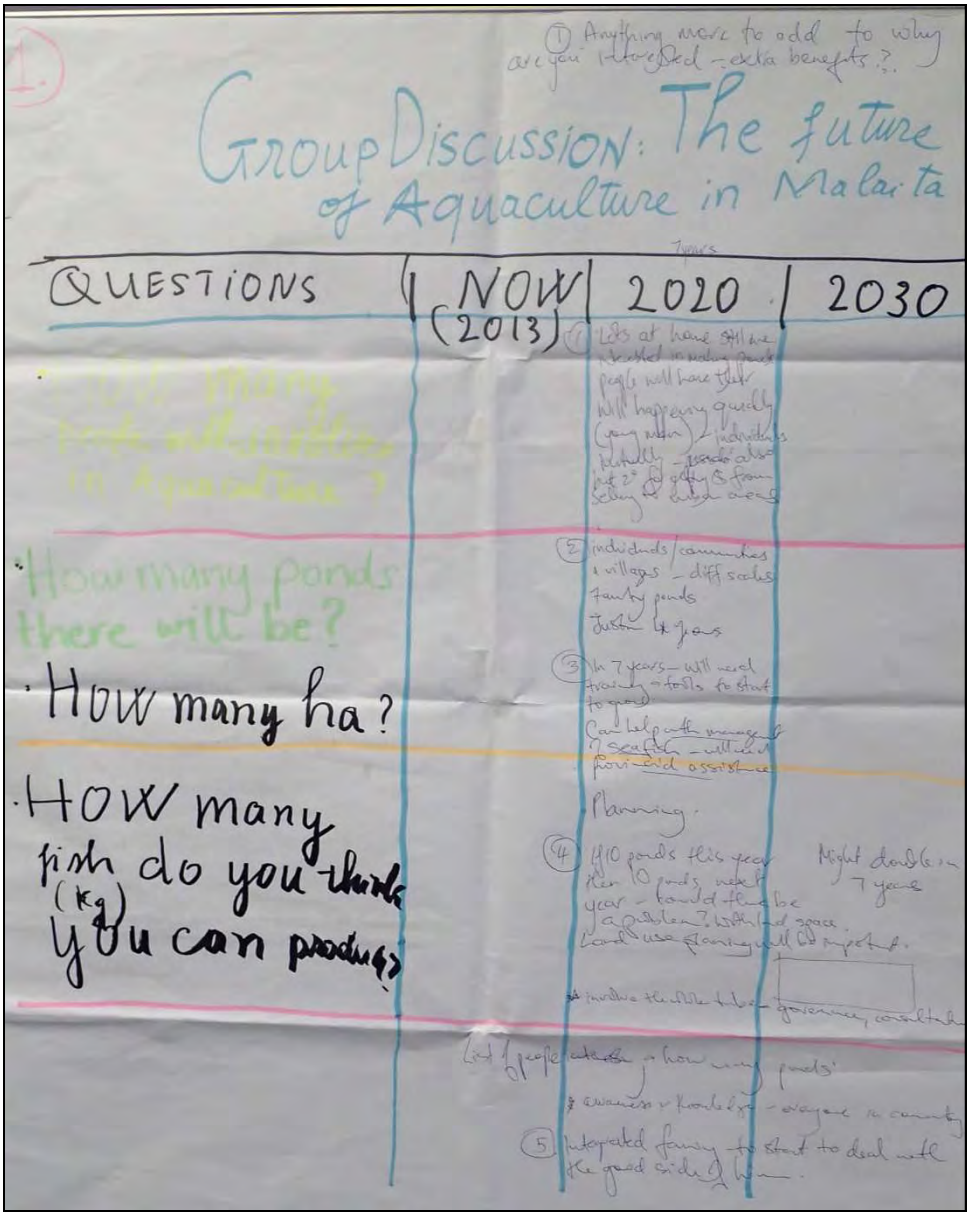


171. Figure 70 shows the range of impacts of climate, with specific reference to aquaculture, identified by the workshop participants in light of their experience of past trends in climate, as well as projections of future changes in climate. These impacts included physical damage to aquaculture and housing infrastructure, physiological responses by fish (i.e., a change in growth rates), and an increased incidence of flooding, with implications for crop yields. The adaptations suggested by the workshop participants included reinforcing the infrastructure associated with pond aquaculture and reducing the impact of a change in climate through planning.

Figure 70: Participants' views on impacts and possible adaptations for climate trends and projections

172. Exploring the future of aquaculture in Malaita. The aim of this activity was to understand how participants saw aquaculture as fitting into the future development of Malaita. Participants thought about the size and scale that aquaculture might develop to and recorded this information on butcher paper (Figure 71). This information has been included in further analysing pond aquaculture on Malaita from an environmental and economic perspective (see mid-term report, Sections 4.4 and 4.6).

Figure 71: Participants' responses to the question of how aquaculture might develop in Malaita in the future



173. Social network mapping in Malaita. The workshop participants were then guided through an activity to map their social networks, and identify who they engaged with in relation to aquaculture. Due to the larger than expected number of attendees at the workshop, the participants were randomly separated into two groups, with each group responding to the same set of questions and following the same method. These groups are distinguished as the “Left group” and the “Right group” (see Figure 72 and Figure 73 below). Detailed analysis of the social network maps produced here is provided in the mid-term report, Section 4.6.

Figure 72: Social network map created by the Left group

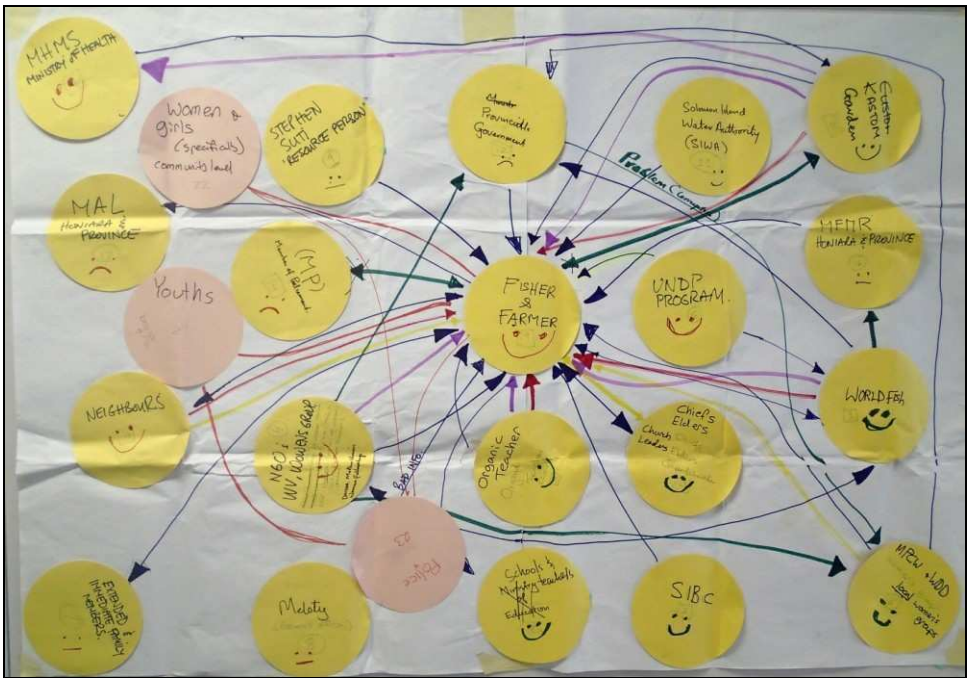
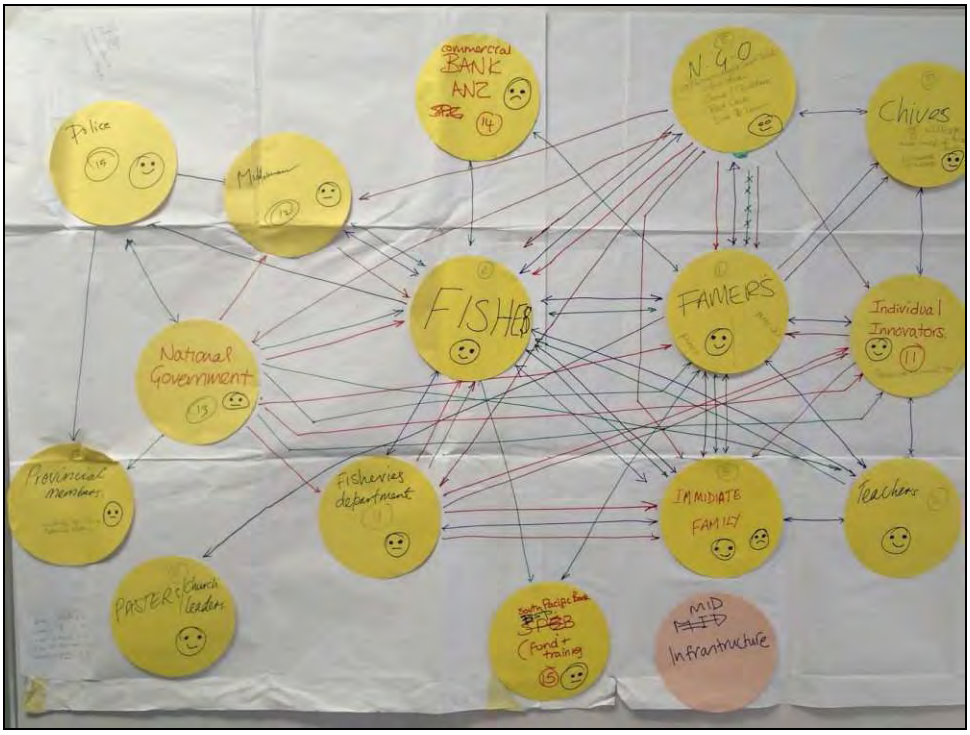


Figure 73: Social network map created by the Right group



B. Climate analysis for Solomon Islands

Activity:	Assessment of climate using: • Analysis of observed (historic) temperature and rainfall data from terrestrial and marine sources. • Assessment of (secondary source) projections of future climate change.
Aim/ Key question:	Are there any trends in past temperature and rainfall data, and are these trends consistent with projections of future climate change? What does this mean for adaptation using pond aquaculture?
Brief details of method:	• Observed climate data for mean monthly temperature and rainfall interrogated using statistical analyses • Consideration of climate change projections
Key results:	Summary of trends in observed data • Inter- and intra-annual rainfall is highly variable in Solomon Islands, but the long-term trend has been generally stable over the past 60 years (1952-2012) • 'Wet' seasons and 'dry' seasons are not as clearly defined in Solomon Islands as in other countries in the region, e.g., East Timor. • The wettest months are January to March, and the driest June to October. • Air temperatures are higher during the 'wet' season, than in 'dry' season months. • The duration of the cooler season has contracted between 1962 and 2011/2012 (as indicated by both air temperature and sea surface temperature data). Conversely, the duration of the 'warm' season has expanded. • Marine temperatures have increased over the past five decades but the trend is not as pronounced as evidenced in the terrestrial data.

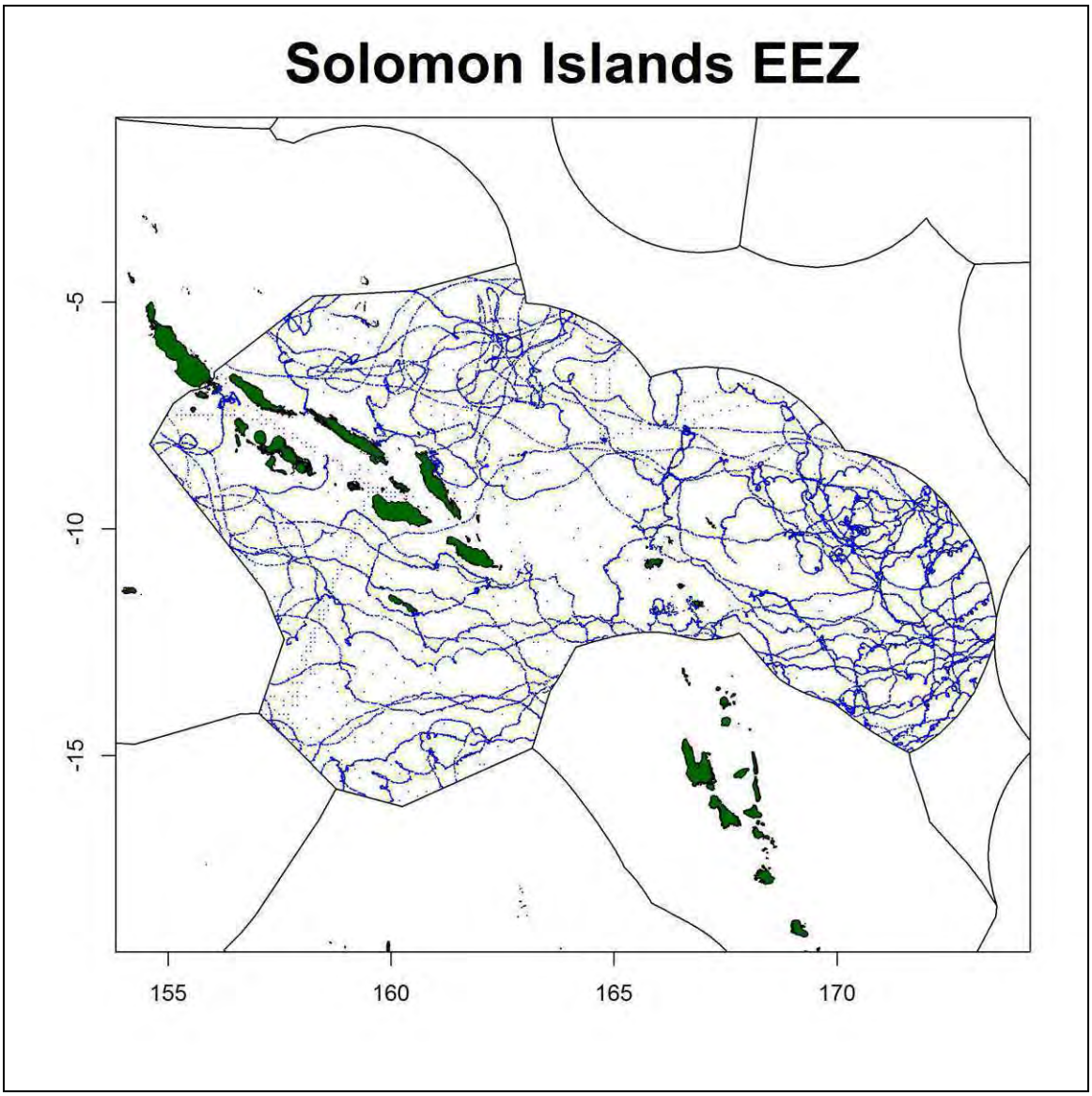
1. Method used for analyzing trends in observed climate data

174. Terrestrial weather stations at Auki. Historic precipitation and temperature data at Auki, Malaita Island were sourced from Solomon Islands Government Meteorological Service Division (http://www.met.gov.sb/index.htm) and the (US) National Center for Atmospheric Research (NCAR, http://ncar.ucar.edu/). The precipitation data for Auki were available at a daily resolution (1952-2011) while the air temperature data were available at a coarser temporal resolution, consisting of monthly minima and maxima (1962-2010).

175. Global Land Precipitation Data. Historical precipitation data for Solomon Islands were also obtained from the global historical climate network (GHCN) (http://www.ncdc.noaa.gov/oa/climate/ghcn-daily/, see also Chen et al. 2002). It should be borne in mind that these data are a 'gridded product' and the result of 'interpolation' between real stations.

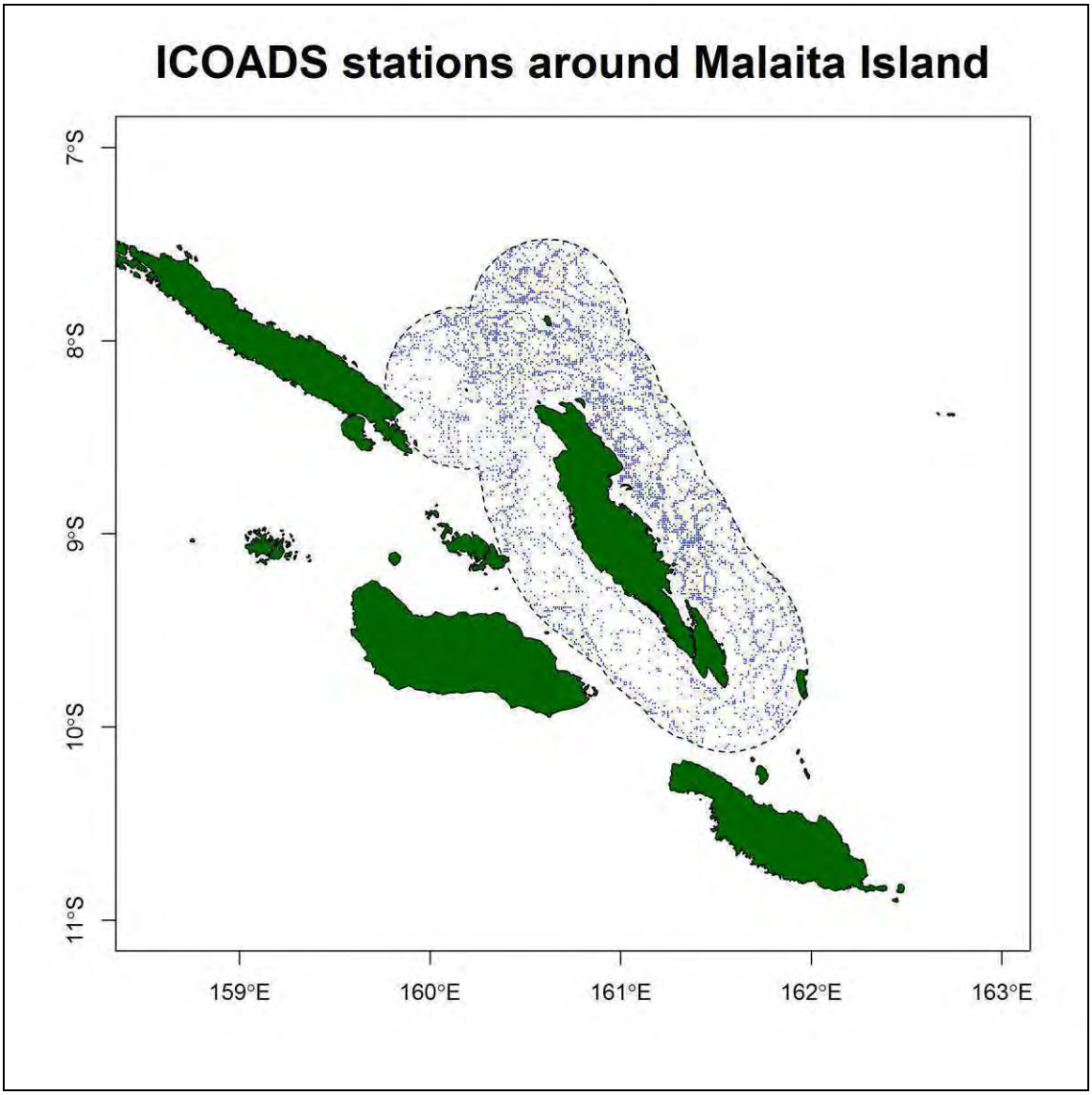
176. Marine climate data. Data for air and sea temperatures within the Exclusive Economic Zone (EEZ) of Solomon Islands were obtained from the International Comprehensive Ocoean Atmosphere Data set (ICOADS) (http://icoads.noaa.gov/). ICOADS contains surface marine data for the entire globe and spans the past three centuries. ICOADs consists of observations from many different observing systems covering the evolution of measurement technology over hundreds of years and is probably the most complete collection of surface marine data in existence. The location of ICOADS data in 2010, for the EEZ of Solomon Islands is displayed in Figure 74. ICOADS also contains many other variables of interest such as cloud cover, wave height and period and wind speed and direction.

Figure 74: ICOADS stations 2010 (blue dots) in Solomon Islands EEZ



177. Data in the ICOAD dataset were available for the period 1763 to present. In this analysis we use data for the period 1960 to present only, since those collected prior to 1960 were too sparse. The focus of this analysis was the island of Malaita so we extracted the ICOADS data for an area around Malaita (Figure 75) and subsequent time-series analyses was conducted on that subset only.

Figure 75: ICOADS stations 1960-2012 around Malaita Island, Solomon Islands



178. Statistical analyses. The precipitation data analysed came from the following two sources: monthly data (1950-2012) from (The Global Land Precipitation Data) the GHCN; and daily data (1962-2013) collected by Solomon Islands Government Meteorological Service Division. Monthly air temperature data (monthly minima and maxima) also originated from Auki while the sea surface temperature data were from ICOADS.

179. All data were initially assessed using exploratory visual techniques, i.e., plotting as functions of both long-term and seasonal time. A smoothing function available within the R-package called 'supsmu' was used to summarise some of the trends. The 'supsmu' smoothing function is a running lines smoother which chooses between three spans for each line. Running line smoothers are symmetric, with k/2 data points each side of the predicted point, and values of k as 0.5 * n, 0.2 * n and 0.05 * n, where n is the number of data points. If a span is specified,

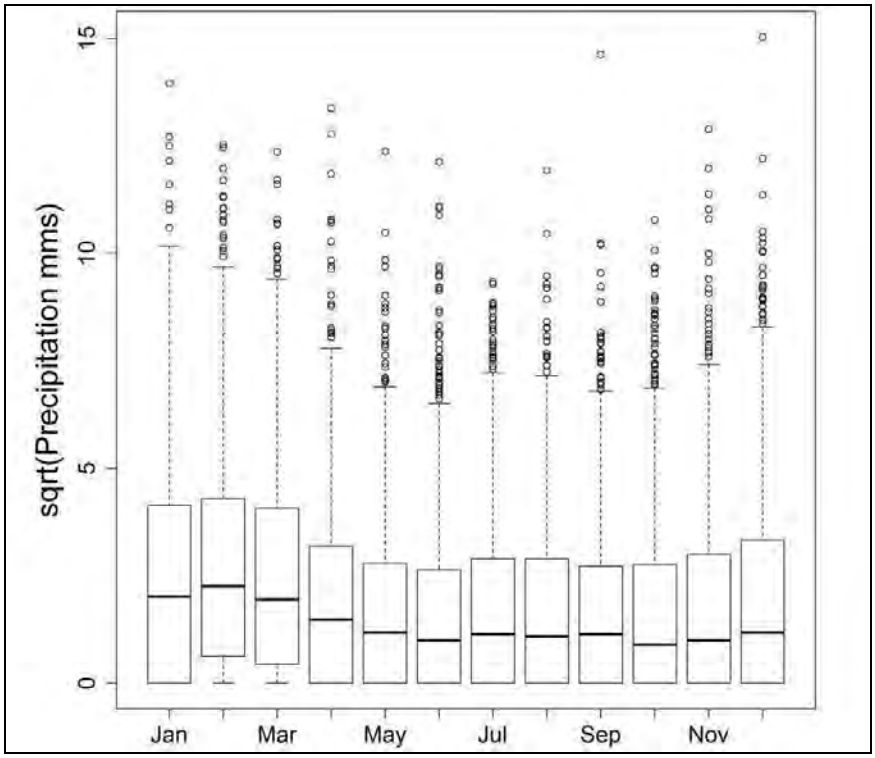
a single smoother with span '*span x* 'is used. The best of the three smoothers is chosen by cross-validation for each prediction. The best spans are then smoothed by a 'running lines' smoother and the final prediction chosen by linear interpolation (Friedman 1984).

180. Modelling analyses. The rainfall data were also modelled statistically using both linear and generalised linear models (McCullagh and Nelder 1989). Non-linearity in the long-term trends was modelled using polynomials while the seasonal functions were modelled using harmonics (Metcalfe and Cowpertwait 2009). The model outputs, however, require further investigation and improvement and, at this stage, are best considered as 'exploratory'.

2. Results

181. Precipitation - terrestrial station at Auki. Average daily rainfall at Auki was 8.75 mms per day between 1962 and 2012. The maximum recorded was 226.1 mms on 8th December 1971. The driest month on average is October; the wettest typically February (**Figure 76**).

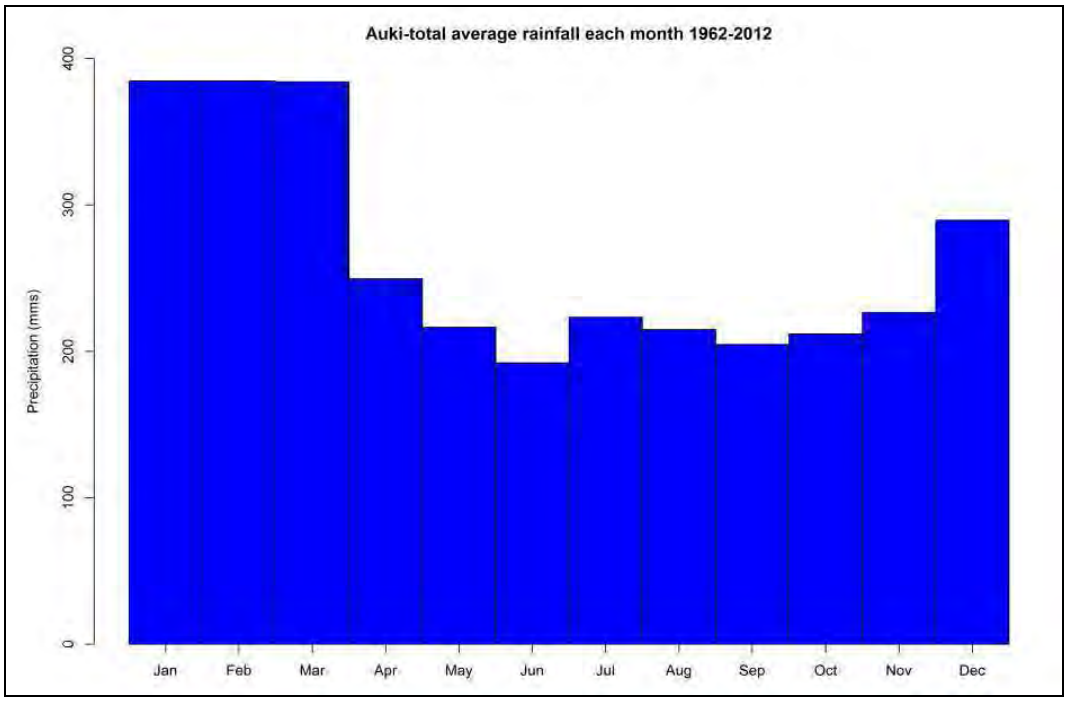
Figure 76: Seasonal pattern of precipitation (1962-2012) at Auki, Malaita, Solomon Islands*



*The precipitation data have been square root transformed to aid legibility.

182. Data were additionally examined and presented in a different format in Figure 77, where the total average rainfall per month has been plotted. This representation is easier for local farmers to interpret (Sharon Suri, pers comm.). It shows that June typically gets the least average total amount of rain and January, February, and March the most.

Figure 77: Total average rainfall each month at Auki 1962-2012



183. The relationship between rainfall at Auki and the El Nino Southern Oscillation index (ENSO) was also compared during our analyses. Total annual rainfall was typically highest between 1966 and 1978 (Figure 78) while more recently levels have been lower. There is a positive, and statistically significant (p = 0.0047), relationship between ENSO and rainfall at Auki with large positive values of the ENSO being reflected in higher than usual amounts of annual rain (Figure 79).

Figure 78: Relationship between total precipitation at Auki (top) and El Nino Southern Oscillation (bottom) between 1962 and 2012

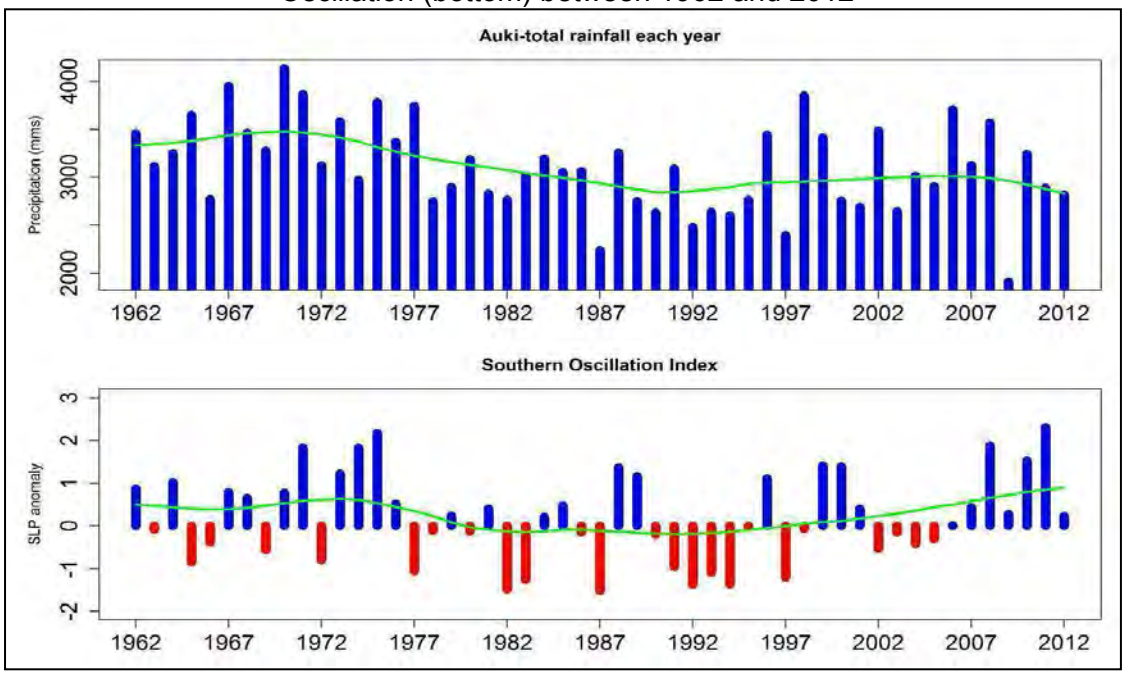
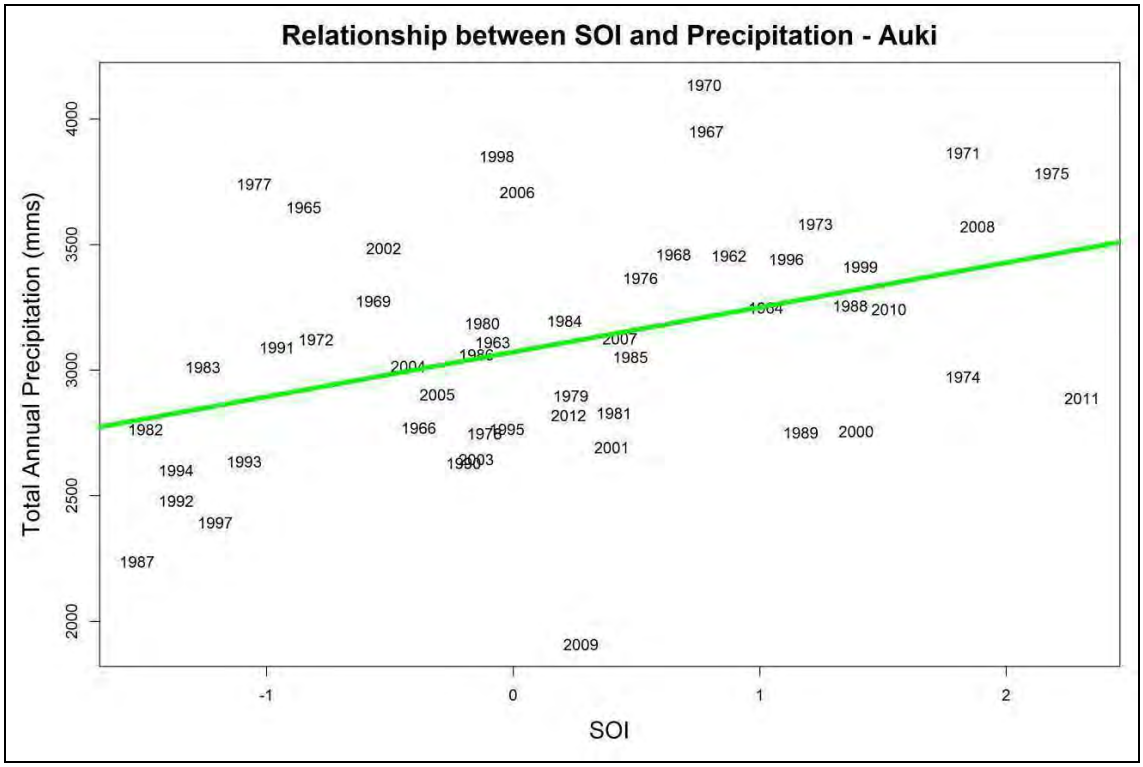


Figure 79: Graph showing positive correlation between total annual rainfall at Auki and El Nino Southern Oscillation Index



184. The average duration of wet and dry periods can have a substantial impact on the livelihoods of small-scale and subsistence farmers. These were calculated using the R-package 'seas' (Toews, Whitfield, and Allen 2007). The results are plotted along the seasonal (month) and long-term (year) temporal dimensions in Figure 80 and Figure 81.The definition of how much rain constitutes a 'wet' or 'dry' period has a rather subjective element. Here the value of 5mms was selected, but the software is flexible and this can easily be redefined. Typical wet periods (consecutive wet days) are between 1 and 7 days at Auki (Figure 80) and they have a longer duration between January and March. Dry periods can last between 1 and 30 days (Figure 81), the longest dry periods occurring between April and November.1987 experienced two exceptionally long dry periods in June and August (Figure 81) which, incidentally, correspond also to the record lowest ENSO value between 1962 and 2012.

Figure 80: Average duration of 'wet' periods each month at Auki between 1962 and 2012

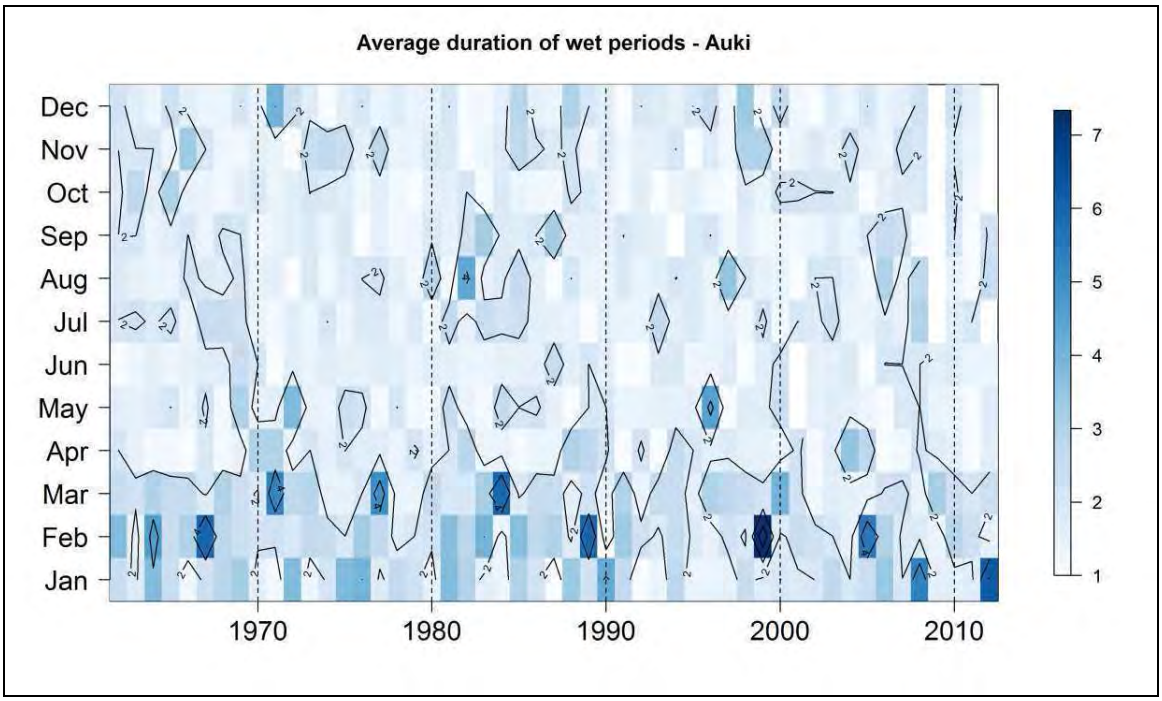
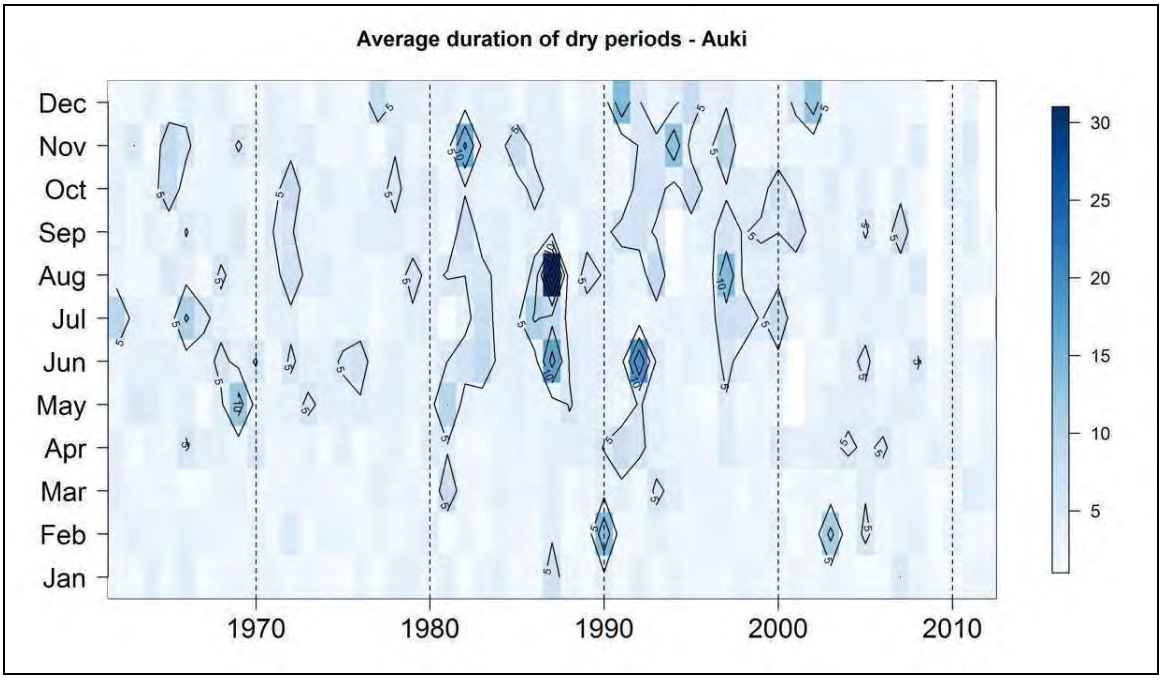


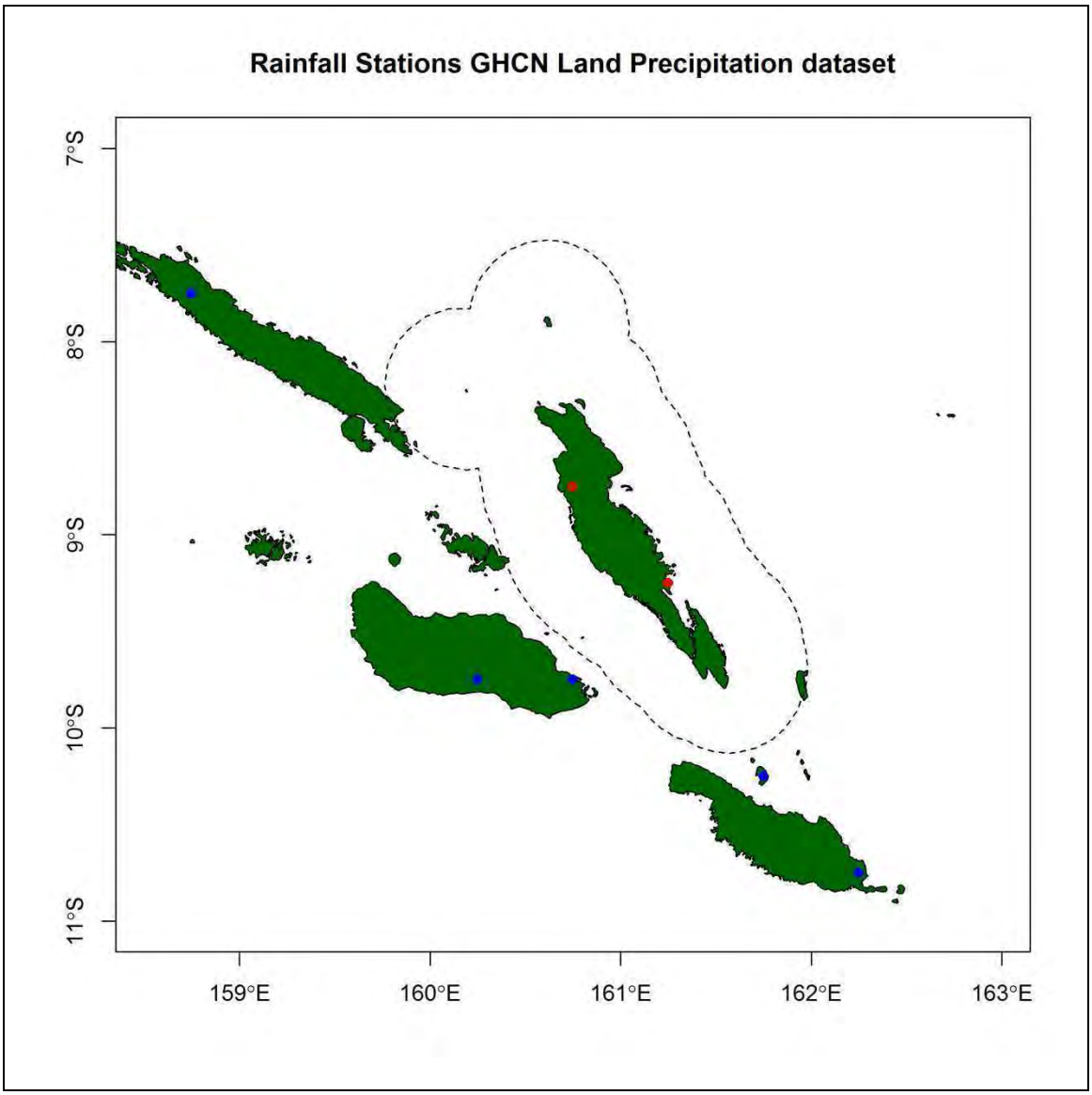
Figure 81: Average duration of 'dry' periods at Auki between 1962 and 2012



185. Precipitation - Global Land Precipitation Data. The Global Land Precipitation data are a 'gridded' product for the entire globe; the result of 'interpolation' between *actual* meteorological stations. At workshops in Solomon Islands some skepticism was voiced in relation to the utility of these data, and whether or not they were capable of capturing meaningful variability in

precipitation ‘on the ground’. The simultaneous availability of both datasets presented us, therefore, with a valuable opportunity to examine the extent to which this was actually true.

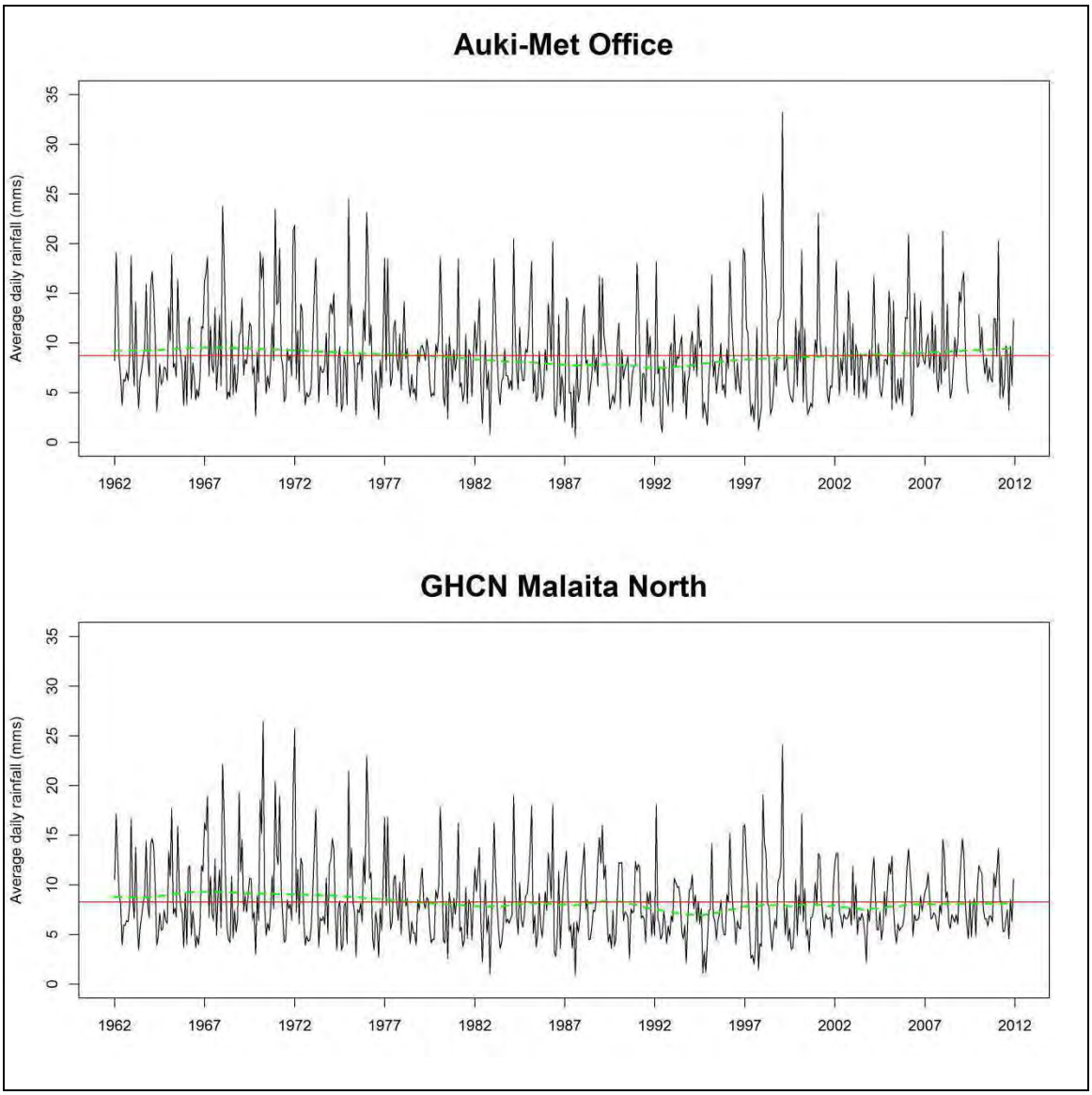
Figure 82: Global Land Precipitation ‘grid nodes’ for Solomon Islands. Red dots are nodes in Malaita Island



186. The two red dots (Figure 82) represent the data we analyzed here (Malaita stations ‘north’ and Malaita stations ‘south’). They were available from 1948 to the present but, since the Auki data were only available from 1962 the data were truncated to capture the same period. The rain gauge data collected by Solomon Islands Government Meteorological Service Division were available daily whereas the GHCN Global Precipitation data were available at only monthly averages. Hence in order to make comparisons the Auki rain gauge data were also aggregated into monthly averages. The time-series from the two data sources are plotted in **Figure 83** and the close correspondence both long-term trend and absolute level is immediately clear. Average rainfall was a bit higher in the 1960s and early 1970s and then fell to lower average levels

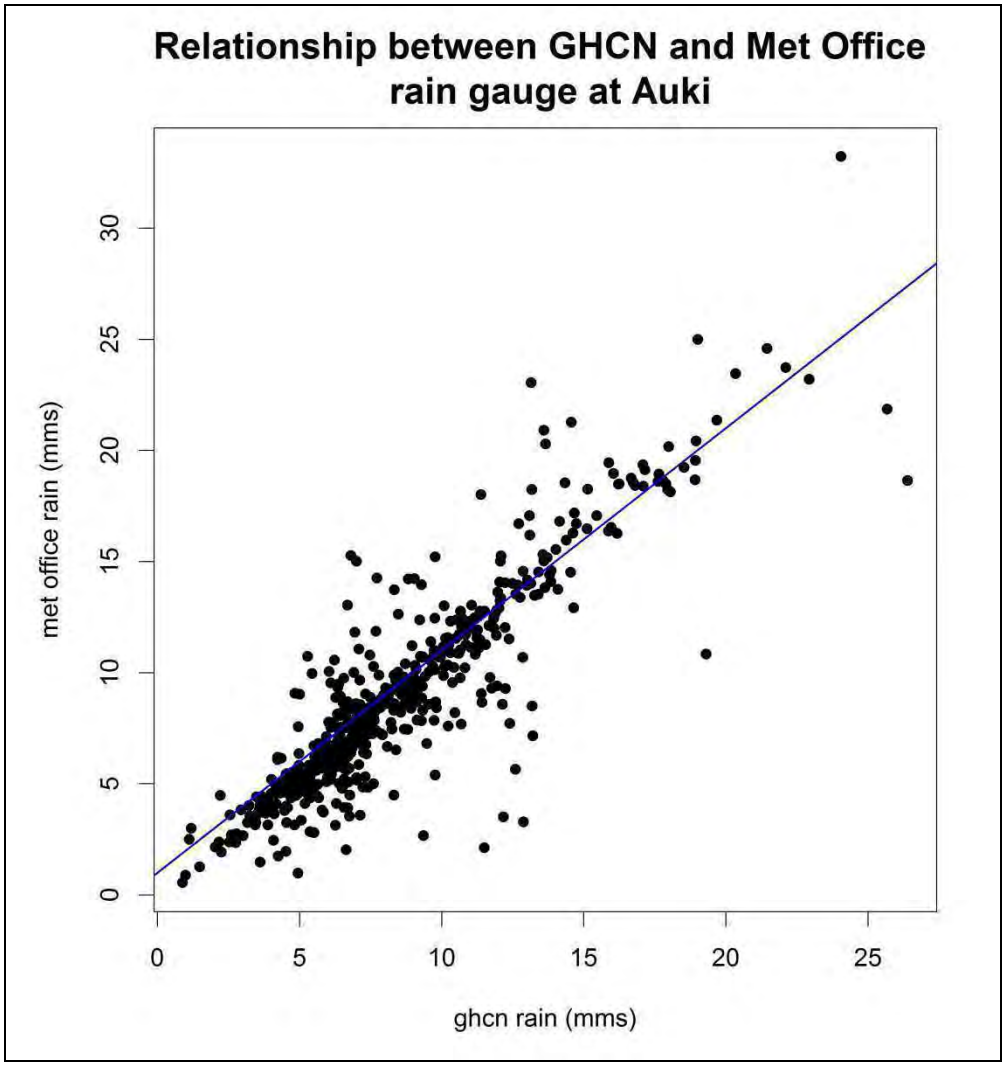
between the early 1980s and late 1990s. The correlation coefficient between the two series is 0.89 and the data are plotted against each other in **Figure 84**. This indicates a high correlation between the two datasets.

Figure 83: Average daily rainfall each month recorded 1962-2011 by (top) Solomon Island Meteorological Division and according to the GHCN global precipitation database (bottom) for a grid node on north Malaita*



*The black lines are the raw data, the red line is the long-term mean and the broken green line is the supsmu smoothing function which summarizes long-term trend.

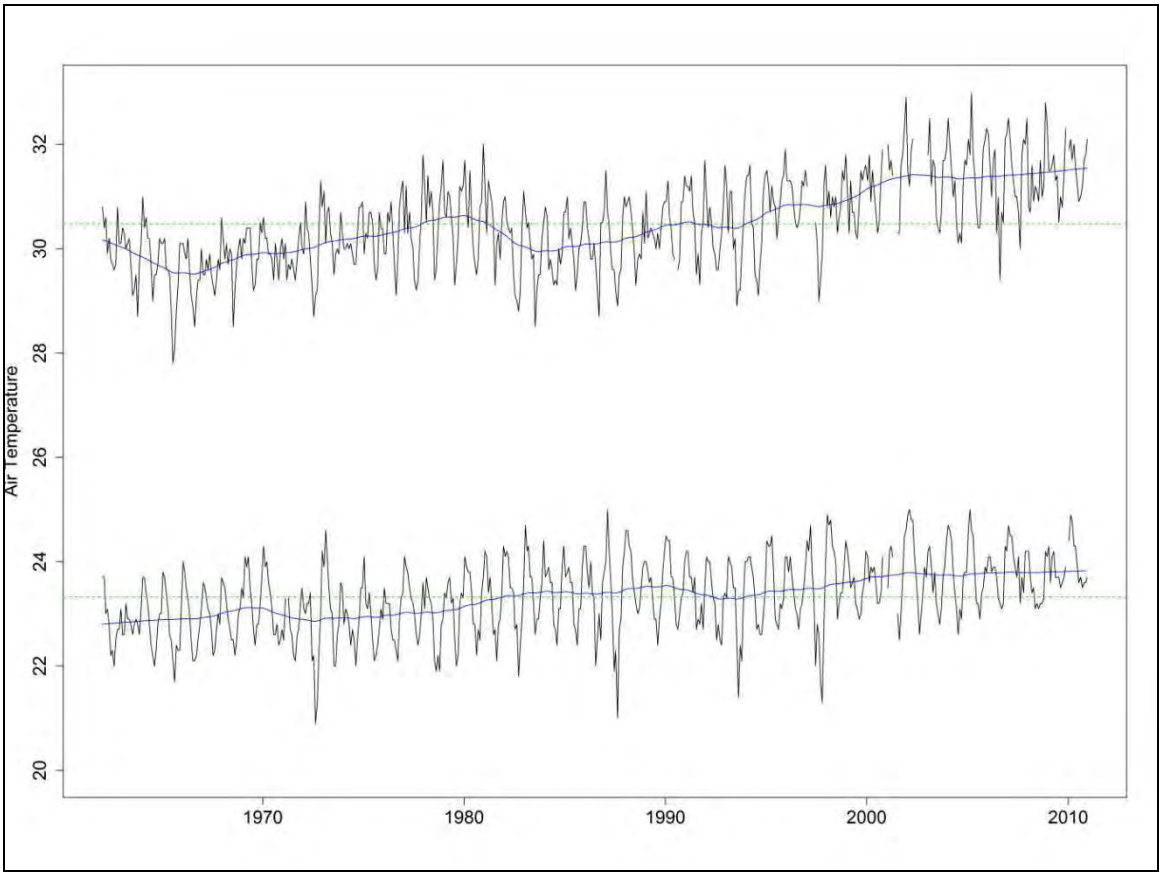
Figure 84: Relationship between data collected at Auki by Solomon Island Meteorological Division and the Global Precipitation database available from the Global Historical Climate Network*



*The blue line is the 1:1 relationship.

187. Temperature – terrestrial station at Auki. Solomon Island Meteorological Division also provided minimum and maximum air temperature data for Auki, at monthly resolution, for the period 1962 to 2010. The two time-series are plotted together for comparison in **Figure 85**. The average maximum air temperature during this period was 30.47°C and the minimum 23.32°C. Increasing long-term trends in air temperatures are very clear from these data. Average maximum temperatures on land have increased from just below 30 °C in the late 1960s to above 31°C in the 2000s (**Figure 85**). Similarly average minimum temperatures have increased, rising from just below 23°C in the 1960s and 1970s to around 24°C in the 2000s.

Figure 85: Maximum (top time-series) and minimum temperatures (bottom time-series) at Auki, Malaita, Solomon Islands*



*The horizontal green dotted line is the mean temperature, while the blue line is the 'supsmu' smoothing filter summarizing long-term trend. These data were recorded by the Solomon Islands Meteorological Department.

188. All meteorological time-series data are also strongly seasonal and the air temperatures are no exception. The box and whisker plot in **Figure 86** shows average maximum temperatures by month for the period 1962-2010. Air temperatures are highest in December to January and lowest in July and August.

189. The relationship between long-term trend (year) and seasonality (month) can also be examined simultaneously by plotting the data on a 3 dimensional plot (Figure 87). The blue color represents the 'colder' part of the season (in reality around 28.5-29 °C) and the yellows and oranges the warmer part of the season (around 31°C). It is clear how the cold period between July and August has contracted since the 1960s as temperatures have increased.

Figure 86 - Average (1962-2010) seasonality in maximum air temperature recorded at Auki

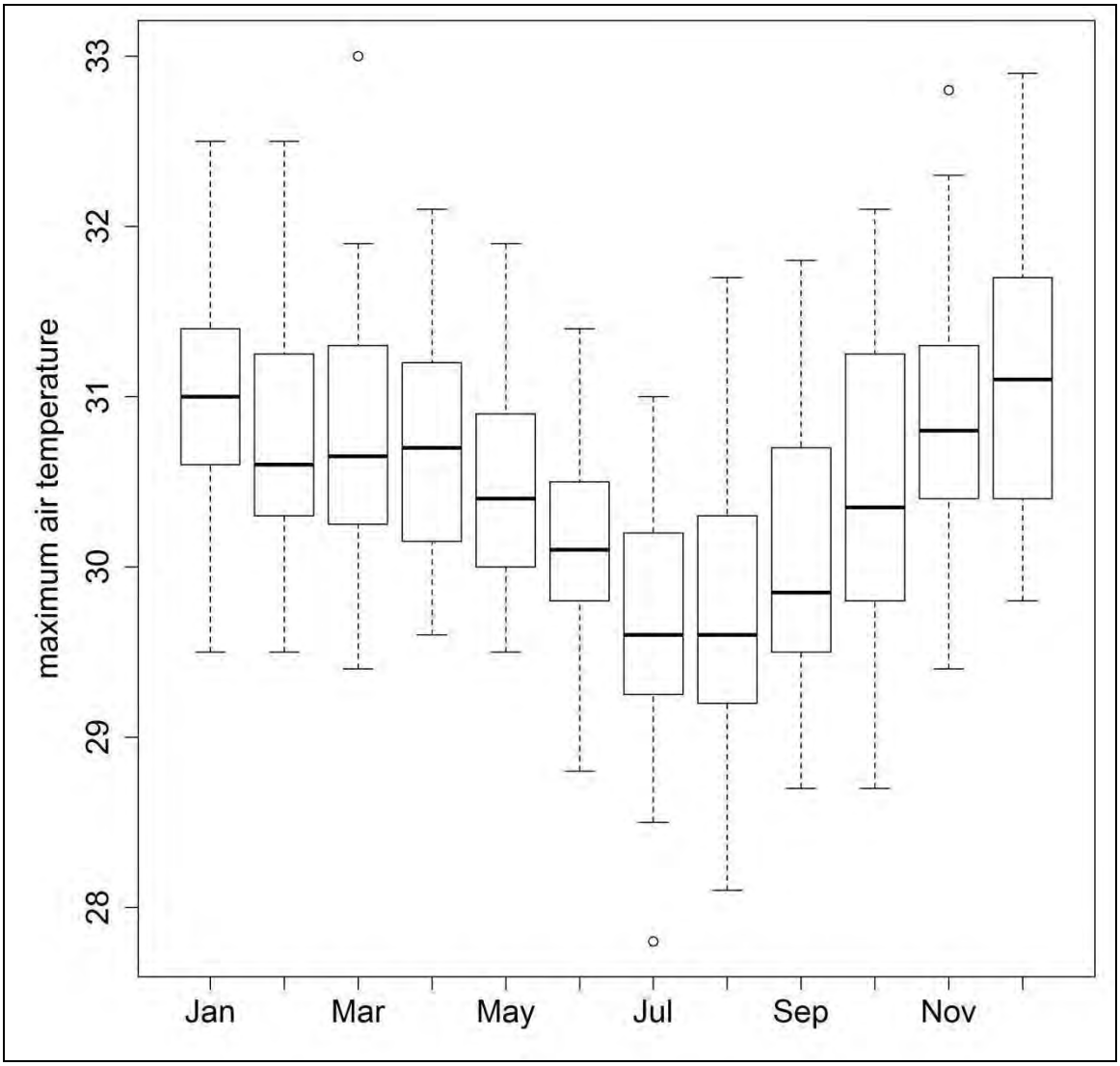
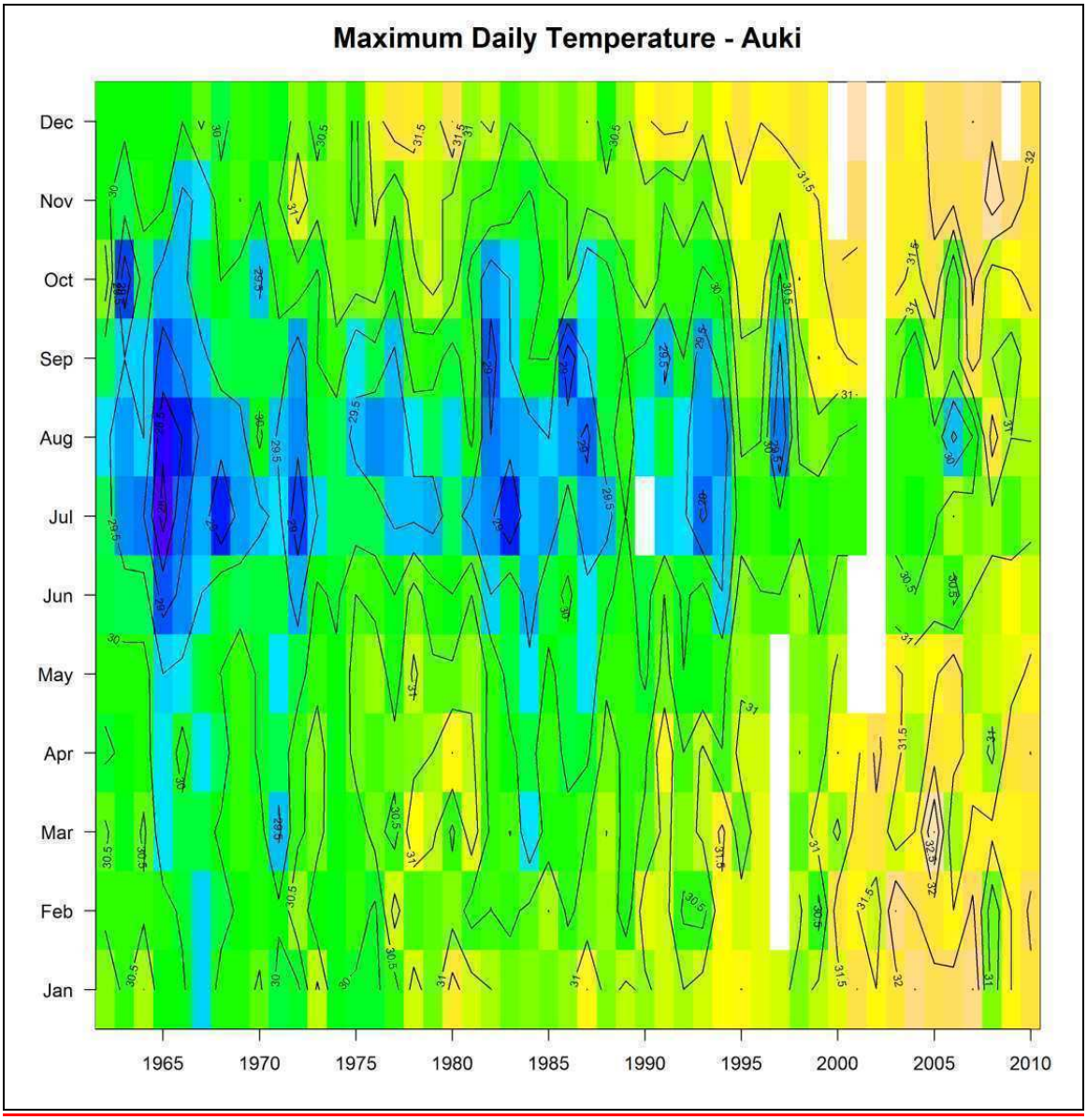
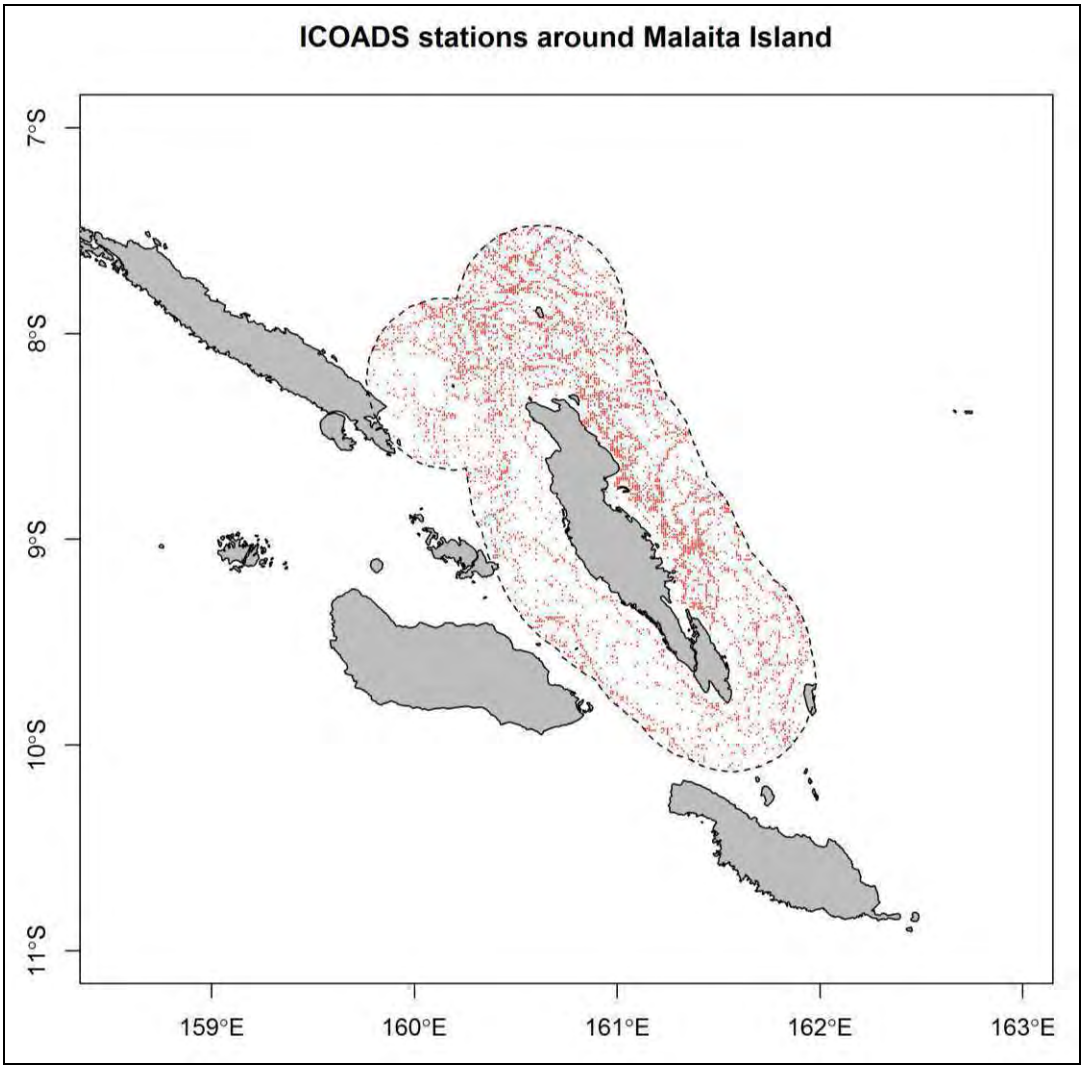


Figure 87: Maximum air temperatures in Auki plotted as a function of year (x-axis) and month (y-axis)



190. ICOADs sea surface temperatures and wind speeds from the EEZ of Solomon Islands. Average sea-surface temperatures by month and year, for an area around Malaita Island (Figure 88) were calculated.

Figure 88: ICOADs stations (red dots) around Malaita Island



191. The boxplots (Figure 89 and Figure 90) show average seasonal and long-term change in sea surface temperature (SST) around Malaita. The sea surface temperature data are slightly 'behind' the terrestrial data with lowest temperatures being recorded in August and September (Figure 89). There is also an increasing long-term trend in the SST data (Figure 90) but it is not as pronounced as recorded in the terrestrial data.

Figure 89: Average sea surface temperature around Malaita Island (1960-2012)

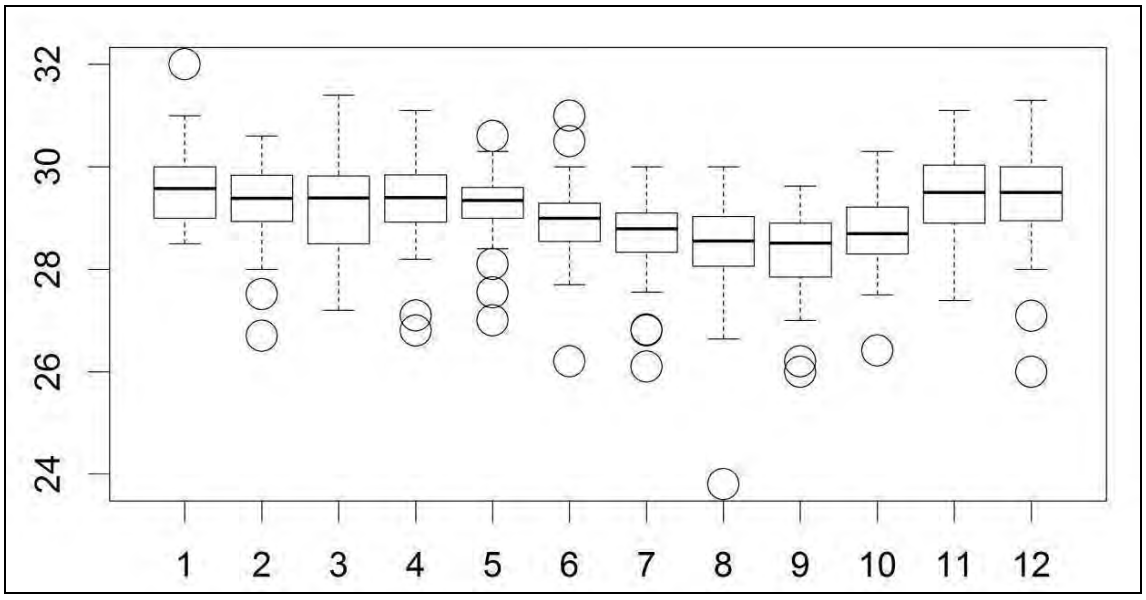
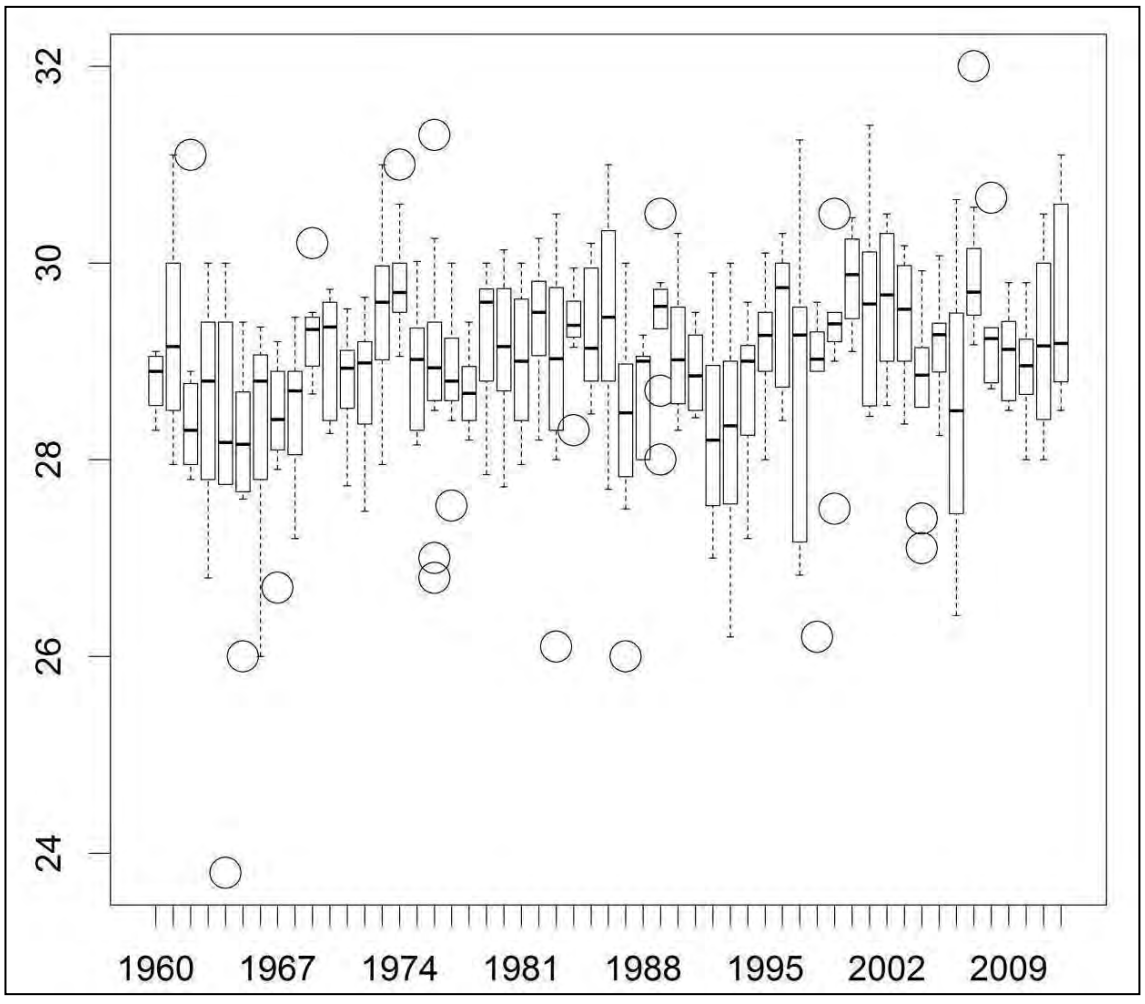
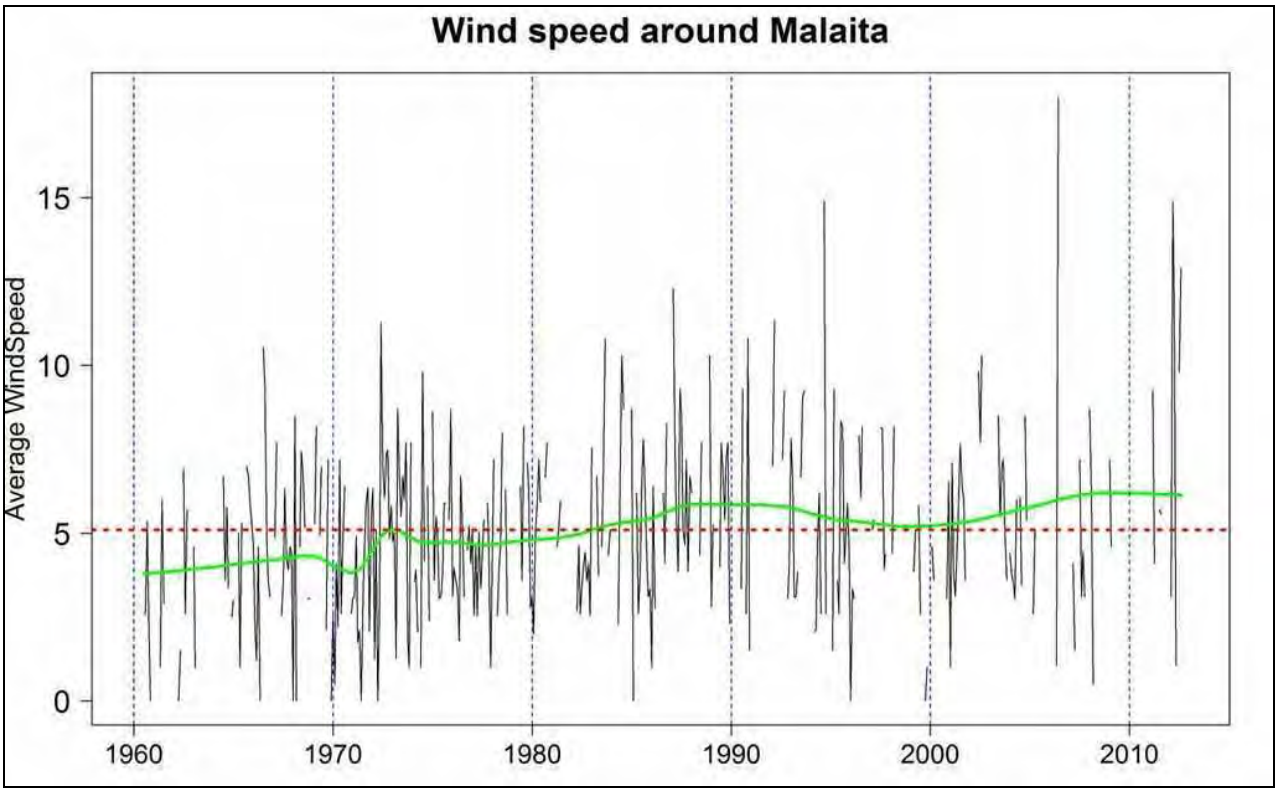


Figure 90: Sea surface temperatures around Malaita Island 1960-2012



192. Wind speed is also recorded over the sea by ICOADs and is possibly an important variable to consider given its influence on rates of evaporation, wave height and its potential impact on marine transport. We have plotted the average wind speed (meters per second) for the area around Malaita Island defined in **Figure 91**. Wind speed appears to have increased over past 50 years.

Figure 91: Average wind speed (meters per second) around Malaita Island between 1960 and 2012 estimated from ICOADs data*



*Red dotted line is the long-term average, while the green solid line is the long-term trend summarized with 'supsmu'.

193. In summary, the temperature data from Auki (terrestrial station) and ICOADs (marine locations) are supportive of each other. Terrestrial air temperatures show an increasing long-term trend, generally over all months, which is supported by similar (but not quite as pronounced) increasing long-term trends recorded over the marine area. Sea surface temperatures also show increasing annual trends both when examined overall and by individual months. The terrestrial and marine data show that, on average, both air and sea surface temperatures are cooler during the dry season compared to the wet season.

C. Governance and Institutional Assessment

Activity:	Governance and institutional assessment
Aim/Key question:	What key actors and actions influence the development of long term capacity to reduce community vulnerability relating to natural resources?
Brief details of method:	• Identification of key government and non-government organizations operating at provincial level in Malaita Province. • Key informant interview using semi-structured interviews focusing on institutional capacity. • Analysis of operational documentation and budgets.
Key stages in method:	Collect information on the governance and institutional environment from: • semi-structured interviews with provincial level stakeholders, identified through a snowball sampling strategy; • literature and document review; • cross-check with network analyses.
Key results:	• Communities were found to be poorly linked to national or provincial institutional governance and that this was largely attributable to a combination of poor capacity, lack of resources, inadequate coordination and ineffective implementation. • Government services channeled through the provincial government are relatively poorly funded for a province the size of Malaita and this means that, with a few exceptions (such as health and medical services and education) much of the development work and provincial services are carried out through short-term projects implemented by central government or civil society organizations including the churches. • Sustained and wide-scale impacts of adaptation interventions will require mechanisms to be in place that survive beyond the short-term of prevailing project approaches. Adaptation and other interventions should seek to strengthen the service delivery capacity of the appropriate provincial authorities through: Working in partnership with relevant provincial staff towards simple and achievable outcomes of mutual relevance with an emphasis on learning by doing and addressing basic operational issues and challenges like budgeting and planning and maintaining emphasis on the need for increased efficiency of provincial government service delivery using mechanisms such as the provincial networks and partnerships.

1. Method – key informants and review of documentation

194. An initial governance assessment performed for aquatic agricultural systems governance in 2012 for Malaita Province using the CORE and PROFOR frameworks (Govan et al., 2013 and mid-term report, Appendix 6) identified four major governance issues at three main levels of governance (local, sub national and national):

1. emerging problems in family and community decision-making;
2. poor links between community and national governance;
3. little capacity for provincial government to provide services to support CBRM, and
4. lack of impact or presence of government at local level.

195. Accordingly, the present assessment intended a more in depth study that focused on the identified institutional aspects, particularly relating to the provincially-based institutions that would be expected to provide linkages between national level and communities.

196. Stakeholders were identified and interviewed using a semi-structured interview format modified from one previously used in institutional assessments in other Solomon Islands provinces (See Govan 2012, Govan et al. 2013). Interviewees provided copies of work plans, budgets and other institutional policy or permission to photo-reproduce such documents on the spot (owing to the lack of power, computers and photocopiers). Key informants suggested other informants and institutions and sampling proceeded in snowball fashion. Key informants interviewed are detailed in Table 27.

Table 27: Key informants interviewed in Malaita, May 2013

Institution	**Position**
Malaita Provincial Government	Minister of Planning.
Malaita Provincial Government	Provincial Secretary
Malaita Chazon (Development) Authority	General Manager
National Disaster Management Office (MECDM)	Provincial Disaster Officer / Climate focal point
Ministry of Fisheries (MFMR)	CFO Seconded staff PFO Seconded staff PFO Seconded staff
SWOCK UNDP (agric) / Adaptation Fund	Field officer (Malaita)
World Vision	Area Manager
SI Police Force	Sergeant (2nd in command)
World Bank Rural Development Project (RDP)	Coordinators
Save the Children	Coordinator (education)
Min. Agriculture and Lands (Malaita)	Principal Agriculture Officer
Provincial Fisheries (Malaita)	Provincial Officer
Malaita Province Partnership for Development (MPPD) Network / WorldFish	Acting Secretary MPPD

197. Owing to location and availability, rural schools, clinics and churches, though considered relevant stakeholders, were not covered in this assessment.

2. Results

198. The key provincial institution is the Malaita Provincial Government which serves as an umbrella to both the decentralized provincial government functions and those that are the responsibility of national government. In most sectors there is a mix of national and decentralized inputs.

a) Malaita Provincial Government (MPG)

a.1 Policy guidance

199. *Overall guiding policy:* The province is guided by the National Development Strategy 2011-2020 and by the, slightly preceding, Government for Reform and Regional Development and Empowerment's Regional Rural Development and Empowerment Policy Framework 2011-2015.

200. The guiding policy framework at provincial level comprises the "IU MI TUGETA BILDIM MALAITA - 10 year Strategic Development Plan 2007-17", Three year Development Plan 2013-2016 (draft) and the Malaita Provincial Government Corporate Plan (2013 – 2015).

201. *Ordinance*. The Malaita Province Fisheries Ordinance is still in draft and at the consultation stage. Compared to other Solomon Islands provinces Malaita seems to have no other natural resource related ordinance as far as could be ascertained[3]. Ordinance establishing the Malaita Chazon Development Authority has been approved and ordinance to establish 5 regions or development centers is being considered along with ordinance supporting the establishment of Ward Development Committees.

202. The focus of senior staff at MPG seems strongly oriented towards resolving major internal problems surrounding accounting and staffing issues. Hence there is a considerable amount of documentation relating to corporate strategy, human resource challenges and plans (Overall review of staff establishment and staffing need Malaita Province 2013-2016 (draft)) and budgetary processes. Other provinces have been able to utilize the Provincial Government Strengthening Project (PGSP) whereby provincial governments that meet essential accounting and administration criteria have access to considerable increases in capital, through the Provincial Capital Development Funds (PCDF). Guadalcanal and Central Islands Provinces have both acceded to these funds in the last budget but MPG failed to qualify partly attributable to the lack of a treasurer who should have been appointed by Central Government.

203. Policy priorities reported by senior staff included health and sanitation, education and the relocation of Outer Island populations at risk from sea level rise. Aquaculture and FADs were mentioned as areas of interest.

a.2 Budgetary and staffing

204. The budget under the control of MPG depends primarily on the national government grants and lack of revenue raising options is one of the major provincial challenges as in other provinces. The recurrent provincial budget is low compared to other provinces, in 2011/2012 the recurrent budget per capita was about 51% that of Central Province or Guadalcanal Province (Govan 2012). The 2012/13 Malaita Province budget appears to represent 52% increase on previous years despite an original request nearer 85% (Table 28). Even if the larger increase materialized the recurrent provincial budget per capita may still remain substantially lower than the two other provinces cited as these are also requesting substantial increases.

Table 28: Malaita provincial budget summaries and recurrent expenditure for selected divisions

Summary of Estimates (SBD)	**Actual 2010/11 (est.)**	**Actual 2011/12 (est.)**	**Actual 2012/13 (est)**	**Budget 2012/13**
Total recurrent expenditure	6,240,687	6,269,516	9,553,782	11,589,501
Total capital expenditure	**-**	**-**	-	**-**
Recurrent expenditure selected divisions				
Agriculture and livestock	137,785	71,881	112,169	248,756
Fisheries and marine resources	76,798	47,012	105,107	99,726
Forestry	89,060	165,400	137,700	-
Mines and energy	43,847	24,735	35,592	150,522
Environment and conservation	51,300	-	-	-
Disaster management		20,000		10,000*

* Under Premier's Office budget

[3] Copies of Malaita Province Wildlife Management and Licensing Ordinance 1995 could not be located.

205. The budgets for natural resource related divisions are notably low though these figures do not reflect funds that are under the direct control of national government or specific nationally administered projects. More than half the provincial budget is taken up by the provincial assembly, administration and finance, public works with a further 25% attributed to education, lands, health and local councils and sports.

206. Malaita Province has some 484 staff, the majority of which work in the rural health clinics though there are reportedly an additional "2,000 teachers and medical staff stationed outside in the substations / rural areas"[4]. Over half the MPG staff are seconded from central government, although most of these are in the health, education and agriculture sectors (Table 29 and see mid-term report, Appendix 5).

Table 29: Malaita provincial staffing for 2013 by division and including officers seconded from central government*

	Seconded	Direct
Headquarters	3	9
Finance	3	7
Speakers office	-	7
Culture / Tourism	-	1
Planning	4	-
Infrastructure and transport	-	9
Ecclesiastical	-	20
Education	13	2
Lands / Urban	5	6
Youth/sport/women	-	3
Fisheries	3	1
Commerce / Industries	3	1
Agriculture	24	6
Forestry	8	-
Met Office	3	-
Health	190	143
Disaster*	(1)	-
Total = (484)	263	221

* Staff member not mentioned in source material.
Source: Overall review of staff establishment and staffing need Malaita Province 2013-2016 (draft)".

207. Administrative and planning staff are difficult to recruit and, though operational, these areas will need more staff in the near future. Historical staffing practices are regarded as one of the main challenges facing the Province at the current time. An estimate of around half of the staff are deemed unproductive and unlikely to become so as many are beyond the age of retirement. The senior MPG staff intends to put in place staff performance systems in the hope that this can improve staff turnover and resolve the current impasse.

b) National ministries associated with Malaita Provincial Government

208. Central Government delivers services to the provincial population but to a varying extent this is carried out in association with the Malaita Provincial Government. The lines of command and allocation of resources are blurred through direct and indirect support modalities. Section

[4] Overall review of staff establishment and staffing need Malaita Province 2013-2016 (draft)

4.3.2 of the mid-term report, presents the official institutional context from the point of view of the Provincial Government but it necessary to ascertain the reality of the situation as actually implemented in each of the sectoral institutions. The national ministries relevant to the management of natural resources related to marine resources in Malaita are Ministry of Fisheries and Marine Resources (MFMR), Ministry of Agriculture and Lands (MAL), Ministry of Environment, Climate Change Disaster Management and Meteorology (MECDM) through the National Disaster Management Office (NDMO) and the Solomon Islands Police Force. The characteristics of these ministries are presented in Table 30. Broadly, the government organizations in Malaita are poorly supported whether centrally or provincially controlled and lack of oversight, under-staffing, poor motivation and low and unpredictable levels of funding are generalized.

Table 30: Overview of capacity of national ministries relevant to marine and aquatic natural resource management in Malaita

Institution	Strengths	Constraints	Opportunities
National Disaster Management Office (MECDM)	Technically capable staff (1) Well-resourced support ministry (NDMO) Partners with NGOs	Only one staff Staff on-call at national level (frequently absent) Disaster committee dysfunctional Main impacts are delivered by NGOs	Convening of Provincial Disaster Committee Networking and disseminating DRR and CCA relevant information
Ministry of Fisheries (MFMR)	Infrastructure: Auki office and 4 fisheries centers, truck Staff: 3 national seconded and 4 provincial Potential access to 2 budgets – provincial and national	Infrastructure non-functional, no maintenance, no power, no telephone, no internet or computers Provincial budgetary disbursement delayed, national financial contribution is unspecified and tends to be in a lump at years end. National staff experienced but past retirement age Provincial staff enthusiastic but under-qualified	Staff enthusiastic and able to engage and provide limited implementation if budgetary and logistical constraints are removed.
Ministry of Agriculture and Lands (Malaita)	More than 15 regionally (locally) based extension officers provide a potential network and conduit. Some functioning trucks and OBM and some fuel budget Existing projects provide impetus (RDP, SWAK)	Majority of staff are nationally seconded and managed from Honiara Many staff posts are vacant (~35%) and low motivation Weak logistics and transport Relatively low capacity in terms of experience or qualifications (e.g., no university graduates) Most activities take place under short-term externally managed projects	Staff could benefit and potentially improve effectiveness with improved management including training, rotation, more prompt support and follow-up Permanent presence in local communities may provide entry point or conduit for information
Ministry of Environment, Climate Change and	Have funds through the Coral Triangle Initiative and the IUCN MESCAL projects supporting	No provincially based staff for environmental services (though NDMO and meteorology are present)	MECDM and Provincial authorities have the intention to increase staff presence at

Institution	Strengths	Constraints	Opportunities
Disaster Management and Meteorology (MECDM)	mangrove management in several sites		provincial level. Meteorology staff present might potentially fulfill other climate change or environment-related roles
SI Police Force	Organized staff and regional outposts (Ato'ifi, Auki and Malu'u) with good communications Regular patrols Have some experience enforcing natural resource issues such as logging permits, beche de mer poaching and fish dynamiting Some available transport (1 boat and 1 truck)	Staff under-strength Inadequate transport Regional outposts have no resources Challenging to monitor environmental issues such as logging unless issues are called in	Network with good communications to rural areas Proficient public awareness and logistical capabilities

c) Civil Society and other organizations

209. Aside from the regular running of health and education services many of the services and initiatives that communities actually receive are provided by civil society organizations including churches and NGOs. National projects may be implemented by NGO partners but even when implemented through national government ministries they tend to have self-contained and independent management. The main NRM-related non-government institutions surveyed are summarized in Table 31.

Table 31: Overview of capacity of civil society organizations relevant to natural resource management in Malaita

Institution	Strengths	Constraints	Opportunities
World Bank Rural Development Project (RDP)	Well-resourced with transport, staff and equipment At least one (infrastructure) project in each ward (33) and communications and outreach to same	Parallel organization to the official institutions which will not remain after project finishes	Communications and connection to the rural areas Potential to improve the project in order to strengthen provincial institutions
World Vision	19 staff (11 in field) working with 15 high-risk communities Competent staff (4 are graduates) Works with partners including provincial government Provide transport for provincial government staff to assist in project sites	Concentrated on relatively small area (S. Malaita)	Keen to collaborate with other organizations especially if they can contribute expertise in other sectors (e.g., NRM and aquaculture)
Save the Children	Well-staffed (26) many of which are community based focusing	Concentrated on N. Malaita	Good network for N. Malaita and presence in schools

Institution	Strengths	Constraints	Opportunities
	on education targeting 20 schools Currently being re-organized Aims to encourage Provincial Government to improve service delivery by demonstration		(one of the few functioning institutions)
Malaita Chazon (Development) Authority	Focus on development and small business 9 staff, some relatively well qualified Staff connected at field level Generates income / own budget through town market and other properties rents Office building and other properties Computer and internet access	No transport Fund-raising capacity is limited Budget given by Provincial Government around SBD 100k and limits MCDA capacity to expand operations or enter new fields	Small business and marketing skills Relatively strong local knowledge and ability to interface at local level With project funding can operate as convener and interface with local and provincial institutions
WorldFish	Well resourced, 7 staff in Auki, focus on Research in Development with communities that rely on fisheries and Agriculture. MOU with Provincial Government	Staff numbers small so rely on partnerships and innovative communications for a broader reach	Strengths in marine resource governance and can tap into a broad suite of skills in wider organization; Mandate to work through and with partners provides opportunity to strengthen collaborations and networks
Malaita Province Partners for Development (MPPD) Network	Brings together NGOs, church groups, national government and provincial government Focused on improving broad development in the province Attempts to support and work with government	Dependent on individuals and their motivation Participation of government organizations is weak	Coordination of service provision across sectors and geography Potential to emphasize need to improve capacity of government through partnership and demonstration Sharing between organizations in order to provide examples of more integrated approaches

* Note: Kastom Garden and the Adventist Development and Relief Agency (ADRA) were not available for interview but are considered important stakeholders

3. Potential pathways

210. General assessment**.** Respondents in the present study overwhelmingly confirmed that communities were poorly linked to national or provincial institutional governance and that this was largely attributable to a combination of poor capacity, lack of resources, inadequate coordination and ineffective implementation.

211. For a province the size and importance of Malaita it appears that disproportionately few resources are made available, though this may be partially attributable to poor historic performance of the provincial government particularly in the area of accountability.

212. With a few exceptions (such as health and medical services and education) much of the development work and provincial services are carried out through short-term projects

implemented by central government or civil society organizations. The NGOs tend to work in defined geographies and tend not to overlap, preferring to cooperate in areas of potential overlap, and this is increasingly facilitated by MPPD.

213. A key civil society sector is that provided by the various churches operating in Malaita, many of which have their own NGO arm, and provide services ranging from education through to health and livelihoods. Generally these operate in defined geographical areas but it was beyond the scope of this study to assess their operations in the present study. Table 32 provides an overview of the capacity, constraints and opportunities for support and collaboration in Malaita Province.

Table 32: Summary of key opportunities and constraints in Malaita Province to reduce community vulnerability relating to natural resources*

Organizational level	Capacity / opportunities	Constraints
Individual (government)	Fisheries Officer (time and basic skills) MCDA officer (skills) Potential MAL extension officers	Poor history of public service delivery, few examples of efficient systems Demotivation
Individual (civil society)	NGO staff highly capable and motivated	Need for clearer meshing with provincial systems
Organization	Provincial governments stated desire to reform systems, need for demonstrable delivery	Lack of budgets or cash flow Technical and support staff shortages, management systems need developing Lack of central government support to provincial government "Projectization" of service delivery
Infrastructure and logistics	Transport (truck), provincial sub-centers developing	Lack of internet, telephone, computers, printer, office, accommodation
	MPPD coordination between all ministries, province and civil society	Disconnect between provincial government and national government / projects

* Bold text represents major opportunities or limiting issues.

4. General recommendations

214. Sustainable development interventions will require that systems be left in place that can ensure minimum ongoing oversight and support. This is the traditional role of central and provincial government and until such time as donors commit to fulfilling this role, if ever, it will be necessary for all development interventions seeking such sustainability to consider how best to improve systems of government service delivery. Two general approaches are proposed to be taken concurrently to strengthen the service delivery capacity of the appropriate provincial authorities– equivalent to institutional bottom-up and top-down approaches.

a. Bottom up: Work in partnership with relevant provincial staff (e.g., in MAL, Fisheries, MCDA and provincial administration) towards simple and achievable outcomes of mutual relevance with emphasis on "learning by doing" and addressing basic operational issues and challenges like budgeting and planning. Try to ensure

appropriate staff selected (keen, motivated) and graduated increase in workload complexity.

b. Top down: Maintain profile at high level of the need for Provincial Government (PG) reform and enhanced service delivery focus. Aside from direct interaction with senior national and provincial officials a potentially good vehicle for maintaining emphasis on this aspect and increasing leverage is through the developing provincial network, the MPPD. The support for PG reform and strengthening could be included in the ToR of the MPPD as well as using opportunities arising, maintaining the issue on the agenda, focusing discussions on the need for reform and building for the sustainability of the NGO and government (e.g., RDP) outcomes and not just coordination and sharing functions currently the focus of MPPD.

5. Specific recommendations

215. Individual assessment of field and extension officers in MAL and Fisheries was made for the identification of under-supported, under-employed but keen staff to form partnerships as in 1 above. It is likely that some of the more than 30 staff from both ministries would be able to perform important functions with a little support and serve as good examples to the rest while demonstrating service delivery options.

216. Monitor ward development committee progress and support and participate in ward development planning when and where appropriate. Ward development plans have the potential to be ideal legal (provincial and national) and legitimate integrated management plans for community issues. Ward development funds may allow aspects of these plans to be supported through recurrent national budgets.

217. Encourage national ministries to clarify and normalize budgetary and other support to provincial departments even for non-devolved functions. This would encourage provincial level joint planning and reduce confused signals in terms of whether national or provincial ministries are driving the work plan.

218. Review of national strategies such as the Inshore Fisheries Strategy should be encouraged to include discussion of the interface with provincial delivery mechanisms and building decentralized systems. The principle of subsidiarity bears exploration; in seeking to ensure that actions are taken at the lowest feasible level the current government emphasis on grass-roots and community level delivery may find a programmatic expression.

219. The inclusion of interventions in agriculture and fisheries and possibly NDMO and others as well as work at local and ward level combined with wider networking in the MPPD should aim to encourage cross-scale governance and strengthening for Malaita.

D. Land-based aquaculture development in Malaita in response to climate change: Implications for pond development, location, land use coincidence and ecosystem services

Activity:	Government stakeholder participatory workshops
Aim/Key question:	To examine and map land-based aquaculture development scenarios and consider potential areas of land use coincidence/conflict and environmental threat. The specific research questions were: • What do recent projections and postulations for land-based aquaculture development in Malaita mean for pond numbers, spatial area of ponds and water

Activity:	Government stakeholder participatory workshops
	use? • How might land-based aquaculture be distributed across the landscape? • What are the land use and environmental implications of projected land-based aquaculture investment? • What are the implications of the use of different fish species for land-based aquaculture development?
Brief details of method:	• We extrapolated projected nutritional shortfalls into the numbers of ponds required, area required by ponds and water use for several scenarios. • We used aquaculture suitability mapping to determine likely locations of future land-based aquaculture development. We compared the resulting projected aquaculture locations with existing land uses and natural assets to examine possible areas of land use coincidence and resource use. • We worked with national and provincial level government stakeholders to map priority land uses and natural assets.
Key results:	• The projected nutritional shortfall suggests very large numbers of ponds may be required to meet this shortfall. • Nile tilapia would require half the number of ponds of Mozambique tilapia. • For small numbers of ponds, land use coincidence/conflict and offsite-impacts should be manageable. For a large number of ponds the management of land-use coincidence/conflict and offsite pollution may become more problematic and urgent. • Current levels of community and institutional capacity may prevent land-based aquaculture from being conducted at the very large scales that nutritional shortfall projections indicate may be required. This is likely to leave an unmet nutritional shortfall that will require addressing through some other means or mechanisms.

1. Introduction

220. Land-based aquaculture in Malaita is still in its early stages of development with most farmers practicing aquaculture concentrated in the central region, and generally conducting this on a subsistence basis. However, there are a growing number of farmers interested in pursuing land-based aquaculture ponds (WorldFish, 2011), and those that already have ponds seem to be generally positive about them and optimistic about the role ponds may play in providing food, income and nutrition in the future (M. Phillips, pers. comm.). Furthermore there have been a number of recent studies examining the potential for aquaculture to become a viable form of production in the region, and one that may be able to bridge the fish supply and nutrition gap between fish production and nutritional requirements from fish (Bell et al. 2009). The need to bridge this fish supply and nutritional gap is only likely to increase, as:

- The population of Solomon Islands is growing steadily at a rate of 2.17% per annum (CIA, 2012);

- Fish stocks are in decline (Brewer, 2011) with contributory factors including: i) land use practices (e.g., agro-chemical run-off, erosion/sedimentation) impacting reefs (Fabricius, 2005; Mumby and Steneck, 2008); ii) overfishing related to population growth, increased fish consumption, and increased connectivity between fisheries and markets (Brewer et al. 2009); iii) climate change and ocean acidification impacting on coral reef accretion and interacting with threats such as habitat loss and overfishing (Hoegh-Guldberg et al. 2007) to ultimately impact negatively on fish stocks (Lehodey et al. 2010; Bell et al. 2012).

221. As such there is a need to begin quantifying how projected fish supply and nutritional shortfalls may be met (at least in part) by land-based aquaculture, how ponds might be spatially arrayed and how such spatial arrangement may interact with existing land uses and natural assets.

222. Mozambique tilapia (*Oreochromis mossambicus*) is the only food fish currently farmed in Solomon Islands; the species was introduced in the 1950s. Backyard pond farming and wild capture of this species presently supply small quantities of Mozambique tilapia for household consumption, particularly in urban and peri-urban areas of Honiara and Auki (Cleasby et al. 2013). However, this tilapia species performs poorly in aquaculture and the yields of fish to households are very low.

223. While some small yield improvements to existing backyard ponds are now happening, this species of tilapia does not have the necessary characteristics to make it suitable to meet the challenge of supplying future domestic fish demand. It is anticipated that it will be necessary to explore alternative options if land-based aquaculture is to meet future demand for fish. Farming of a native fish is an option, of which ACIAR project FIS/2009/061 (WorldFish, 2011) identified milkfish (*Chanos chanos*) as a priority candidate species. If tilapia is preferred, another option requires the introduction of a new species of tilapia to the country. The Solomon Islands Government is presently considering an ecological risk analysis for importation of Nile tilapia (*Oreochromis niloticus*) to Solomon Islands; however at the time of writing, no decision had been made regarding the suitability/feasibility of this species for introduction.

224. WorldFish research (WorldFish, 2011) has identified that household ponds, village clusters, schools, and small and medium enterprise (SME) options for farming of milkfish and/or Nile tilapia appear feasible options for investment, although research is required to develop appropriate low cost farming systems. Geographical information system (GIS) analysis conducted by ACIAR project FIS/2009/061(WorldFish, 2011) identified suitable locations for pond farming with access to market/demand centers on the two islands of Guadalcanal (Honiara) and Malaita (Auki).

225. In order to consider how an increase in land-based aquaculture in the region might impact positively and negatively on other elements of the landscape, existing productive land uses and ecosystem services, we estimated the number of ponds, total area and water requirements that would be needed under three different aquaculture development scenarios (described below). On the basis of the spatial and water requirements of each, we then:

a. plotted the potential distribution of ponds against a map of areas on Malaita calculated as being physically highly suitable for aquaculture;
b. considered potential land use synergies and conflicts (i.e., potential juxtaposition of aquaculture and existing land uses), and
c. discussed the findings in the context of ecosystem service delivery.

226. Land that is suitable for aquaculture (flat or gently sloping, close to village dwellings, well connected to tracks or roads, close to water sources) tends to also be land that is valued or already used for other productive land uses (e.g., home gardens, plantations). As such, and depending on the scale of future land-based aquaculture development, there may be conflict over where to locate ponds in relation to other productive land.

227. In some cases, where available land is limited, this may have the potential to result in a trade-off of nutritional benefits from different sources (e.g., installation of ponds may result in a loss of area for crops). Certainly, land use conflict can occur in regions with very high population

densities and where available land is scarce (Beveridge and Philips, 1993), or where proposed aquaculture spatially coincides with natural assets such as mangroves, that provide essential but undervalued ecosystem services (Gebhardt et al. 2012). Similarly, the location of aquaculture on a large scale and in close proximity to sensitive environmental and economic assets, such as coral reefs, may lead to nutrients and chemicals (e.g., disinfectants, antifoulants and therapeutic chemicals) negatively impacting on those assets.

228. Alternatively, judicious and well-planned location of ponds may actually enhance cropping through water storage and gradual seepage. For any individual farmer interested in land-based aquaculture, the location of ponds in relation to other land uses and assets should be a primary consideration. If investment in ponds is scaled up to multiple farmers in a community, then decisions about their location and management become all the more important if they are to capitalize on the potential benefits that aquaculture can offer. Collaborative decision-making is an important component to avoiding negative issues, such as land use and resource availability conflict and the offsite-impacts that often occur when small scale production activities are scaled up to 'industrial' levels.

2. Methods

229. Scenario 1: Linear population growth model. The human population growth of Malaita was calculated based on the 2009 census data figures (Solomon Islands Government, 2011) as the starting population and the Solomon Islands estimated population growth rate of 2.17% per annum (Central Intelligence Agency, 2012) was applied. We estimated future population on Malaita annually until 2030.

230. Using these population growth figures, we used the estimates of fish consumed per person per year from Weeratunge et al (2011) (using the figure for rural populations). This gave an annual rise in fish consumption proportional to human population growth (i.e., this model did not attempt to account for non-linear changes in fish consumption).

231. From this we used the upper and lower estimates of required fish nutrition required per person per annum from Bell et al. (2009) to determine the upper and lower estimates of nutritional shortfall from fish production and consumption.

232. These shortfall figures (both upper and lower estimates) were then used to calculate how many 'average' (typical current homestead) sized ponds (30 m^2) would be required to fill the estimated nutritional shortfall with two species of fish as the production fish. The existing species in Solomon Islands, Mozambique tilapia, were compared with Nile tilapia, a commonly farmed species in other parts of the world. Potential production figures of 2,000 kg/ha/yr and 4,000 kg/ha/yr were used for Mozambique tilapia and Nile tilapia, respectively. These estimates of production were provided by Dr Mike Phillips from WorldFish and based on research into tilapia production. From these data calculation was made of the number of 30 m^2 ponds and the number of hectares (approximately 330 ponds = 1 ha) required to make up the nutritional shortfall using each fish species. On this basis, Nile tilapia would require half the number of ponds and spatial area as Mozambique tilapia (all other factors being equal). The farming systems required for these two species are, in practical terms, not equal—for example there would be more stringent stock management requirements needed to attain this production for Nile tilapia; nevertheless the area calculation remains valid.

233. Finally, the volume of water required for each postulated number of ponds was calculated. This was based on an average pond volume of 30 m^3, with average pond depth taken as 1m. Calculation was only made to the volume required for the total number of ponds at

any one time; water loss resulting from seepage and evaporation (and hence need for continual replacement) was not included. In order to place the projected water use in a meteorological and climate context, the annual volume of rainfall in Malaita (average annual rainfall*land surface area) was then calculated. From this the proportion of total rainfall that would be needed to fill the projected numbers of ponds can be derived.

234. Scenario 2: Government stakeholder scenario. From an interview and mapping exercise undertaken with a key informant of the Malaita Chazon Development Authority (MCDA) in Auki, 22.5 hectares of ponds were estimated as being a potentially realistic development in Malaita over the next 5–10 years. The number of 30 m^2 ponds that would equate to 22.5 ha for both Mozambique and Nile tilapia were calculated, as were water requirements. As the fish production from 22 ha of ponds would be low compared to the other scenarios, calculation was made on the nutritional shortfall for the people of Malaita in nutrition obtained from fish that may eventuate from such a scenario.

235. Scenario 3: Weeratunge et al (2011) 'baseline' scenario. In their paper 'Planning the use of fish for food security in Solomon Islands', Weeratunge et al. (2011) developed a range of scenarios that examined the required target outputs for aquaculture in Solomon Islands. For the sake of simplicity, only their 'baseline' scenario (Table 16) was used to explore what such an eventuation might mean in terms of pond numbers, spatial area of ponds, and water volume requirements in the future. As the figures given by Weeratunge et al. (2011) are for the Solomon Islands as a whole, the fish supply required per capita for the Solomons was calculated as a whole (from Table 16) and then multiplied this by the projected human population of Malaita for the years 2010, 2015, 2020, 2025 and 2030. This provided estimates of the fish nutrition requirements for Malaita. From this, we were able to use the data from Scenario 1 above, to estimate the number of ponds (30 m^2), total pond area in hectares and volume of water required for Weeratunge's baseline scenario of fish supply requirements.

236. The data from scenarios 1 and 3 were then plotted using MS Excel.

3. Mapping

237. In order to map the location and densities of ponds based on the various scenarios we used the location recommendations from the aquaculture suitability mapping conducted by WorldFish (2011). Note that this suitability map is based solely on physical attributes alone and does not account for land tenure or other social aspects of land use. This study therefore sought only to evaluate the physical suitability for aquaculture development and infrastructure location in Malaita (based on a fine scale 90 m x 90 m grid system).

238. Suitability was scored using a number of criteria:

a. Biophysical factors — i) proximity to rivers and perennial streams (as a surrogate for water sources); ii) slope steepness (ease of pond construction).

b. Market — i) village cluster population (local market demand); ii) proximity to road network (off-road access); iii) proximity to demand centers (local markets); iv) access to provincial capital within 3.5 hours by road (ease of transportation to largest market).

c. Village production — i) proximity to village (security and ease of care); ii) distance from coral reef (incentive to produce fish).

239. In this study, these measures were weighted according to perceived relative importance and used to score each 90 m x 90 m pixel of land in Malaita for aquaculture suitability. These data were then aggregated into the number of km^2 in each Ward[5] in Malaita that were considered 'least suitable', 'moderately suitable', 'suitable' and 'most suitable' for aquaculture. In order to then distribute the number of ponds from each of our scenarios 'equitably', the following process was used:

- Took only the figures of most suitable area for each Ward.
- Summed the total number of km2 of 'most suitable' land for each Ward (e.g., km2 for Aiaisi + km2 for Aimela, etc.).
- Calculated the percentage of land that each Ward contributed to the total of 'most suitable' land by using the equation: (area of suitable land in Ward N/total area of suitable land among all Wards)*100.
- Therefore each Ward's area of land included in the final calculations was proportional to its contribution to the total of 'most suitable' land across all of Malaita.
- For each scenario the number of ponds required across Malaita was then multiplied by the percentage contribution that each Ward made to the total of 'most suitable' land. This meant that Wards that had a large amount of land that had scored as 'most suitable' would be allocated a correspondingly high number of ponds.

4. Land use, coastal use and ecosystem services

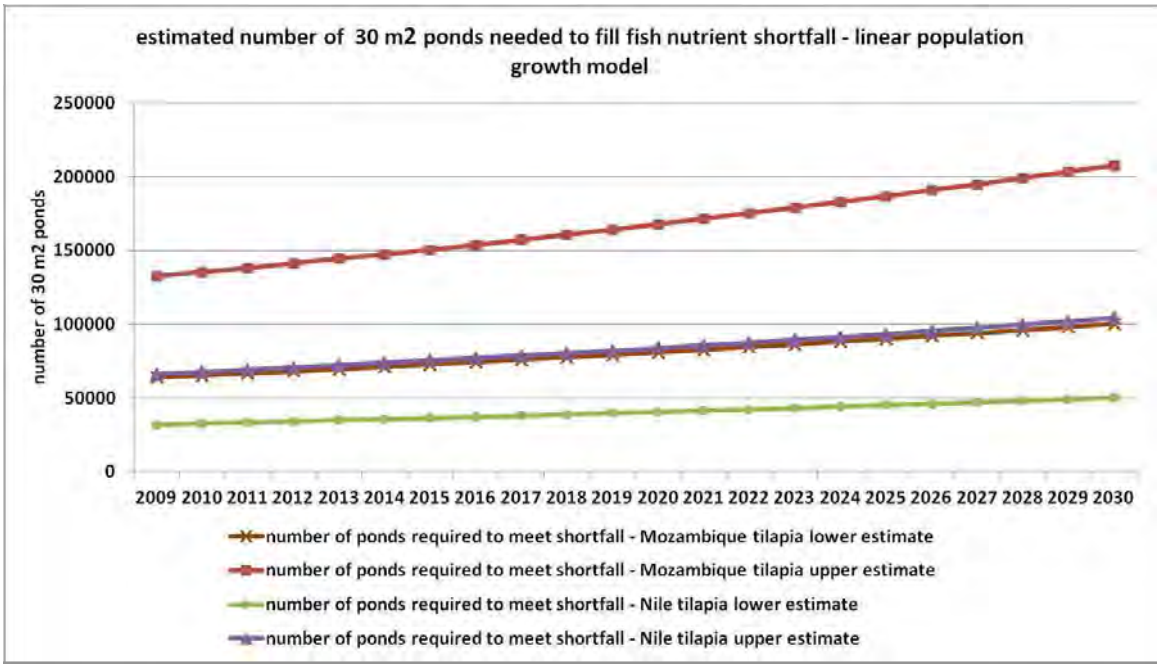
240. The coincidence of areas projected to be both suitable for land-based aquaculture and to have a high likelihood of high pond density was examined, in respect to existing land uses and natural assets. This enabled an initial assessment to be undertaken of how high density aquaculture might coincide with and, potentially, run into conflict with existing land uses, and where aquaculture at high densities might impact on natural assets that provide essential ecosystem services. This was done by comparing the Wards that were projected to have the highest aquaculture future densities, detailed land use mapping of Malaita (Ministry of Lands, 2007) and the mapping undertaken as part of this study in targeted meetings with national and provincial level government stakeholders.

5. Results and discussion

241. Scenario: 1 Linear population growth model. Figure 92 shows that with a high nutritional/fish supply shortfall, and basing aquaculture entirely on Mozambique tilapia, the number of average sized ponds required may exceed 200,000 by the year 2030. Alternatively, if the nutritional/fish supply shortfall is at the lower end of Bell et al's projections, and aquaculture is based entirely on Nile tilapia, then the required number of average size ponds would be a quarter of that needed under the aforementioned scenario (i.e., 50,000). Interestingly, the number of ponds required under a low shortfall, Mozambique tilapia scenario and a high shortfall, Nile tilapia scenario, are virtually identical.

[5] Wards are equivalent to local council areas.

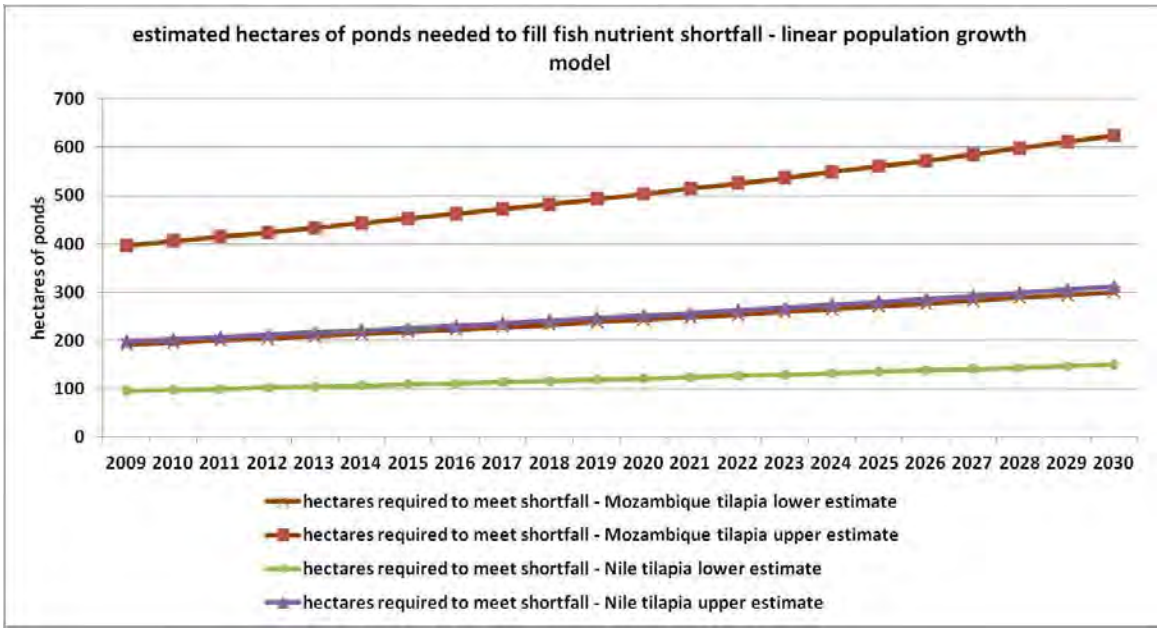
Figure 92: Estimated number of ponds required for different fish and nutritional scenarios



242. By translating the number of ponds required into hectares needed to accommodate the above pond number estimates, the spatial area under the 'Nile tilapia, low shortfall' scenario is estimated at a relatively modest 150 hectares, compared to more than 600 hectares required under the 'Mozambique tilapia, high shortfall' scenario (Figure 93). These figures only include the actual water area, and do not account for borders of ponds, necessary infrastructure and other spatial requirements.

243. Water use for the lower nutritional shortfall scenario using Mozambique tilapia would require an estimate of over 3,000,000 m³ of water by 2030, and the upper nutritional shortfall scenario using Mozambique tilapia over 6,000,000 m³ of water in the same time period. This may appear to be a substantial volume of water, but represents only approximately 0.02% of the region's annual rainfall. While the amount of actual water available may not be an issue, ensuring the effective collection and storage of that water is paramount. This would help ensure that water extraction does not detract from other land uses (e.g., water and crops), or impact negatively on other natural assets such as wetlands. Projections of a potential increase in future rainfall during the wet season suggests increasing demand for water may be accommodated if good water and land management actions are practiced.

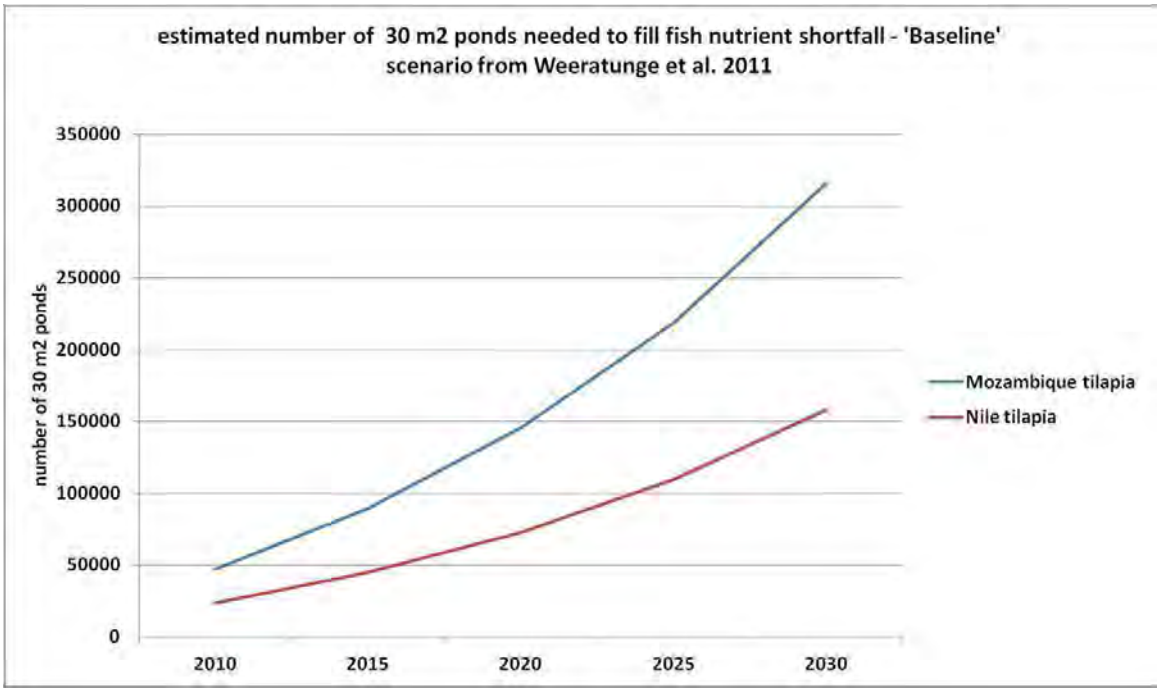
Figure 93: Estimated number of hectares required for different fish and nutritional scenarios



244. Scenario 2. The potential future investments in aquaculture in Malaita postulated by the MCDA stakeholder (i.e., a total of 22.5 hectares of aquaculture development), is far more modest than that proposed by the model projections. Given current levels of expertise and investment, this lower scale of development is perhaps more realistic for Malaita. This would translate into 7,500 average sized ponds over the next 5 to 10 years. If all these ponds were functioning and producing to their full potential, this could result in annual yields of 45,000 kg of Mozambique tilapia (90,000 kg in the case of Nile tilapia). These yields fall a long way short of making up the predicted nutritional shortfalls in fish for Solomon Islands (Bell et al. 2009). By 2023, the shortfall based on 7500 average sized ponds stocked with Mozambique tilapia, would range from 475 tonnes at a low shortfall estimate, to 1033 tonnes for an upper shortfall estimate. Even with the higher yields associated with Nile tilapia, shortfalls in the same time period would range from 430 tonnes at a low shortfall estimate, to 988 tonnes at an upper shortfall estimate. Clearly, while this may represent a more realistic and feasible level of medium to long term aquaculture investment, it still leaves a considerable nutritional shortfall that needs to be accounted for through some other form of production, harvesting or product importation.

245. Scenario 3. The non-linear scenario using Weeratunge et al. (2011) baseline projections indicates that increasing demands for fish, coupled with human population growth, will result in a very high demand for aquaculture ponds by the year 2030 (**Figure 94**). This scenario predicts that by 2030, more than 300,000 average sized ponds would be required if aquaculture were dependent on Mozambique tilapia. Half this number are estimated to be required if aquaculture was to be based entirely on Nile tilapia.

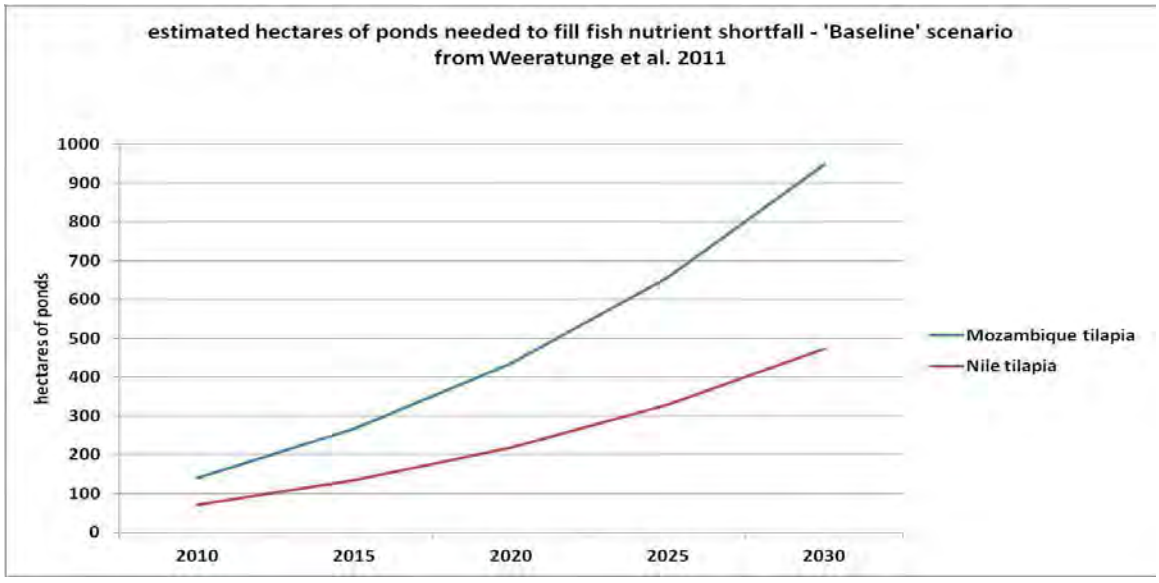
Figure 94: Estimated number of ponds required for different fish and nutritional scenarios*



*The number of ponds required under the less productive Mozambique tilapia model would require twice as many ponds as that for Nile tilapia.

246. This high projected demand for ponds under the Mozambique tilapia scenario, by 2030, could result in over 900 hectares of land being required to meet the projected nutritional shortfall (**Figure 95**). Water use for this projection is of a similar magnitude to that described in scenario one, and while apparently minuscule compared to total water availability in Malaita, may still require careful management in certain locations.

Figure 95: Estimated number of hectares required for different fish and nutritional scenarios*



*As for Figure 94, the area of ponds required under the less productive Mozambique tilapia model would be twice that required for Nile tilapia.

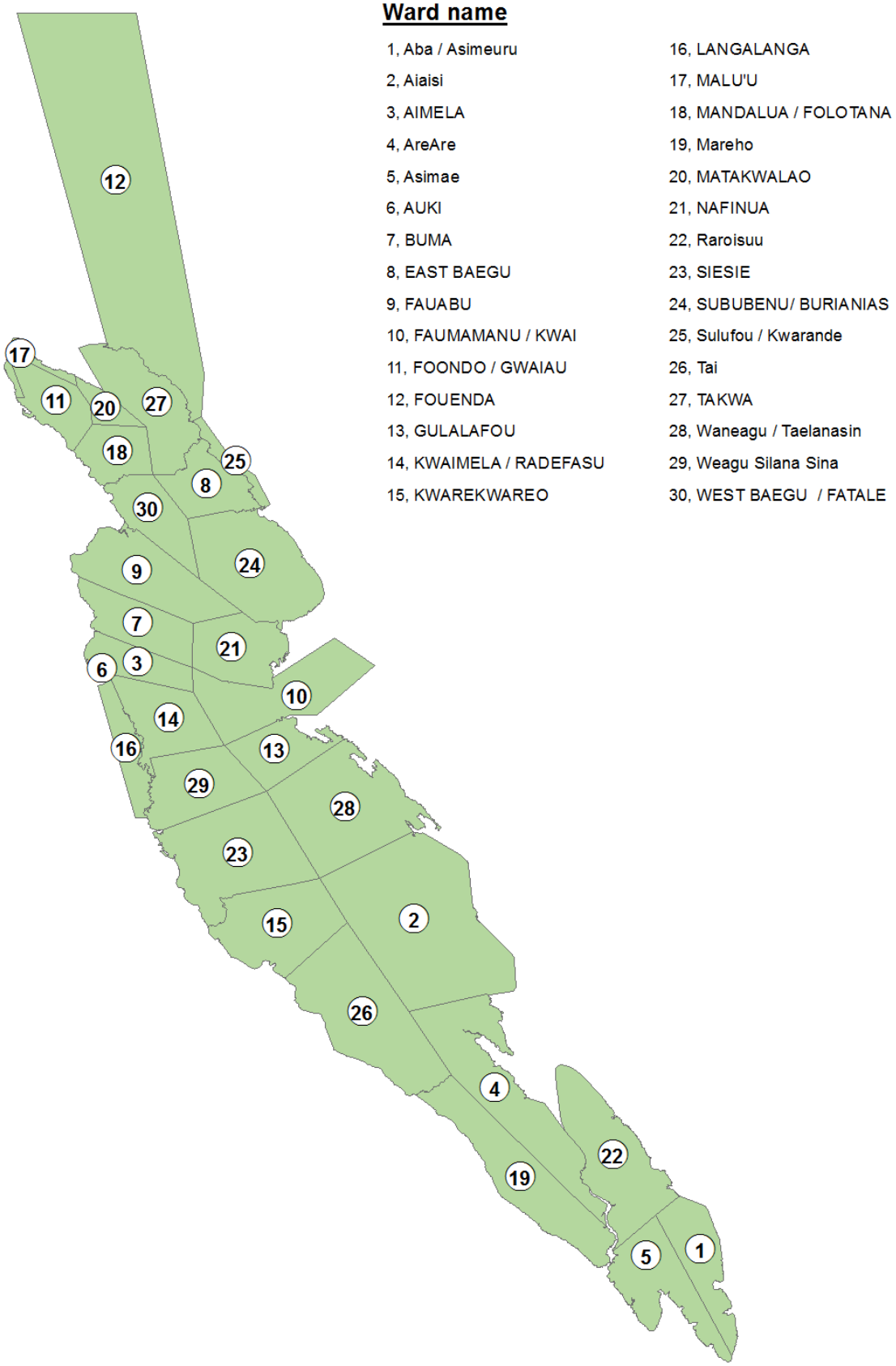
6. Mapping

247. Table 33 provides a summary of estimated number of 30 m^2 ponds required in each Ward of Malaita if land-based aquaculture were to make up projected nutritional shortfalls in 2015 and 2030 using different scenarios, fish species and upper and lower nutrition gaps. To visualize this data, the estimated number of ponds required for each Ward for each scenario was plotted. Figure 96 shows the location of the thirty Wards in Malaita. The estimates are based solely on secondary data and available map information. No consideration is given in this analysis to land tenure or community and Ward development plans and goals. While this level of analysis is beyond the scope of this study, it would be a next step in further exploring this scenario approach.

Table 33: Estimated number of 30 m2 ponds required in each Ward of Malaita if land-based aquaculture were to make up projected nutritional shortfalls in 2015 and 2030. Different scenarios of human population growth, nutritional shortfall and fish species used, are depicted

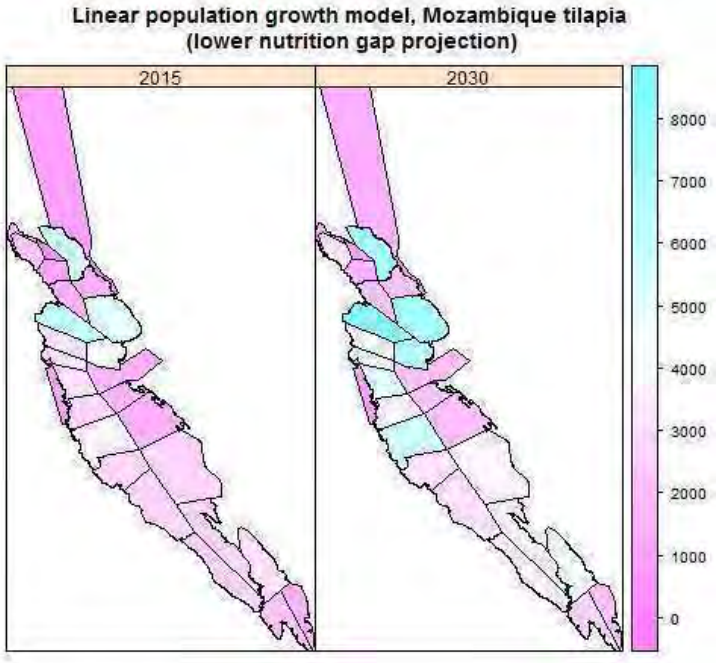
Ward name	linear population growth model, Mozambique tilapia, lower nutrition gap, 2015 projection	linear population growth model, Mozambique tilapia, lower nutrition gap, 2030 projection	linear population growth model, Mozambique tilapia, upper nutrition gap, 2015 projection	linear population growth model, Mozambique tilapia, upper nutrition gap, 2030 projection	linear population growth model, Nile tilapia, lower nutrition gap, 2015 projection	linear population growth model, Nile tilapia, lower nutrition gap, 2030 projection	linear population growth model, Nile tilapia, upper nutrition gap, 2015 projection	linear population growth model, Nile tilapia, upper nutrition gap, 2030 projection	Weeratunge et al. non-linear population growth model, Mozambique tilapia, 2015 projection	Weeratunge et al. non-linear population growth model, Mozambique tilapia, 2030 projection	Weeratunge et al. non-linear population growth model, Nile tilapia, 2015 projection	Weeratunge et al. non-linear population growth model, Nile tilapia, 2030 projection
Sulufou / Kwarande	30	41	61	85	15	20	31	42	36	128	18	64
Auki	261	360	540	745	130	180	270	373	320	1132	160	566
Matakwalao	588	811	1218	1680	294	406	609	840	722	2552	361	1276
Langalanga	660	911	1368	1888	330	456	684	944	811	2867	405	1434
Fouenda	1056	1457	2187	3017	528	728	1093	1509	1296	4583	648	2291
Mandalua / Folotana	1094	1509	2265	3126	547	755	1133	1563	1342	4748	671	2374
Malu'u	1242	1713	2572	3549	621	857	1286	1774	1524	5390	762	2695
Waneagu / Taelanasin	1324	1827	2743	3785	662	914	1371	1893	1625	5749	813	2874
East Baegu	1375	1897	2848	3930	687	949	1424	1965	1688	5969	844	2985
Aba / Asimeuru	1558	2149	3226	4452	779	1075	1613	2226	1912	6762	956	3381
Gulalafou	1644	2269	3406	4699	822	1134	1703	2350	2018	7137	1009	3569
Faumamanu / Kwai	1663	2295	3445	4754	832	1147	1722	2377	2041	7220	1021	3610
West Baegu / Fatale	1671	2306	3462	4778	836	1153	1731	2389	2052	7256	1026	3628
Asimae	1867	2576	3867	5336	933	1288	1933	2668	2291	8104	1146	4052
Foondo / Gwaiau	2374	3276	4918	6787	1187	1638	2459	3393	2914	10307	1457	5154
Kwarekwareo	2392	3301	4955	6838	1196	1650	2478	3419	2936	10385	1468	5192
Tai	2574	3552	5332	7358	1287	1776	2666	3679	3160	11175	1580	5588
Areare	2706	3735	5606	7736	1353	1867	2803	3868	3322	11749	1661	5875
Mareho	2722	3755	5637	7779	1361	1878	2819	3890	3341	11815	1670	5907
Weagu Silana Sina	2751	3796	5699	7864	1376	1898	2849	3932	3377	11943	1688	5972
Aiaisi	2754	3801	5706	7873	1377	1900	2853	3937	3381	11958	1690	5979
Aimela	3010	4154	6235	8604	1505	2077	3118	4302	3695	13068	1847	6534
Buma	3107	4287	6435	8880	1553	2143	3218	4440	3813	13487	1907	6744
Raroisuu	3385	4671	7011	9675	1692	2335	3506	4837	4155	14694	2077	7347
Kwaimela / Radefasu	3509	4842	7268	10029	1754	2421	3634	5015	4307	15232	2153	7616
Siesie	4133	5703	8561	11813	2066	2851	4280	5907	5073	17942	2536	8971
Nafinua	4739	6539	9817	13546	2370	3270	4908	6773	5817	20574	2908	10287
Sububenu/ Burianias	5190	7162	10751	14835	2595	3581	5375	7418	6371	22532	3185	11266
Takwa	5372	7412	11127	15354	2686	3706	5563	7677	6593	23319	3297	11660
Fauabu	5997	8276	12423	17143	2999	4138	6212	8571	7361	26036	3681	13018

Figure 96: Location of Wards in Malaita



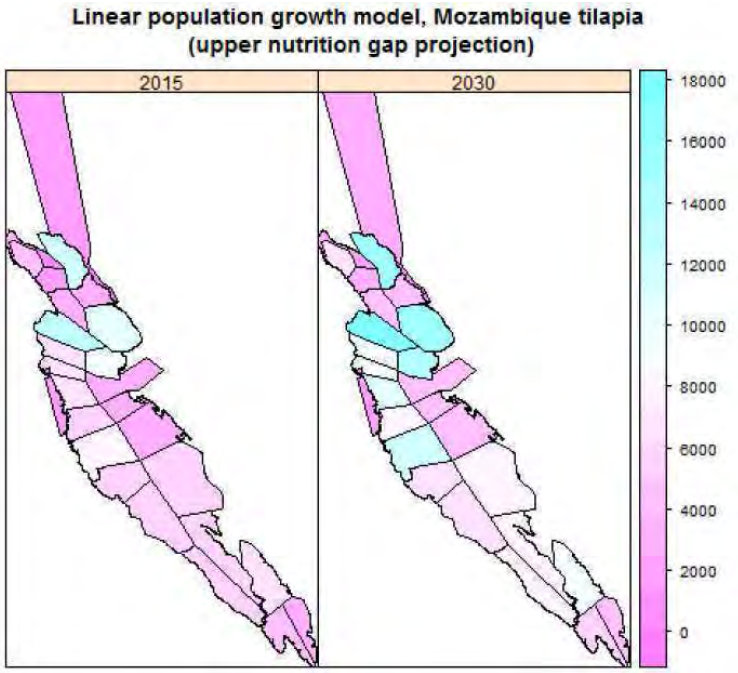
248. Scenario 1 Linear population growth model. Using the linear population growth model, with a lower nutritional gap, and considering the use of Mozambique tilapia, Figure 97 shows that by 2015, an estimate of nine Wards have a 'moderate' (3,000–6,000) requirement of pond numbers. By 2030, the number of ponds required is projected to have increased from 6,500 for Nafinua, to just over 8,000 for Fauabu, for the 'top four' Wards. While the numbers of ponds are undoubtedly very high under this model, it does indicate a more incremental increase in numbers of required ponds compared to other scenarios and model variations.

Figure 97: Projected number of average sized ponds in each Ward of Malaita that are required to fill a scenario of lower nutritional shortfall and Mozambique tilapia, and using the linear population model



249. The situation alters dramatically if the requirements per Ward are modeled using the upper projection of nutritional shortfall (Figure 98). The number of $30m^2$ ponds required under this projection more than double for each time period. This translates into 14 Wards requiring more than 5,000 ponds by the year 2015, the highest number being for Fauabu, with a projected requirement of over 12,000 ponds. By 2030, this projection begins to look even more challenging, with 17 Wards requiring more than 5,000 ponds, 6 requiring more than 10,000 and Fauabu requiring over 17,000. Clearly, given the number of households and the inevitable competition for land, such a scenario looks unfeasible on a number of fronts.

Figure 98: Projected number of average sized ponds in each Ward of Malaita that are required to fill a scenario using the upper projection of nutritional shortfall, Mozambique tilapia, and the linear population model



250. Re running this model for Nile tilapia results in a greatly reduced number of ponds being required. For instance, even under the high nutritional shortfall scenario, only six Wards would require more than 5,000 average sized ponds by 2030 (Figure 99). Under the more conservative lower nutritional shortfall estimate, no Ward would require more than 4,200 average sized ponds (Figure 100).).

Figure 99: Projected number of average sized ponds in each Ward of Malaita that are required to fill a scenario using the upper nutritional shortfall, Nile tilapia, and the linear population model

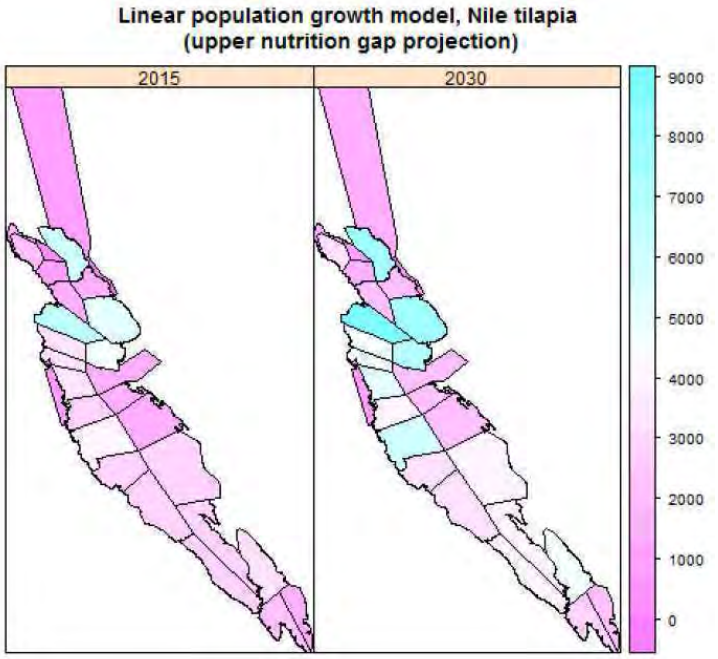
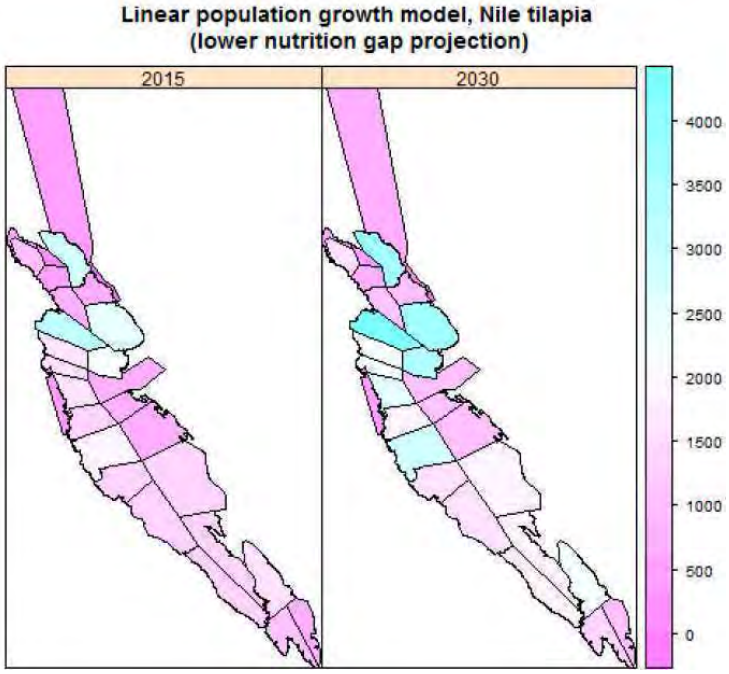


Figure 100: Projected number of average sized ponds in each Ward of Malaita that are required to fill a scenario using the lower projection of nutritional shortfall, Nile tilapia, and the linear population model



251. The non-linear land-based aquaculture model shows relatively modest pond requirements by 2015 (Figure 101 and Figure 102). For instance, under the Mozambique tilapia model only five Wards would require more than 5000 average size ponds, and under the Nile tilapia model no Wards would require more than 4000 average sized ponds. However, the non-linear growth in demand for fish protein used in this model would lead to very high pond requirements by 2030. This would be particularly apparent under the lower yield Mozambique tilapia model, where six Wards would require more than 15,000 average sized ponds, and much of the island would be under a relatively high density of aquaculture. The number required would be approximately half for Nile tilapia.

Figure 101: Projected number of average sized ponds in each Ward of Malaita that are required to fill a scenario using the upper projection of nutritional shortfall, Mozambique tilapia, and the non-linear population model

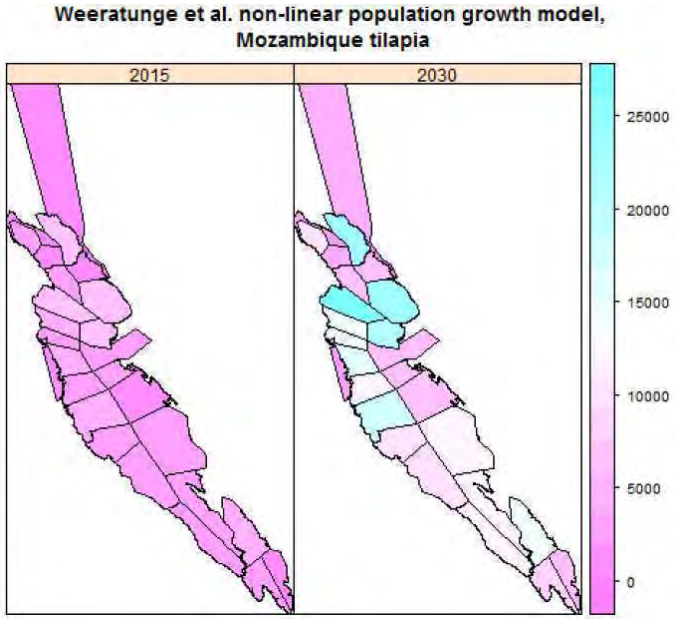
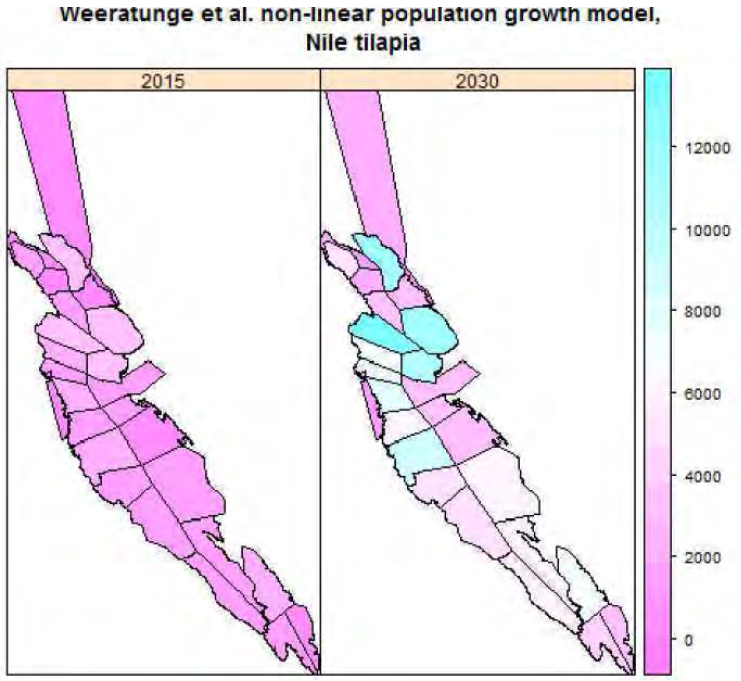


Figure 102: Projected number of average sized ponds in each Ward of Malaita that are required to fill a scenario using the upper projection of nutritional shortfall, Nile tilapia, and the non-linear population model



252. It is apparent from these projections that a future land-based aquaculture industry based on subsistence ponds as currently practiced sporadically in Malaita, and stocked primarily with Mozambique tilapia, would be unsuitable due to the enormous number of ponds required to fill the nutritional gap. Therefore, other species need to be considered as the basis for future inland aquaculture in Malaita. Nile tilapia, with its higher yield, appears to be a potential candidate (WorldFish, 2011). However, if large scale aquaculture is to be productive, effective and sustainable in Malaita in the long-term a great deal of prior work would need to be undertaken in terms of: i) developing markets (for example in fish food supply and output demand); ii) developing infrastructure; iii) supporting informed and effective management of ponds, and iv) developing and implementing policy and institutional support. Further work would also be required in terms of assessing and managing the potential negative environmental impacts of introducing Nile tilapia into the system where the species is not native. For instance, the introduction of Nile tilapia, along with other species, contributed to the decline in cichlid fish species in Lake Victoria (Ogutu-Ohwayo, 1990). Also, the introduction of Nile tilapia in Brazil has been shown to have contributed to water eutrophication and increased algal blooms (Figueredo and Giani, 2005). As with any postulated biological introduction, thorough trials and environmental impact assessments will be required. Such a risk analysis has been undertaken by the SPC (Secretariat of the Pacific Community) and the findings are under consideration by the government. It should be noted, however, that Mozambique tilapia is already present in Solomon Islands, and this species is considered to be more invasive than Nile Tilapia (M. Phillips, pers. comm.). Another potential option is to use a native fish species as the basis for large scale aquaculture. The only candidate proposed for this so far is milkfish, and this too would require considerable research and development prior to large scale implementation.

253. For the analysis an assumption of average pond size that is consistent with current levels of subsistence fish production is used. However, it may be possible to reduce the number of ponds to a more realistic level, while approaching estimated nutritional shortfalls,

by having a smaller number of larger and more productive ponds that can sustain a much greater fish yield per pond area. Such an approach would be far more akin to commercial fish production, and consequently would require greater infrastructure, market and institutional development. Environmental risks, such as nutrient and chemical pollution and disease occurrence, would also need to be managed (Anchor Environmental, 2013).

7. Aquaculture density, land-use coincidence and potential environmental/ecosystem service impacts

254. A very fine scale analysis of aquaculture suitability and current land use in each 90 by 90 meter grid square is far beyond the scope of this report. However, we are able to make some preliminary observations about how aquaculture at large scales may interact with the surrounding landscape and seascape. We have done this by visually examining the areas classified as physically highly suitable for aquaculture, the Wards where we have predicted land-based aquaculture may be undertaken at relatively high densities, and current land use mapping.

255. The area considered most suitable for land-based aquaculture was the Ward of Fauabu. This due to its flat or gently sloping land forms, relatively good road communication, the presence of numerous sources of fresh water such as rivers and streams, and relatively high human population density. However, the area is presently used extensively for cocoa and coconut plantations, as can be seen in the detailed land use topographical map (Figure 103), and in the maps that were annotated by national and provincial level government stakeholders (Figure 104). Depending on the density of these plantations, their juxtaposition with households gardens and the availability and accessibility of other suitable land, the specific location of large numbers of ponds, would need to be carefully considered by individual farmers, and ultimately, planning authorities. Given that stakeholders indicated that deforestation was occurring in the area, this suggests that there may be suitable land for inland aquaculture that would not clash with existing productive land uses. However, large-scale clearing of native woody vegetation could have highly detrimental effects such as biodiversity loss and soil erosion, if not managed and limited in extent.

256. While actual volume of water required for ponds may not be an immediately limiting issue, highly localized, high density pond aggregation could potentially lead to similarly highly localized water resource conflict. In such instances, the collection of rainwater during the wet season may assist in water management for ponds and other uses during the dry season. Of more immediate concern is that essential water sources and waterways do not become polluted by nutrient-rich pond water and pond waste. Such risks might be managed through integrating farming approaches, such as use of pond water for agricultural and plantation irrigation. Such concerns are integral to sensible and carefully considered (as opposed to ad hoc) pond location and well informed and diligent management of individual ponds.

257. It may be possible to locate individual ponds so that gradual seepage of nutrient-rich water can be used to increase crop growth, especially given the presence of: a) a relatively high number of households, many of which are likely to have productive home gardens for subsistence use, and b) the presence of larger scale plantations.

Figure 103: An annotated map of the Ward of Fauabu, indicating aspects that render it suitable for aquaculture [green text] and elements where land-based aquaculture at a very large scale could cause land use conflict or environmental issues [black text].

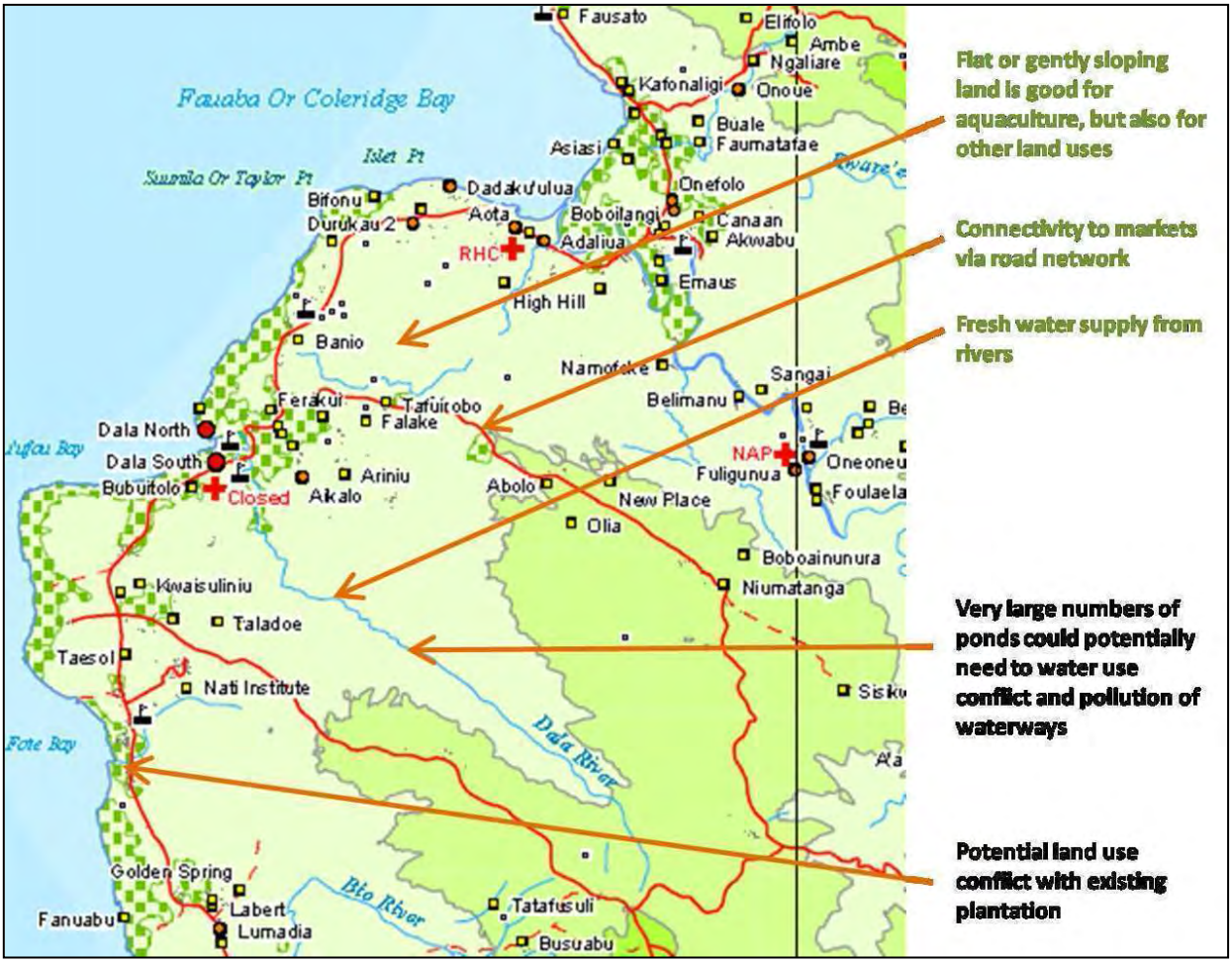
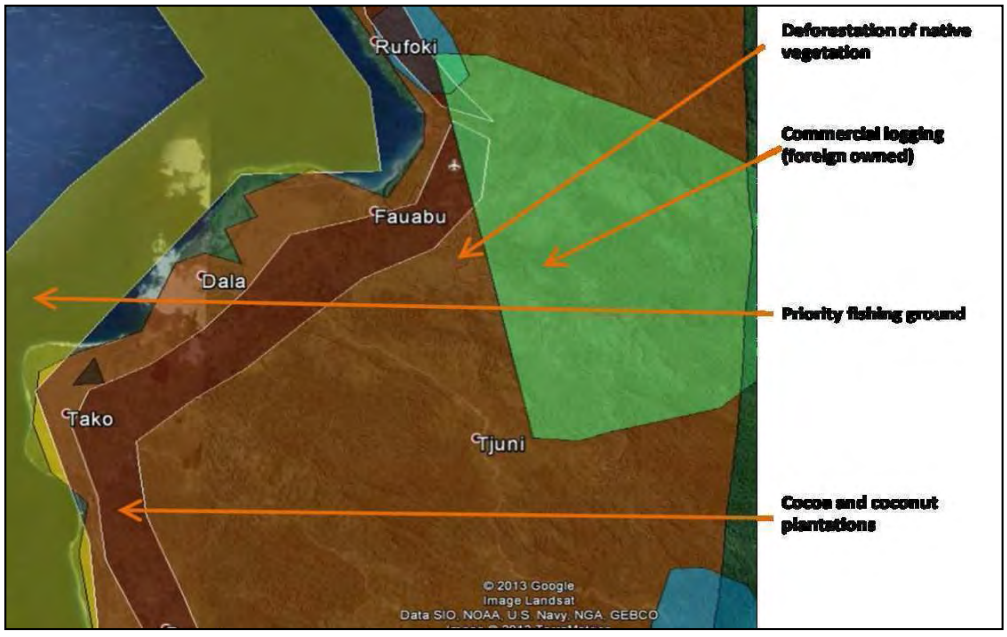


Figure 104: Existing land uses and priority natural resources [and hence, source of ecosystem services] in the Ward of Fauabu, as depicted by stakeholders. These need to be taken into consideration if land-based aquaculture is to be introduced at a very large scale.



258. Another area considered physically highly suitable for aquaculture was the Ward of Takwa (**Figure 105** and Figure 106). Again, it is considered suitable due to good connectivity, freshwater supplies, gently sloping land and a high human population density that creates both demand for fish, and the households and labor required to install and manage ponds. However, there is also the potential for land use conflict with cocoa and coconut plantations, a conflict likely to be found in any area of well connected, flat, productive land. Another potential issue relates to the proximity of coral reefs and sea grass areas to this Ward. If pond numbers become exceptionally high, as some of the projections for the year 2030 indicate, then there is potential for increased nutrification and chemical pollution of waterways, reefs and sea grass beds from pond waste. However, each individual small-scale pond would potentially produce fewer pollutants than a smaller number of large and intensively managed ponds. Regardless of the scale and management regime, off-site impacts need to be considered carefully as the extent and intensity of management of ponds increases in the region. Water diversion to ponds may also need to be carefully managed if ponds densities become exceptionally high, as large scale diversion of stream and river water can lead to siltation of reef systems.

Figure 105: Annotated map of the Ward of Takwa, indicating aspects that render it suitable for aquaculture [green text] and elements where land-based aquaculture at a very large scale could cause land use conflict or environmental issues [black text].

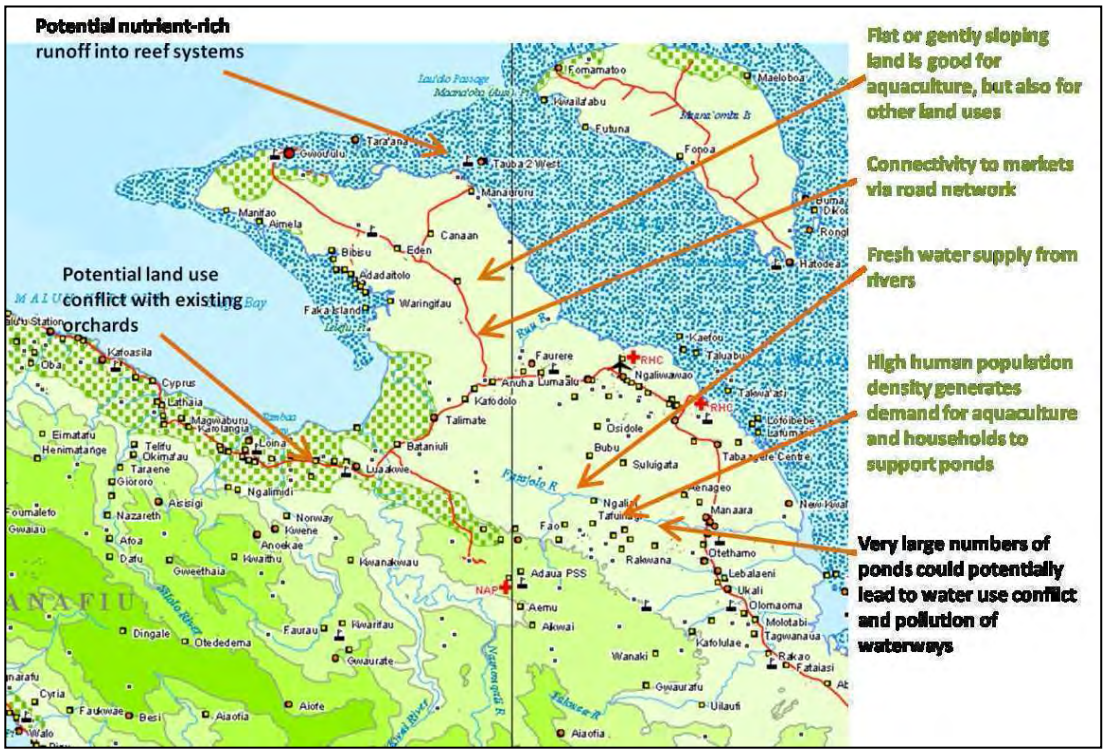
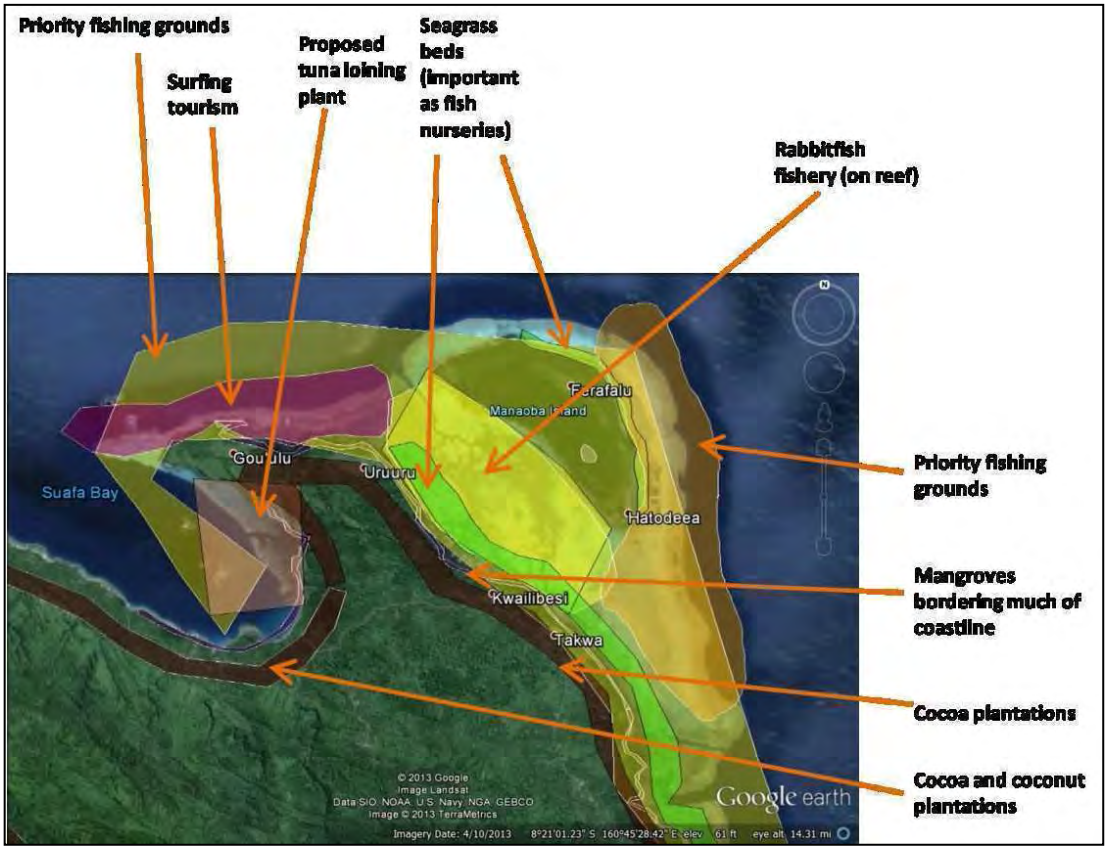


Figure 106: Existing land uses and priority natural resources [and hence, source of ecosystem services] in the Ward of Takwa, as depicted by stakeholders. These need to be taken into consideration if land-based aquaculture is to be introduced at a very large scale.



259. While the main focus of land-based aquaculture development is likely to be in the hinterland, in many countries brackish water aquaculture development can lead to loss of mangroves when conducted in coastal areas. While this may not be an issue in Solomon Islands yet, policy makers, developers and the community should be mindful that mangroves provide an enormous range of ecosystem services, such as providing nurseries for fish on which communities depend, coastal protection from storm surges, firewood, building materials, fruit and (in a broader sense) carbon sequestration (Warren Rhodes et al. 2001; Albert et al. 2012).

8. Conclusions

260. A range of approaches have been used for estimating and spatially depicting the amount of land-based aquaculture that may need to be implemented in Malaita to address projected shortfalls in fish nutrition in the future. Shortfalls in fish supply and nutrition are projected to be high, and the yield outputs from an average sized family subsistence pond are relatively low. Consequently, the required number of average size ponds needed to address projected nutritional shortfalls, are estimated to be generally very high. Such scenarios may simply be unfeasible to implement and manage due to lack of expertise, infrastructure, and availability of feed for fish and possible land use conflict. A potential solution is the development of a smaller number of very large ponds that operate on a more intensive commercial scale, have high yields, are more centrally managed, and act to augment individual household ponds. However, such developments would require additional investment, expertise, and policy and institutional support. Given the intensity of management of such ponds they could lead to pollution and losses of native vegetation

elements, such as mangroves, that provide essential, though largely undervalued ecosystem services. Regardless of the scale of future aquaculture development in the region, very careful consideration needs to be given to: a) the suitability of any given site for pond location; b) the extent to which ponds use resources that may be required for other uses; c) how waste products from ponds can be managed so as to reduce their negative impact on the environment and ecosystem services (e.g., pollution of waterways and reefs), and d) how ponds and their waste products (e.g., water seepage) might be more effectively integrated into other aspects of food production such as plantations and home gardens.

9. Mapping and natural assets and land uses from a community and provincial stakeholder perspective

261. In addition to using existing land use mapping of Malaita, spatially explicit data from national and provincial level government stakeholders were also collected that aimed to show: (a) how they perceived land use and natural assets in the region, and (b) which they felt were the most important. In order to do this, government stakeholders were presented with a map of Malaita that consisted of two A2 sheets. Over this were placed a series of similar sized clear plastic sheets. Stakeholders were asked to mark, draw and annotate particular features on each sheet (Figure 107 - Figure 109) that included:

- Natural habitats. This could include forest, existing mangroves, cleared mangroves, replanted mangroves, coral reefs, sea grass beds, conservation areas and areas known to support particularly notable communities or species.

- Aquaculture. This grouping was divided into existing aquaculture and the location of communities or individuals who have expressed considerable interest in undertaking aquaculture. A subset of this grouping included an interview with the MCDA stakeholder in Auki, who was asked to predict broad regional levels (in terms of hectares) of aquaculture investment and approximate potential timescales for implementation.

- Fisheries. Some of the most important fishing grounds around Malaita were depicted. Unfortunately at the time of this study quantitative information on catches at the various fishing grounds were unavailable.

- Land use mapping of different kinds of agricultural and other production land use types. This was mostly restricted to existing land use, though in some cases it also contained elements of land use change over time, and possible future land uses.

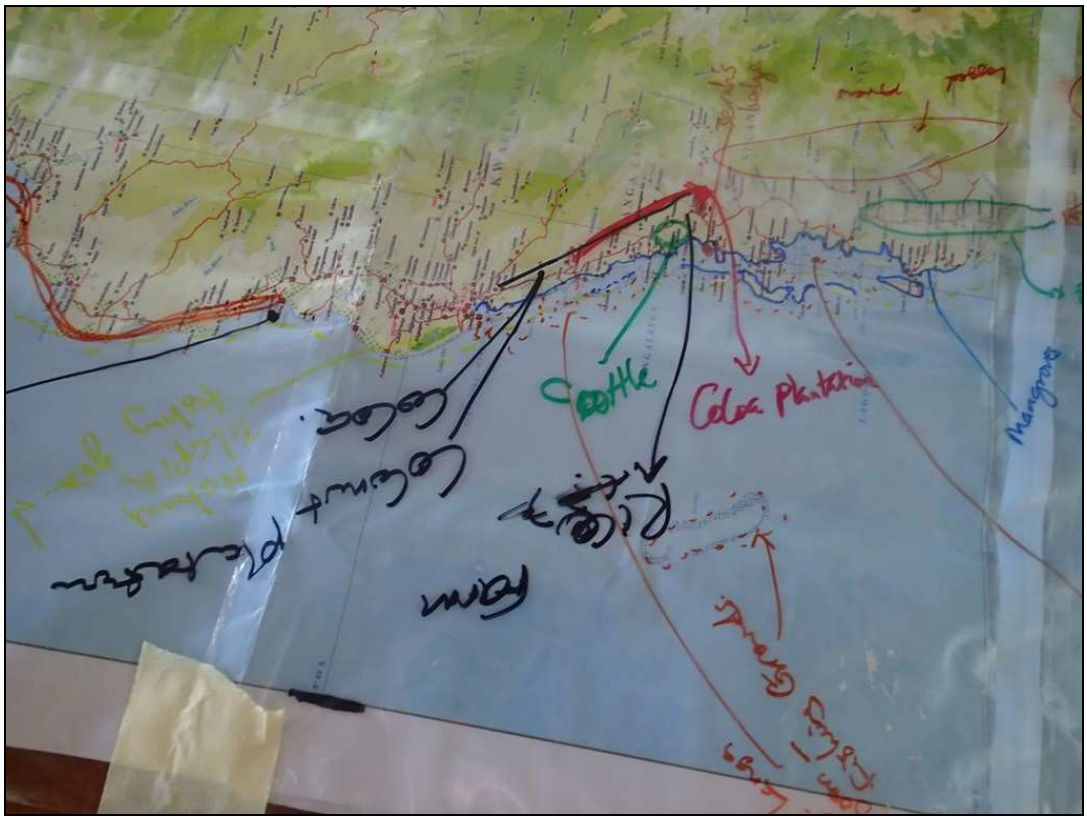
- Ecotourism. Due to the specialist nature of this category this area was only mainly explored with provincial level stakeholders.

- Other categories included agricultural or fisheries research stations or other income streams that did not fit readily into any of the other categories.

Figure 107: Land use, coastal and environmental features mapped by national government fisheries officers

Figure 108: Land use, coastal use and environmental features mapped by stakeholders

Figure 109: Land use, coastal use and environmental features mapped by stakeholders



262. Following the mapping activities with stakeholders, the features were entered into Google Earth as a series of data layers.

263. **Figure 110** and **Figure 111** depict a broad category (fishing grounds) mapped at a broad scale and the details of several layers presented at a smaller geographical resolution.

Figure 110: Priority fishing grounds mapped by government stakeholders and entered into Google Earth

Figure 111: Multiple data layers mapped by government stakeholders and entered into Google Earth

264. Following the mapping, information relating to specific layers or features can be added to the attribute table in Google Earth. As an example **Figure 112** depicts the attribute table for mangroves and Figure 113 those for possible oil palm development. This information can be continually updated by any stakeholder, so that, in time, it could build into a contemporary and comprehensive, community-based database of landscape and seascape features. Such a database, rather than being rigid and informal, could be easily amended and would be able to reflect personal and differing perspectives on the productive uses and natural assets of the region. The completed KMZ file for the stakeholder mapping accompanies this report and can be viewed and edited/updated in Google Earth. This file will require that you have Google Earth on your computer – this program is free to download at the following website: http://www.google.com/earth/.

265. To open this file, double-click "Malaita Land Use CCA Project" file. The file will open in Google Earth. To access the data layers, double-click the "Malaita Land Use CCA Project" Google Earth icon and then open the folder of the same name that will appear. This will now open six subfolders: i) natural habitats; ii) aquaculture; iii) fishing grounds; iv) ecotourism; v) land use; vi) other features. By opening any of these files you will be able to access the individual data layers. Clicking the check box immediately to the left of each of these files will allow the futures to become visible on the Google Earth map. Some of these data layers have additional information embedded within them – this can be accessed by simply clicking your mouse on a particular feature on the map.

266. It is important to note that the features mapped and information included represent the views, opinions and perspectives of the various stakeholders attending workshops. The features mapped and information provided are not necessarily accurate portrayals of existing features, and do not necessarily represent formalized future planning developments.

Figure 112: Attribute table for an area of mangroves mapped by stakeholders. The attribute table contains a summary derived from the scientific literature of the ecosystem services provided by mangroves

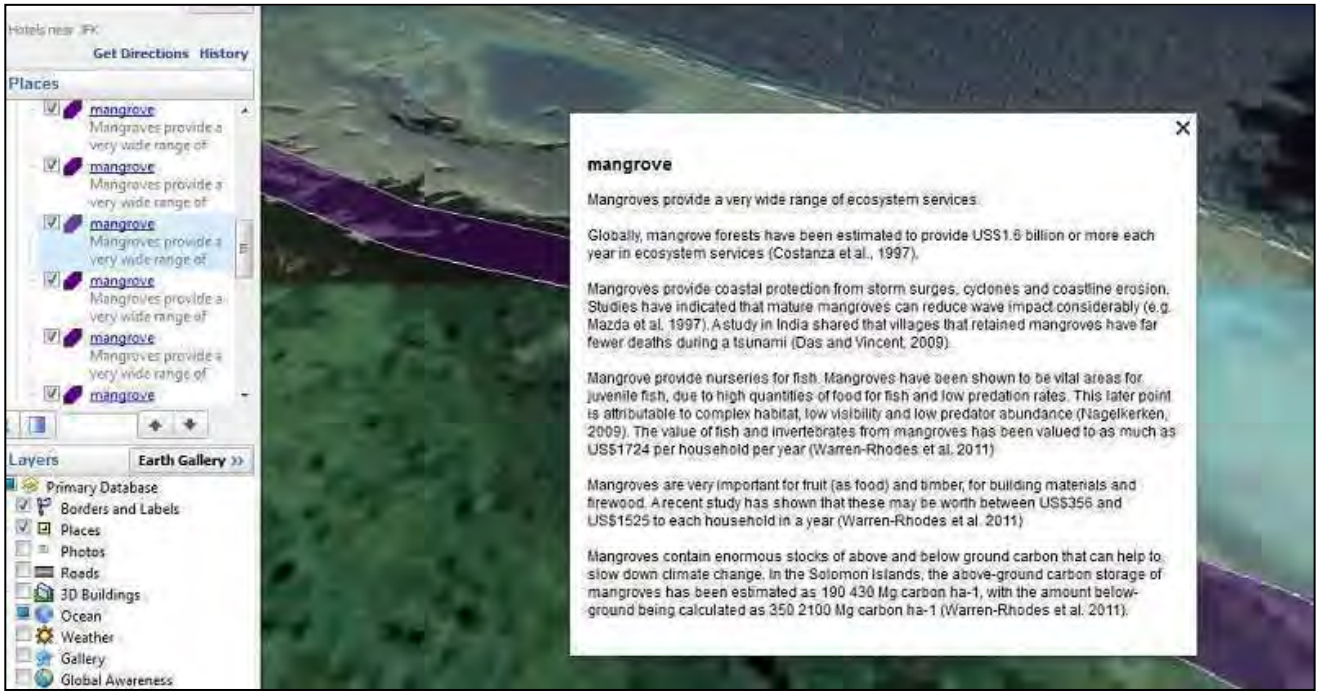


Figure 113: Attribute table for a particular feature mapped by stakeholders. Hyperlinks to relevant websites can be embedded into the attribute table

267. The Google Earth file produced to capture stakeholder perspectives on natural assets, land use, etc., is only meant to illustrate the capability of this approach in association with this mapping tool. Consequently, the data layers produced are not publicly available. However, the Google Earth screen grab figures in this chapter are intended to provide an idea of how data can be spatially represented using the approach we have described. Other

organizations and individuals are urged to experiment with similar approaches to capturing and representing spatial data."

E. Land-based aquaculture development in Malaita in response to climate change: Evaluation from an economic perspective

Activity:	Social and economic analysis of potential aquaculture development scenarios (visions)
Aim/Key question:	What are the scenarios (visions) for future land-based aquaculture development for local food and nutrition security in Malaita Province from an economic perspective?
Brief details of method:	• Combine literature review and stakeholder interviews and consultation to understand the economic perspective of future aquaculture development.
Key stages in method:	• Review the literature on fish supply and demand, and the potential role of aquaculture development as an option for addressing food security in light of climate change and decreasing marine resources. Stakeholder consultations and interviews to understand: (i) what visions there are for future aquaculture development in Malaita Province; and (ii) what the potential benefits and costs of aquaculture development are, especially with regards to local food and nutrition security.
Key results:	• Despite increasing shortfalls of fish supply to meet nutritionally required fish consumption levels, there has been little progress on aquaculture development in Solomon Islands and in Malaita Province. There may be many reasons for this, but from an economic perspective the reality is that private investors have low incentives for investing in aquaculture for local fish nutrition and food security.
Recommendations	• If fish food and nutrition security is to be addressed, in part by aquaculture development, it will be important to pursue a dual strategy that also promotes and improves fisheries' governance, access and distribution. • Government and donor support will be needed to create a better enabling environment for aquaculture production to be economically feasible. • There is a need to set up good monitoring and evaluation programs to ensure sustainable aquaculture development.

268. Fish products play a vital role in food security in Solomon Islands. Various studies (e.g.,, Bell et al., 2009; Weeratunge et al., 2011) suggest that gaps between fish production and consumption in the country will increase. The trend of fish supply shortage is already becoming evident and is predicted to become more serious in the future. Several strategies have been identified to address fish supply shortfall including small-scale aquaculture development and improving fish marketing and access systems. This section analyses the future of aquaculture development in Malaita Province of Solomon Islands and aims at: 1) exploring different scenarios (visions) for future aquaculture development in the province for food and nutrition security, and 2) discussing potential benefits and costs of aquaculture development in the province as an adaptation option to cope with climate change. The purpose of the analysis is to provide information to stakeholders involved in planning and development of aquaculture for local food and nutrition security in Malaita Province.

1. Method

269. The selection of aquaculture for analysis was made by the project team based on consultation with the WorldFish country team in Solomon Islands. Because aquaculture in Solomon Islands is still in its early stages of development, this analysis seeks to contribute information in response to the need to understand future potential development of aquaculture in Malaita. The analysis is based on two data sources:

a. Review of the literature, analyzing the potential role and target outputs of aquaculture in addressing fish demand deficits for ensuring fish food security in the country. This work was done prior to, and after, the visit was made to the country.
b. A field visit was made to Solomon Islands from 9 to 17 May 2013 to collect data and information for the analysis. Informant interviews and stakeholder group consultations were used to gather data. Through participatory group discussions, local stakeholders were encouraged to think about the future of aquaculture in Malaita Province. The following research questions were asked during focus group discussions and individual interviews:
    i. Why are local stakeholders and farmers interested in exploring aquaculture? Information collected from this question is used to understand the role and benefits that aquaculture may provide to local stakeholders.
    ii. How do local stakeholders and farmers think aquaculture will fit into the future of Malaita Province? This question encourages stakeholders to think about scenarios (visions) of aquaculture development in their province.

270. By working with key informants, the following three scenarios (visions) of aquaculture were collected and analyzed:

a. Provincial Government view: A vision of aquaculture development for Malaita Province from the perspective of the Provincial Government, provided by a provincial officer via an individual interview. The officer was asked to consider two time periods (within 5 years, and within 10 years). Mozambique tilapia is the only fish species established in household aquaculture in the province. The production assumptions presented in the mid-term report, section 4.4 was used regarding the target species. It is assumed in this analysis that all suggested land areas for aquaculture are used for Mozambique tilapia and also compared with Nile tilapia (a species not present in Solomon Islands but widely farmed elsewhere in the world). A low input system was assumed with an average productivity of 2 tonnes/ha/year for Mozambique tilapia and 1.5 tonnes/ha/year and 4.0 tonnes/ha/year respectively for Nile tilapia operating in semi-intensive and low intensive farming systems (see mid-term report, section 4.4). Further sensitivity analysis can be conducted by modifying assumptions on farmed aquaculture species and applied technical production systems and productivity targets to give an understanding on plausible ranges of fish food production that can be supplied by aquaculture.

b. Local stakeholder representing community view: A vision of aquaculture development in a Ward in the Province provided by a local stakeholder, representing communities' views on the future of aquaculture development in Malaita. Similar assumptions to scenario 1 on farmed species and production systems were applied. In addition, a further assumption that each household would construct a pond with an average pond size of 30 m^2 was applied to this scenario.

c. Prior WorldFish analysis: A vision of aquaculture development provided by a WorldFish manager, representing an aquaculture development outlook in Malaita from a technical support organization (WorldFish). Similar assumptions to scenarios 1 and 2 on farmed species, production systems and pond size were applied.

2. Results

271. The potential role and target outputs for aquaculture production in Solomon Islands and Malaita province. Based on fish demand and supply projections SPC (2008), Bell et al. (2009) and Weeratunge et al. (2011) have all projected that there will be an increasing shortfall in fish supply in Pacific Island Countries and Territories to meet the nutritional requirements designated by the World Health Organization (adjusted for Pacific Islands and Territories). Bell et al. (2009) predicted a shortfall of 5,000 tonnes in Solomon Islands by

2030 and Weeratunge et al (2011) projected that by 2030 there would be a shortfall of between 6,000 and 20,000 tonnes of fish per year to meet required nutrition standards (Table 34).

272. Since this study focuses on Malaita Province we have down-scaled fish supply shortfall from the country level to province level. To get an illustrative projection of fish consumption deficit (nutrition base) in Malaita, fish deficit projections by Weeratunge et al. (2011) were down-scaled by multiplying numbers suggested for Solomon Islands, with the population share for Malaita (i.e., 30% of Solomon Islands' population) (Table 34). This population assumption was based on historical records (1999-2009) observed by Solomon Islands National Statistics Office (http://www.spc.int/prism/Country/SB/Stats/Social/Popcen/Projection.htm) that show population in Malaita province accounted for about 30% of Solomon Islands' population and this historical trend is assumed to be continued from now to 2030.

Table 34: Target outputs for aquaculture (metric tonne) in Solomon Islands (SI) and Malaita Province (MLT) under different scenarios, 2015 to 2030*

Scenarios for capture fisheries	**Trends continue**		**Increase in fisheries productivity results in higher output (5%) due to improved technology and/or higher fishing effort from deep and coastal fisheries**		**Decline in fisheries productivity results in lower output (5%) due to lack of technology and/or reduction in fish stocks lower fishing effort**		**Decline in productivity results in lower output (50%) due to a major reduction in fish stocks or lower fishing effort**	
Year	**Baseline**		**Scenario 1**		**Scenario 2**		**Scenario 3**	
	SI	**MLT**	**SI**	**MLT**	**SI**	**MLT**	**SI**	**MLT**
2010	1,113	334	366	110	1,870	561	9,112	2,734
2015	2,159	647.7	1,315	394.5	3,010	903	11,089	3,326.7
2020	3,515	1,054.5	2,567	770.1	4,470	1,341	13,461	4,038.3
2025	5,293	1,587.9	4,234	1,270.2	6,358	1,907.4	16,322	4,896.6
2030	7,636	2,290.8	6,463	1,938.9	8,816	2,644.8	19,788	5,936.4

*The scenarios are those used by Weeretunge et al (2011).

273. As presented in Table 34, fish supply shortfall in Malaita may range from 2000 tonnes (Scenario 1) to 6,000 tonnes of fish per year (Scenario 3) to meet nutritionally required fish consumption level suggested by Bell (2009). It is important to note that according to Weeratunge et al. (2011) fish supply deficit has already occurred in all investigated scenarios in 2010 and will be increasing as time progresses.

A balance sheet of fish supply and demand can be shown as the accounting identity below:

$$Q + M = Cr + Cu + X + I$$

where supply side includes domestic fish production (Q) and fish imports (M), and demand side includes rural and urban household consumption (Cr and Cu) and intermediate demand (I). Domestic fish production can be divided into capture fisheries and aquaculture, leaving therefore three

possible strategies to improve fish supply: a) increase supply from capture fisheries; b) increase aquaculture production; and c) increase fish imports.

274. Since capture fisheries are no longer meeting demand (Bell et al., 2009) and may decline even further in the future because of impacts such as marine resource degradation and climate change, aquaculture was identified as an important strategy to fill in fish supply gaps to support the nutritional requirements in Solomon Islands (Bell et al., 2009; Weeratunge et al., 2011). Fish supply deficits presented in Table 34 can be used to set output targets for aquaculture production.

275. Based on fish supply and demand projections by Weeratunge et al. (2011), a current WorldFish ACIAR funded project on aquaculture and food security in Solomon Islands has suggested that different aquaculture production models (e.g.,, homestead pond aquaculture, community cluster aquaculture, boarding school aquaculture, and aquaculture enterprises) will likely be required to realize an aquaculture production target of 2500 tonnes. Nevertheless realizing this production target remains a big challenge as it will require substantial capital investment in infrastructure and facility development. Estimates are in the range of $1.2 million for infrastructure and associated capital costs, and $2.6 million for operational capital are required (Aquaculture and Food Security in the Solomon Islands – WorldFish Policy Brief, 2011).

276. Aquaculture development and investment remains in the very earliest stages in Solomon Islands. There are, as yet, few incentives for private investors to invest in aquaculture development. To provide targeted information to assist investors it is important to understand aquaculture development visions from local stakeholders' perspectives. The three aquaculture development scenarios described in the methods are described in more detail in Table 35 - Table 37.

277. Provincial Government. A scenario for aquaculture development in terms of land use suggested by a provincial stakeholder was reported in Table 35. Following this scenario, there will be about 22.5 hectares of land used for aquaculture in Malaita over the next 5 years, spreading into the Northern to Central, Southern and Western regions (see mid-term report, section 4.4 and 4.5). If this development was phased (and funded) an estimate was that perhaps 17 ha of ponds could be realistic within 5 years with a further 5.5 ha within 10 years (note that there is no plan or budget for this at the time of this analysis). Applying the average productivity of 2 tonne/ha/year for traditional Mozambique tilapia production, 1.5 tonnes/ha/year, and 4.0 tonnes/ha/year for semi-intensive and intensive Nile tilapia production respectively, the projected aquaculture land area could potentially yield an annual aquaculture production range from 45 tonnes to 90 tones/year if the projected aquaculture area is fully realized.

Table 35: Land area suggested for aquaculture in Malaita Province and projected aquaculture production – perspective of the Provincial Government

Regions	Aquaculture land (ha) in 10 years			Production output scenarios (tonnes/year)		
	Total	Within 5 years	Within 10 years	Mozambique Tilapia (2.0 tonnes/ha)	Nile tilapia/ semi-intensive (1.5 tonnes/ha)	Nile tilapia/ intensive (4.0 tonnes/ha)
Northern	3.5	2	1.5	7	5.25	14
Central	5	4	1	10	7.5	20
South	12	10	2	24	18	48
Western	2	1	1	4	3	8

Regions	Aquaculture land (ha) in 10 years			Production output scenarios (tonnes/year)		
	Total	Within 5 years	Within 10 years	Mozambique Tilapia (2.0 tonnes/ha)	Nile tilapia/ semi-intensive (1.5 tonnes/ha)	Nile tilapia/ intensive (4.0 tonnes/ha)
Total	22.5	17	5.5	45	33.75	90

278. Local stakeholder representing community view. Table 36 presents an aquaculture development scenario in a community (Ward) in Malaita provided by community stakeholders. The participants in a workshop gave the following information: 10 households were identified as having aquaculture ponds within their region (Ward), where there are about 4,000 people (around 600 households). Land for making aquaculture ponds may come from swampy areas or land previously used for gardening. Average pond sizes commonly found are 30 m^2 (small) and 100 m^2 (large) and ponds are located behind home nearby water streams.

Table 36: A scenario of aquaculture development in a Ward, provided by a local stakeholder representing community views

Year	Ponds	Area (ha)	Production output scenarios (tonnes/year)		
			Mozambique tilapia (2tonnes/ha)	Nile tilapia/semi-intensive (1.5 tonnes/ha)	Nile tilapia intensive (4 tonnes/ha)
2013	10	0.03	0.06	0.150	0.12
2014	15	0.045	0.09	0.225	0.18
2015	20	0.06	0.12	0.300	0.24
2016	25	0.075	0.15	0.375	0.3
2017	30	0.09	0.18	0.450	0.36
2018	35	0.105	0.21	0.525	0.42
2019	40	0.12	0.24	0.600	0.48
2020	45	0.135	0.27	0.675	0.54

279. Population growth rate is projected at 3% per year. Adopting an assumed increasing rate of 5 aquaculture ponds per year and a pond size of 30 m^2 provided by the participants, there would be 40-45 aquaculture ponds with a total pond area of 0.135 ha by 2020. Following this scenario, in 2013 households in this community can produce 60 kg of fish/year when growing Mozambique tilapia with an average productivity of 2 tonne/ha. A linear growth at a rate of 5 ponds in a year would result in fish production in 2020 reaching 135 kg for Mozambique tilapia production systems and 675 kg to 540 kg of fish for Nile tilapia semi-intensive and intensive production systems, respectively, if they are introduced and adopted.

280. Prior WorldFish analysis . The future of aquaculture development in terms of scale of household pond expansion can also be estimated from the current rate of increase in the region of Central Malaita. Data was provided by a Solomon Islands WorldFish field officer and used to estimate future rates of increase in number of ponds (Table 37). Up to May 2013 it is estimated that there were about 25 aquaculture ponds in Malaita and 17 ponds additional ponds that would be dug by the end of 2013. Based on this we have estimated that up to the year 2020 a further 17 ponds/year could potentially be added. Under that scenario, farmed fish outputs may reach few hundred kilograms per year (e.g.,, 252 kg/year if Mozambique tilapia reached an average productivity of 2 tonnes/ha/year). This is still very small compared to projected quantity of fish shortfall to meet nutritionally required consumption level for the whole Province.

Table 37: Projected number of aquaculture households in Malaita Province (assuming an increasing rate of 17 aquaculture households per year) using prior WorldFish analysis

Year	Number of household ponds	Area (ha)	Production output scenarios (tonnes)		
			Mozambique tilapia (2 tonnes/ha/year)	Nile tilapia/semi-intensive (1.5 tonnes/ha/year)	Nile tilapia/intensive (4.0 tonnes/ha/year)
2013	42	0.126	0.252	0.630	0.504
2014	59	0.177	0.354	0.885	0.708
2015	76	0.228	0.456	1.140	0.912
2016	93	0.279	0.558	1.395	1.116
2017	110	0.33	0.66	1.650	1.32
2018	127	0.381	0.762	1.905	1.524
2019	144	0.432	0.864	2.160	1.728
2020	161	0.483	0.966	2.415	1.932

281. The three illustrative scenarios reported above show that from local stakeholders' perspectives, aquaculture in Malaita will be developing slowly and only able to produce a small quantity of farmed fish for food. Under these scenarios it is likely that aquaculture will not be able to make a substantial contribution to fish food security for all of the people of Malaita in the near future, except on an individual household basis. Therefore in addition to addressing fish supply deficits via aquaculture production, alternative strategies such as improving coastal and marine fisheries management, access and distribution need to be pursued.

282. Costs and benefits of aquaculture development. Aquaculture benefits can be assessed at two levels: micro or farm/household and macro-economic/community/society level (Shang, 1990). Good economic analysis can be used to guide farmers in their decision making and government stakeholders and donors in formulating aquaculture development/support policies. Experience in other developing countries suggested that aquaculture can improve livelihoods of rural communities through improved food supply, employment and income (Ahmed and Lorica, 2002). If the right species and conditions are available, income from aquaculture has been reported to be higher than conventional agriculture or any other alternative livelihood options.

283. Since aquaculture is a relatively new practice in Malaita, there was insufficient data available to allow us to conduct a comprehensive economic analysis. It is however useful for Malaita farmers to know how much they would need (costs) to set up and operate an aquaculture pond successfully and how much profit they can make from their fish farming operation. Analysis of the ACIAR aquaculture and food security project shows that average pond size in Solomon Islands ranges from 30m2 to 100 m2. For homestead pond aquaculture with an average size of 100 m2, production cost can be at 1.14 USD/kg of fish (tilapia) and sale price of marketable fish can be at 1.5 USD/kg; for one dollar invested in household pond aquaculture, farmers can get back 0.32 USD of net profit (benefit-cost ratio of 1.32). Of cost items for fish production, feed cost is projected to account for about 60% of total operation cost. High feed cost has a very important implication because Solomon Islands may have to import aquaculture feed to grow fish. Interviews with the provincial government stakeholder show that Malaita witnessed a bad experience with the chicken growing industry. At the beginning of the industry development in the country chicken meat was cheap (at $SBD 10/kg) but has since become expensive ($SBD 100/kg) because

growers have to import feed for chicken farming. Aquaculture development needs to avoid a similar problem to that experienced within the chicken industry.

3. Summary and recommendation

284. Fish nutrition shortfalls can be addressed by developing aquaculture or improving fisheries governance and access (e.g.,, diverting export fish to domestic fish markets).Given that fisheries resources are expected to face more pressures because of accelerating climate change and marine resource degradation, aquaculture is considered an important strategy to address fish food security in Solomon Islands and Malaita Province in particular. Despite increasing shortfalls of fish supply to meet nutritionally required fish consumption levels, there has been little progress on aquaculture development to date in Solomon Islands, though aquaculture development plans (e.g.,, National aquaculture development plan 2009-2014 and Tilapia aquaculture action plan) have been formulated for Solomon Islands and Pacific countries and territories. Even under optimistic scenarios of aquaculture development given here, land-based aquaculture production will remain small in terms of the whole population of the province, and make a relatively small contribution to fish supply in coming years, similar to other Pacific Islands and Territories (Gillett, 2011).

285. There is a need to set up good monitoring and evaluation programs to ensure sustainable aquaculture development. Aquaculture operation in Malaita depends on many factors ranging from natural environmental/resource conditions, technology/production, financial conditions, as well as marketing and management factors. Monitoring and evaluation research should be appropriately designed in order to assess what benefits aquaculture can deliver to stakeholders involving aquaculture production in the province. Essential economic indicators such as investment cost, operation costs breaking down into major cost components as well as gross revenue/income from fish sales, consumption and that given away as gifts by households, should be documented to allow one to evaluate economic benefits of aquaculture (e.g., compute and compare production cost, return, profit, profit margin accruing to a fish farm operation).

F. Evaluation of Aquaculture in Solomon Islands from a social perspective using social network analysis

Activity:	Social network analysis
Aim/Key question:	Who is necessary in farming and fishing social networks to facilitate the effective planning, implementation, and on-going management of pond aquaculture in Malaita?
Key stages in method:	• Produce social network maps to identifying key actors (agents) that influence the capacity of farmers/fishers to engage in and manage pond aquaculture. • Understand the links that exist between the farmers/fishers and other actors in their networks in terms of the flow of information, physical support (e.g., equipment), financial support (e.g., cash and loans), services support (e.g., training, marketing) and problem solving. • Identify what additional actors may need to be included in the baseline networks if aquaculture is to be effectively planned, implemented and iteratively managed.
Key results:	• For all forms of support, fishers and farmers turn first to each other, their families and their neighbours. Fishers and farmers share a lot of information amongst themselves, in addition to information shared from families and neighbours. But useful information is also received from NGOs, provincial government, and the radio. • Fishers and farmers typically go to each other, their families, or neighbours first for financial support. Other connections may provide financial support, but there is scope to strengthen these. • Support in the form of supplies and equipment comes from local innovators,

Activity:	Social network analysis
	NGOs, and provincial government. • Services support typically comes from NGOs local innovators and NGOs, with some additional support from the provincial government. • Fishers and farmers go to neighbours and family, then to chief, elders, and church leaders for help with problem solving. • The Solomon Islands Broadcasting Company (SIBC) may be a potential avenue for disseminating information on aquaculture to communities, possibly through the Provincial Government, Ministry of Agriculture and Livestock, the Ministry of Fisheries and Marine Resources. • The connections with the provincial government have potential to be strengthened further. • Funding from the national government is limited and constrains the development of pond aquaculture activities in Malaita.

1. Methods

286. This activity consisted of three stages:

a. Workshop #1 (May 2013) - preparation of 'baseline' social network maps by workshop participants;
b. Analysis of the information gathered above by the WorldFish project team, and reproduction of the social network maps on A3 posters;
c. Workshop #2 (July 2013) - assessment of the reproduced 'baseline' social network maps by the workshop participants, and editing in response to questions regarding how they might address inadequate resources and strengthen their network to better implement and manage pond aquaculture.

287. Workshop #1 (May 2013). The method used to produce the 'baseline' social network analysis is based on that described in Mills et al., (2013). In summary, the underlying methodology was developed by Carrington et al. (2005), and Bodin and Crona (2009). The key argument in this method is that the ability of farmers and fishers to adapt is strongly linked to:
a. their information, support and problem solving networks (i.e., the size and structure of the network);
b. the influence of different actors within the network (i.e., the structure and attributes of these actors);
c. the attitude (i.e., supportive nature) of different actors within the network (referred to as attributes).

288. Participatory network mapping activities were undertaken in the initial workshop held with a group of twenty-seven individuals from around Malaita who expressed an interest in exploring pond aquaculture (see mid-term report, Section 4.1 for full details of this workshop). Workshop attendees were divided at random into two smaller groups to allow more interaction and discussion. While each group made separate maps, common observations can be drawn from both sets, and the results presented are from all the workshop participants unless otherwise specified. Baseline social networks were produced with both groups by working through the following steps:

Step 1 Explain what a network is, and gain an understanding of a common goal for this activity among participants.

Step 2 Participants identify the following:

a. Actors: the actors considered important for decision making and successfully implementing, maintaining/improving income or food production from aquaculture. The attributes of each actor: their goals and functions, their perceived power and influence, and the helpful or unhelpfulness of their involvement in the network.

b. Existing linkages: the existing links between actors in respect to the flow of information, provision of support (split into financial, physical /technical, and services), and pathways for problem solving.

c. Change: how the existing social network may need to change for aquaculture to be effectively planned, implemented and iteratively managed.

- Planning an intervention: The actors who are important for transmitting information or new ideas;
- Implementing an intervention: The actors who are important for providing support. This was separated into financial support, physical/technical support, and supporting services;
- Maintaining an intervention: The actors who are important for resolving conflicts and problems as they arise.

289. Analysis of the information. After the workshop, the information provided by the workshop participants was input into Microsoft Excel, and then copied into UCINET and NetDraw (Borgatti et al. 2002) to reproduce a visual representation of the social networks and consider the complexities and gaps in the present network to facilitate effective and long-term adaptation to climate change. NetDraw has the capacity to create detailed maps; however, the volume of detail can be overwhelming and confusing to people unaccustomed to reading these types of graphs. To maximize the usability of the maps for reporting back to the workshop participants, the maps created in NetDraw were then manually adapted (in Microsoft Publisher) to make them clearer. Each of the social networks was analyzed separately and qualitative results are presented.

290. Workshop #2 (July 2013). At the follow-up workshop held in Auki in July 2013, workshop participants were asked to reflect on the social network maps they had created in the previous workshop in May. In the vast majority of cases, the participants returned to the original Left and Right side groups they had sat in during the May workshop and reviewed their original network maps. New participants were distributed around the two groups to maintain even sized groups. In addition to the participants from the first workshop, several individuals from provincial and national level organizations also participated. These four individuals formed a separate group, which we have called Group 3. This group also reflected on the maps created in the previous workshop. Group 3 were asked the same questions as the Left and Right groups, but responded based on their own provincial/national level experiences and perspectives.

291. For each network, the groups were asked the following questions:

- Is anyone missing from the network?
- Could you be better connected?
- For the actors engaged in the network, how could they help further? Do they have adequate resources to effectively participate/assist pond aquaculture? Rank this capacity on a scale of one to five (where five is high capacity and can provide lots of resources).
- If the actors currently engaged in the network have low capacity, how else might they access resources?

292. Participants recorded their responses by drawing on the A3-sized poster reproductions of their original network maps. Additional actors were added to the maps and the groups assigned a capacity score to each actor. Following the workshop, the additional data gathered was again entered into the dataset and new Left and Right groups' maps were created using Ucinet and Netdraw. To improve visual clarity of the maps, only the relevant actors for each specific network were included. For example, if Actor 1 was engaged in the information network, but not the financial network, Actor 1 would not appear on the financial network map. Group 3 commented on both the Left and Right groups' maps, complicating the entry of their data into the software. As a result only a discussion of their feedback is included.

2. Results

293. Descriptions of actors involved in the social networks associated with pond aquaculture are detailed in Table 38.

Table 38: Descriptions of actors included in the social networks produced by workshop participants interested in pond aquaculture

Left Group	
Actor	**Actor Description**
WF	WorldFish
SIBC	Solomon Islands Broadcasting Corporation
Organic_Teach	Organic Teacher
NGOs	NGO's
WDD_PCW	Local Women's Groups
UNDP	UNDP Program
Family	Family
MFMR_AQ	Fisheries Official
Local_Person	A local person in the area
MHMS	Ministry of Health
SIWA	Solomon Islands Water Authority
Province_Govt	Provincial Government
Chief_Church	Chiefs, Elders, Church Leaders
MP	Member of Parliament
Neighbor	Neighbors
MFMR	Ministry of Fisheries and Marine Resources
MAL	Ministry of Agriculture and Livestock
Schools	Schools
Fisher_Farmer	Fishers and Farmers
Kastom_Garden	Kastom Garden Association
Youth	Youth in the communities
Women_Girls	Women and Girls in the community
Police	Local Police

Right Group	
Actor	**Actor Description**
Farmers	Farmers
Fishers	Fishers
Chiefs	Chiefs
Church	Pastors/Church Leaders
Family	Immediate Family
Teachers	Teachers
Prov_Member	Provincial Members
NGOs	NGO's
Prov_Fisheries	Fisheries Department
Innovators	Individual Innovators
Middlemen	MiddleMen
Natnl_Govt	National Government
ANZ	ANZ
Police	Police
BSP	South Pacific Bank, (Fund & Training)

294. Information Social Networks. Several observations can be made from the information networks created in May:

- Fishers and farmers receive information from many different actors and many different actors receive information from fishers and farmers.
- A lot of information is shared between fishers and farmers themselves.
- The local radio (SIBC) broadcasts information and has an extensive reach around the island.
- The information link between the Ministry of Fisheries and Marine Resources and fishers and farmers has potential to be improved.
- While many of the non-governmental actors are identified as helpful, most of the governmental actors are identified as either neutral or unhelpful in relation to implementing and maintaining pond aquaculture.

295. Figure 114 shows the legend used for all the social network maps produced. Figure 115 and Figure 116 show the revised information networks resulting from the second workshop (July 2013) for the Left and Right groups, respectively. Both groups identified the fishers, farmers, and other local actors (such as family) as having a large capacity to share information, while non-local actors appear to have less capacity for this. Approximately half of the actors are identified as having a helpful attitude.

296. Group 3 added several new actors into the information networks. Most of these reflect information connections that are indirectly, as opposed to directly, connected to the fishers and farmers. The Secretariat of the Pacific Community (SPC) was identified as having a high capacity for sharing information and linked to the Rural Water Supply and Sanitation program (RWSS), ranked with only slightly less capacity than SPC. The Ministry of Environment, Climate Change, Disaster Management and Meteorology (MECDM), were given a high capacity rating and added to the information network; though the link between MECDM and the fishers and farmers was indicated to be weak. Group 3 tended to indicate higher capacity ratings for some of the national-level actors; however these higher ratings often included a caveat that the distribution of these resources was not always transparent and might depend on outside influences.

297. Financial Support Social Networks. Several observations can be made from the financial networks created in May:

- Multiple financial connections exist for fishers and farmers.
- Fishers and farmers, and their families support each other financially.
- While both BSP and ANZ banks provide support, it is in slightly different forms. BSP offers financial support for activities such as trainings, while ANZ offers loans. However, both banks require applicants provide collateral to be eligible to receive financial assistance and as such are identified as only neutral or unhelpful by fishers and farmers.

298. Figure 117 and Figure 118 show the revised financial support networks for the Left and Right groups, respectively. Similar to the information network, the Left group ranked the fishers, farmers, and family as having the greatest capacity financially. They also identified a set of financial support linkages that do not connect to their own network (see the triangle made up of NGOs, WDD_MPCW, and Provincial_Government). Out of the government connections, they see themselves connected to both the MP and MFMR, which are identified as having very low capacity. The green nodes in the Right group's map mean that no capacity rating was given for these actors, making it difficult to draw conclusions about their ability to support the farmers and fishers in pursuing pond aquaculture. The two banks, BSP and ANZ, are perceived to have a medium capacity rating, while the Provincial Member, National Government, and Provincial Fisheries office are perceived as having relatively greater capacity to support the farmers and fishers in developing and managing pond aquaculture.

299. Group 3 added a number of actors into the financial support network, though many of these were indicated to possess only weak connections to other actors in the network. Members of Parliament (MP) and the high capacity Rural Constituency Development Fund (RCDF) were connected to fishers and farmers, but by weak or broken links only. Connections between fishers and farmers and the high capacity provincial government, high capacity provincial fisheries, high capacity community based organizations (CBOs), and high capacity faith-based organizations were also all indicated to be weak or broken links.

300. Physical Support Social Networks. Physical support is described as physical objects such as seeds, tools, or equipment. Several observations can be made from the financial networks created in May:

- Neighbors are seen as important for helping with supplies and equipment.
- National and Provincial government, NGOs, and local innovators are also seen as important suppliers of equipment and too.

301. Figure 119 and Figure 120 show the revised physical support networks for the Left and Right groups, respectively. Neither group indicated a national level of physical support accessible to them, but rather focused in on local actors such as family and neighbors, and some provincial members and provincial fisheries in addition to NGOs.

302. Group 3 identified multiple constraints in the physical support network, some of which relate to funding or information. Fishers and farmers expressed that they do not always know the best places to get this kind of support. The national government and provincial members were described as having the funds to buy equipment, but lacking in information related to physical support for aquaculture, though there was the thought that they provide this type of support to other kinds of agriculture. Group 3 identified physical support as the priority of the provincial fisheries office, but that the capacity of this office to supply this was low, possibly due to personnel or a lack of funds.

303. Services Support Social Networks. To illustrate the social network relating to essential services, the workshop participants were asked questions about who they received services from and who they provide services to. Services were considered to include such things as training and technical assistance. Several observations can be made of the service networks created in May:

- NGOs and local resource people are key providers or services to fishers and farmers.
- National and Provincial governments, family, and middlemen also provide some support services.

304. Figure 121 and Figure 122 show the revised services networks for the Left and Right groups, respectively. The Left group indicated a reliance on local actors, whom they perceived as having relatively high capacity to provide training and important services related to aquaculture. The network created by the Right group indicated relatively low to medium capacity of most of the actors in this network.

305. Group 3 added more connections to the services network, but again indicated that some of these connections were at present quite weak. They also made reference to several possible future connections in this network; these were to the Solomon Islands Water Authority (SIWA) and the University of the South Pacific (USP). These actors are not currently engaged in this network, but were considered to be potentially useful.

306. Problem Solving Social Networks. To illustrate who helps solve problems in relation to fishers and farmers livelihoods, and in particular to pond aquaculture, the workshop participants were asked questions about who they go to when they have a problem and who

comes to them with their problems. Several observations can be made from the problem solving networks:

- Fishers and farmers consistently indicated that the first people they turn to in times of need are their family and neighbors.
- Other key actors include the church, local chiefs and elders. The police and some women's groups were identified for their assistance in addressing problems of domestic abuse.

307. Figure 123 and Figure 124 show the revised services networks for the Left and Right groups, respectively. According to the Left group, the actors engaged in problem solving are all of relatively high capacity, and again almost entirely local. The actors identified by the Right group expanded beyond the local sphere; however most of these non-local actors were seen as having low capacity to help solve problems.

308. Group 3 indicated a strong link between NGOs and fishers and farmers relating to problem solving. Other actors, such as Solomon Islands Water Authority (SIWA) were seen as having resources, but are generally difficult for fishers and farmers to access. Reflecting on the Right group's map, Group 3 indicated there was sometimes a lack of transparency in the distribution of resources.

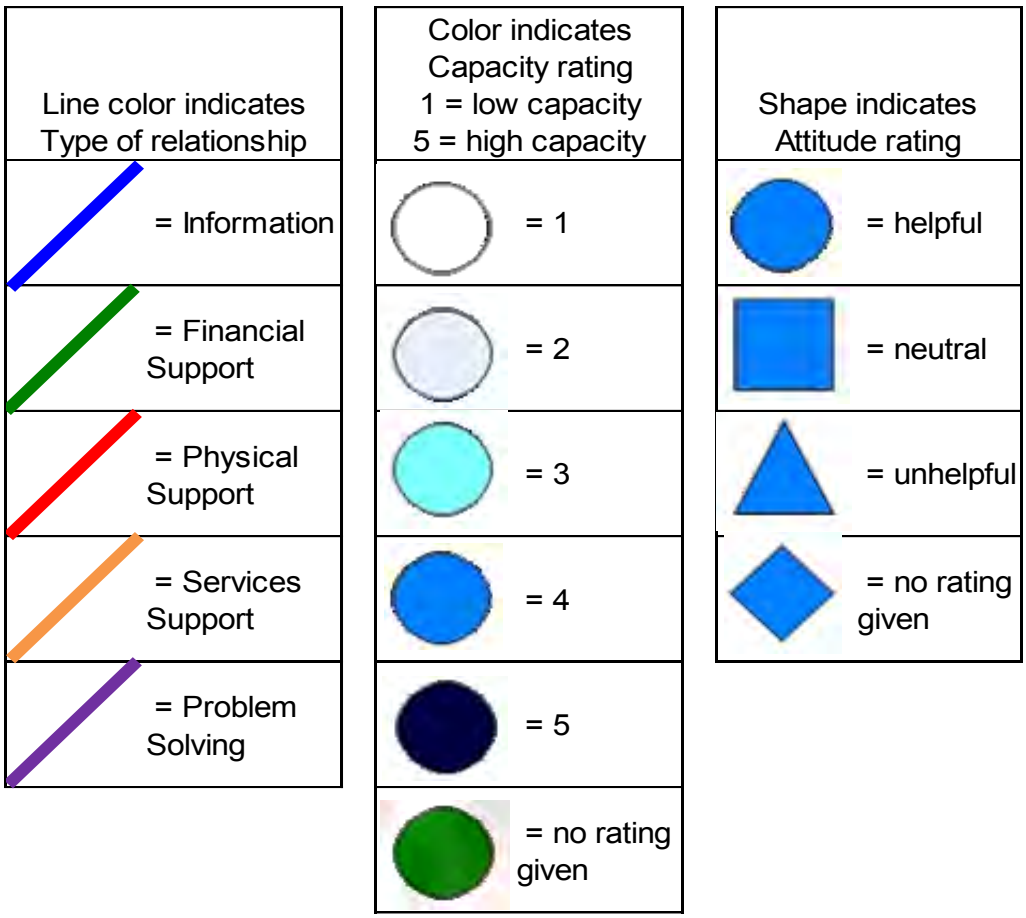


Figure 114 - Legends for interpreting social network maps (Figure 115 - Figure 124).

Figure 115: Information networks created from data collected at the May workshop, and revised at the July workshop. This map was produced by the Left group

Information Social Networks (Left Group)

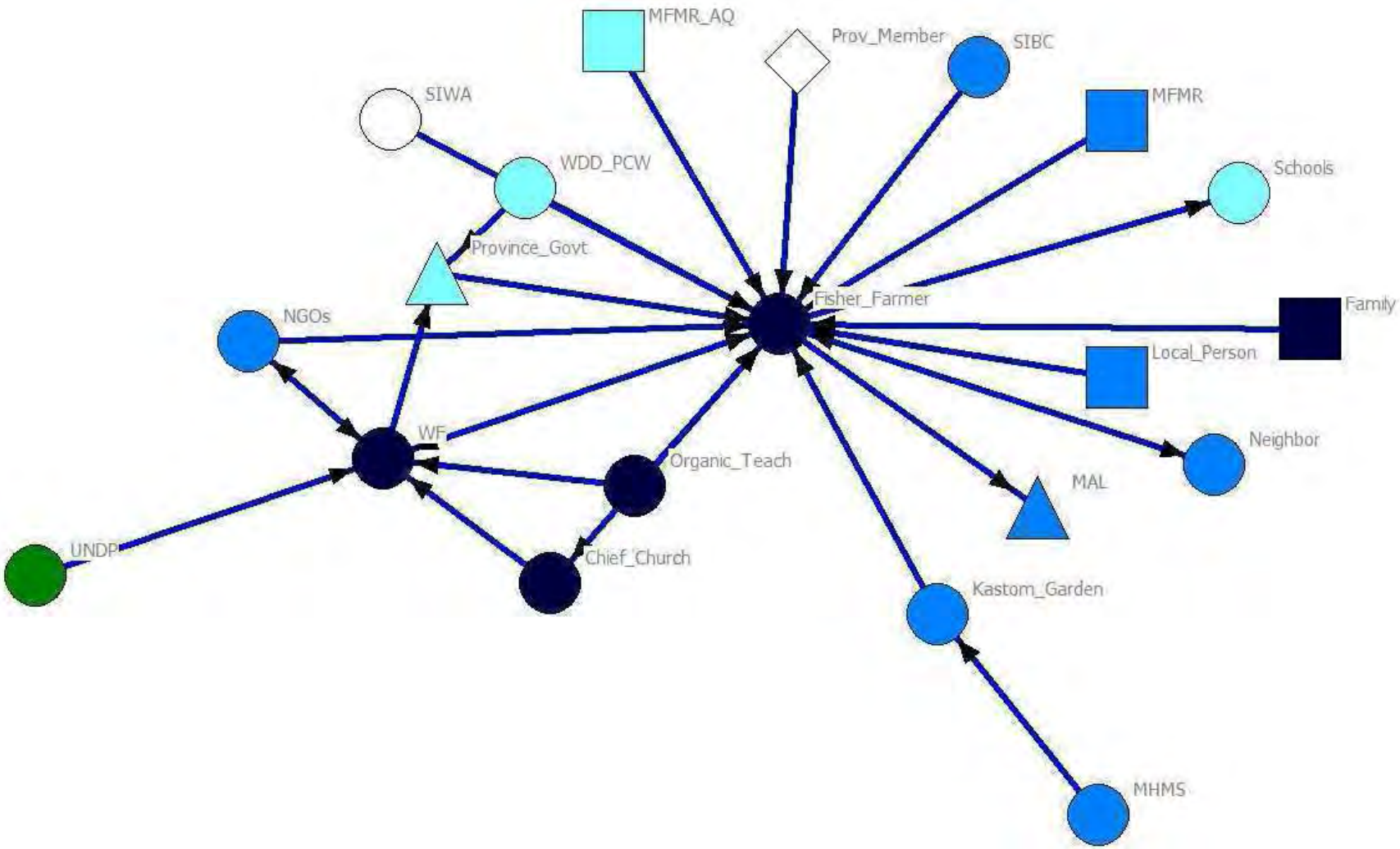


Figure 116: Information networks created from data collected at the May workshop, and revised at the July workshop. This map was produced by the Right group

Information Social Networks (Right Group)

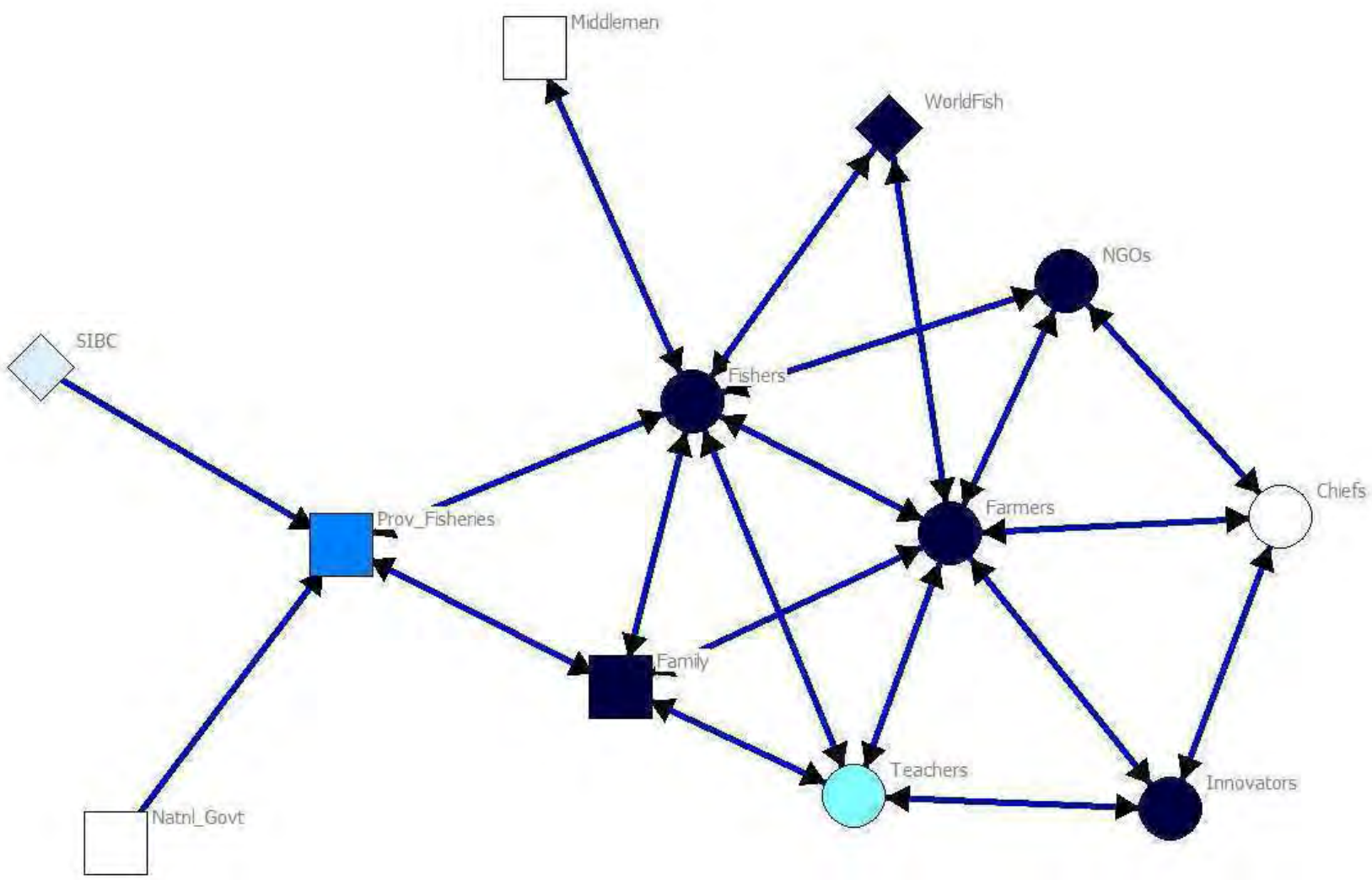


Figure 117: Financial Support networks created from data collected at the May workshop, and revised at the July workshop. This map was produced by the Left group

Financial Support Social Networks (Left Group)

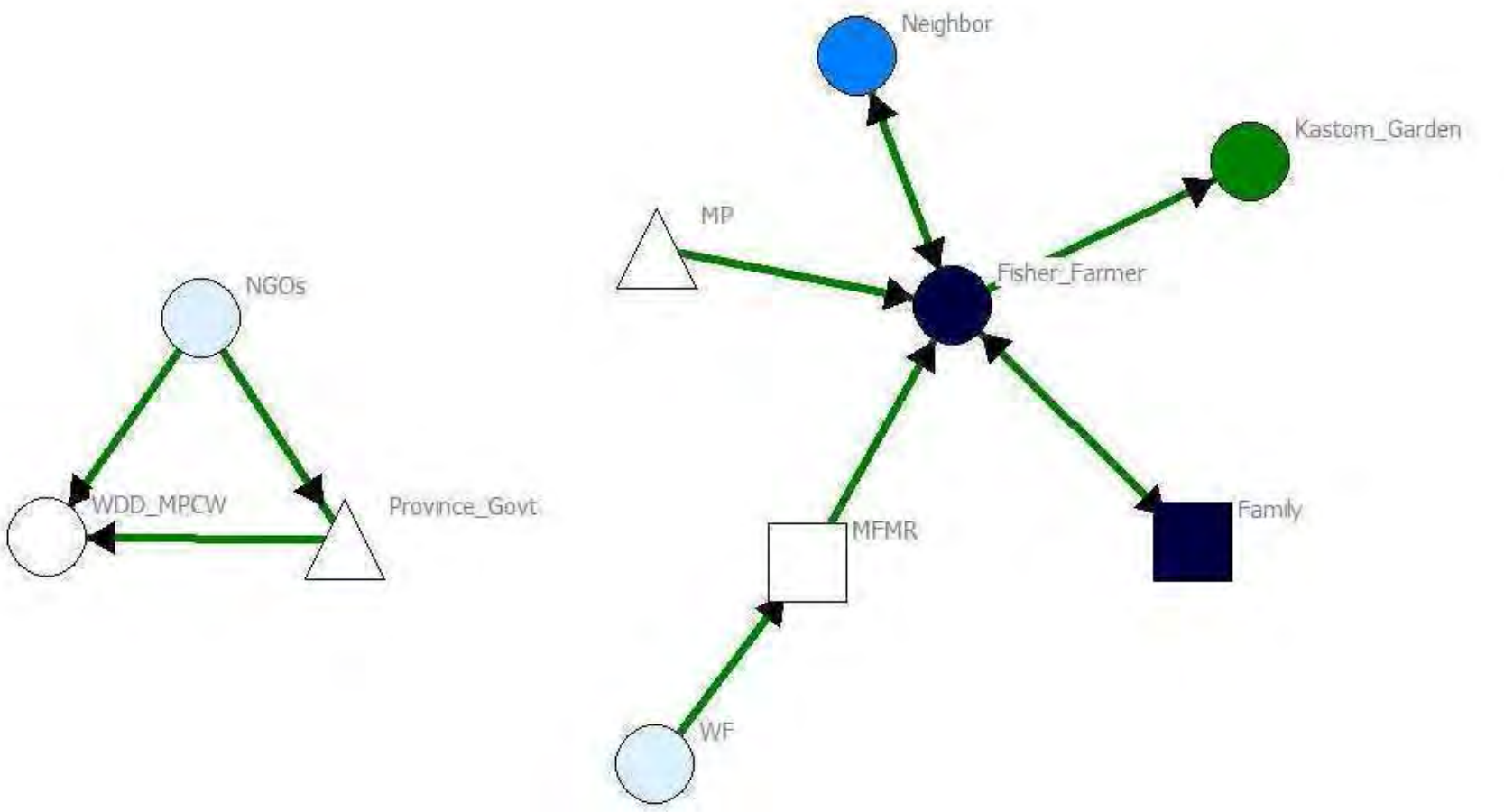


Figure 118: Financial Support networks created from data collected at the May workshop, and revised at the July workshop. This map was produced by the Right group

Financial Support Social Networks (Right Group)

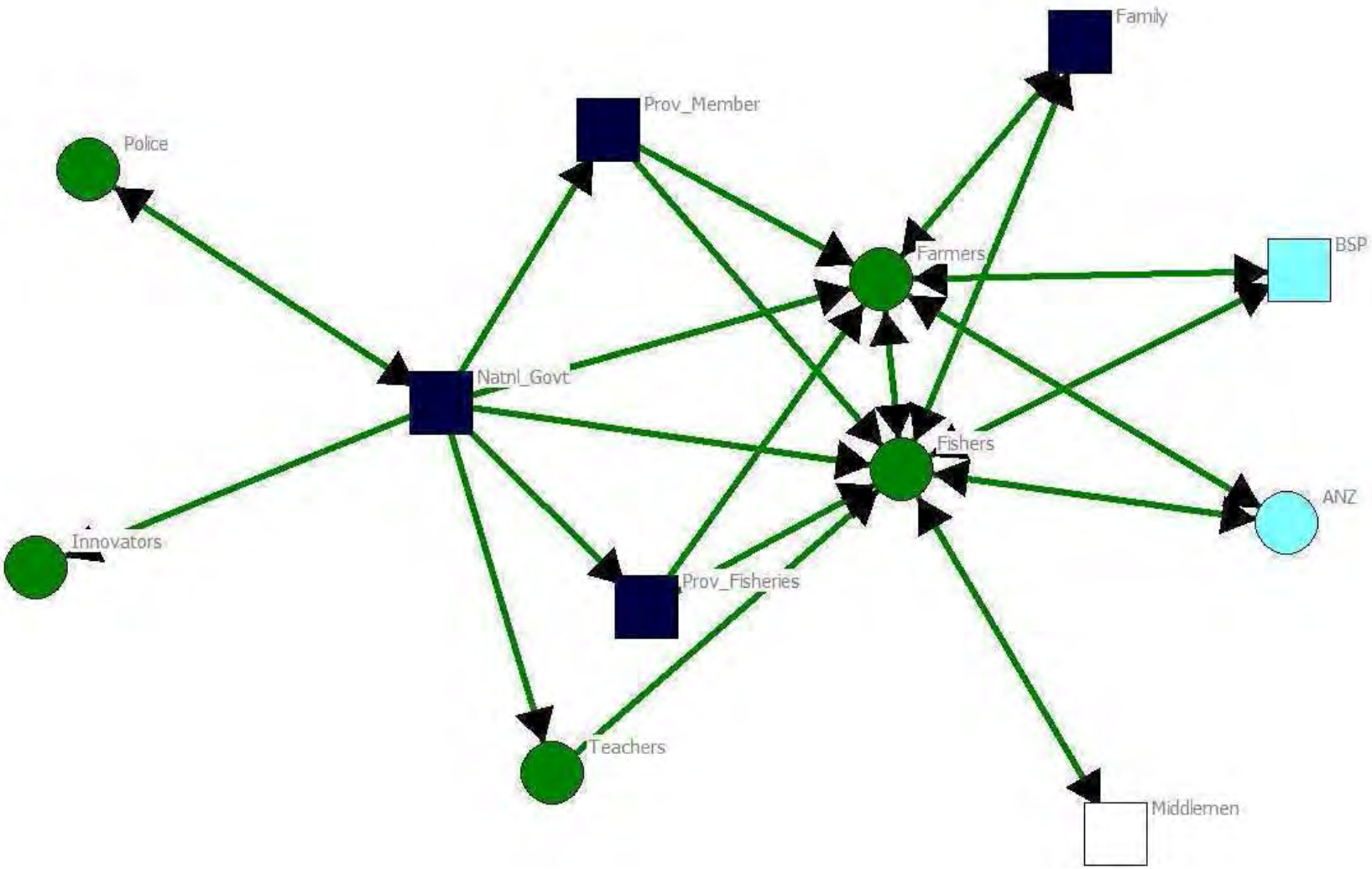


Figure 119: Physical Support networks created from data collected at the May workshop, and revised at the July workshop. This map was produced by the Left group

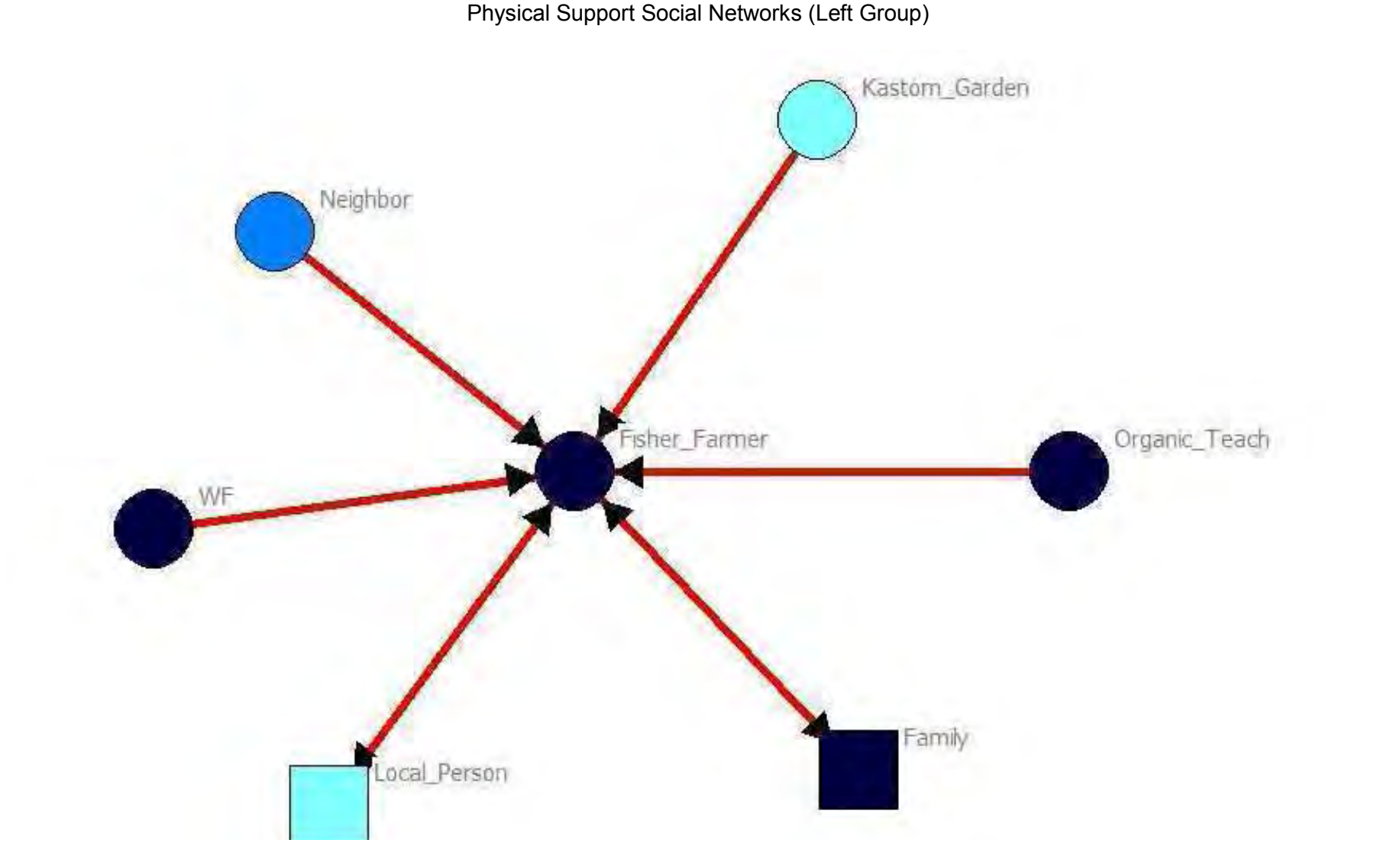


Figure 120: Physical Support networks created from data collected at the May workshop, and revised at the July workshop. This map was produced by the Right group

Physical Support Social Networks (Right Group)

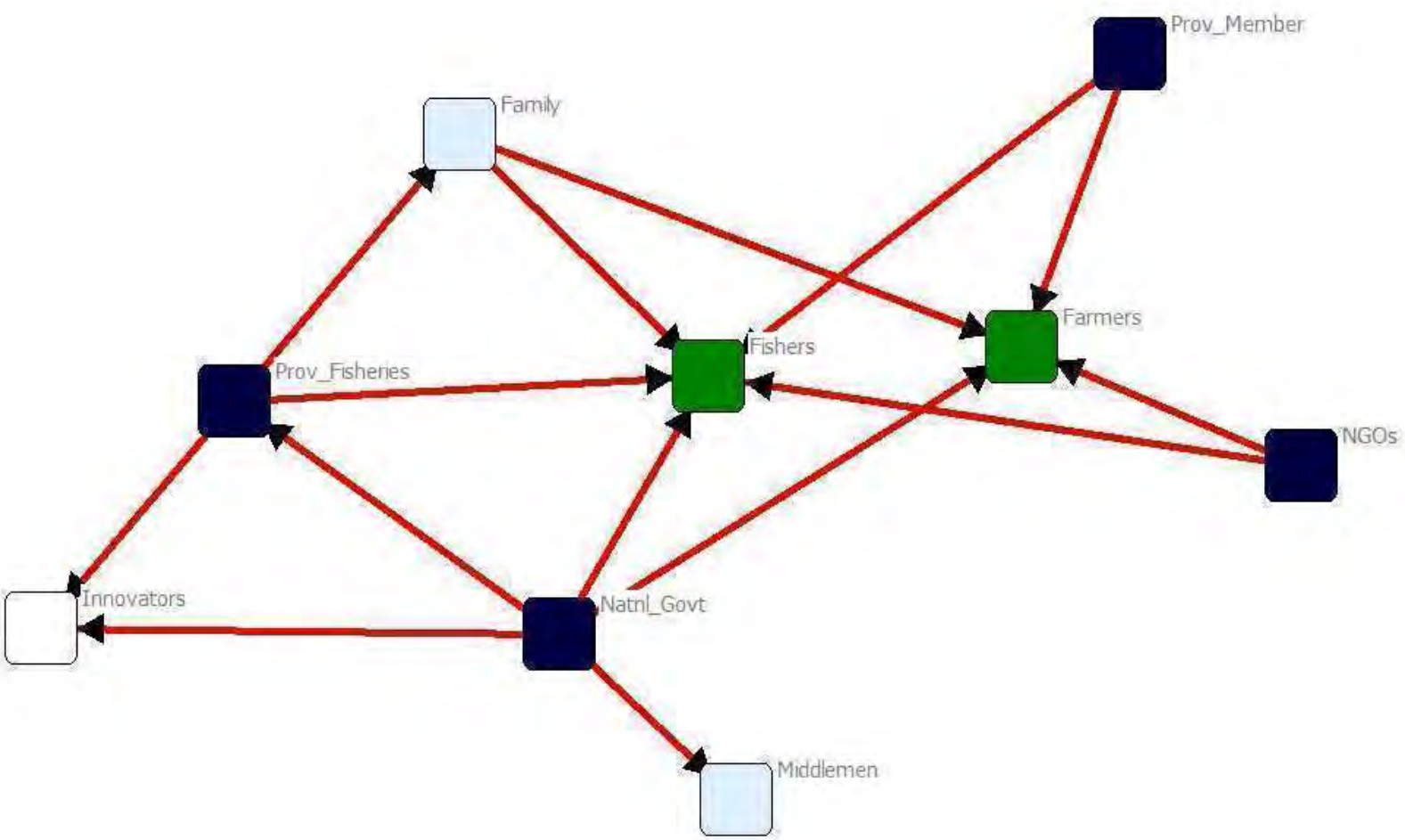


Figure 121: Services network created from data collected at the May workshop, and revised at the July workshop. This map was produced by the Left group

Services Social Networks (Left)

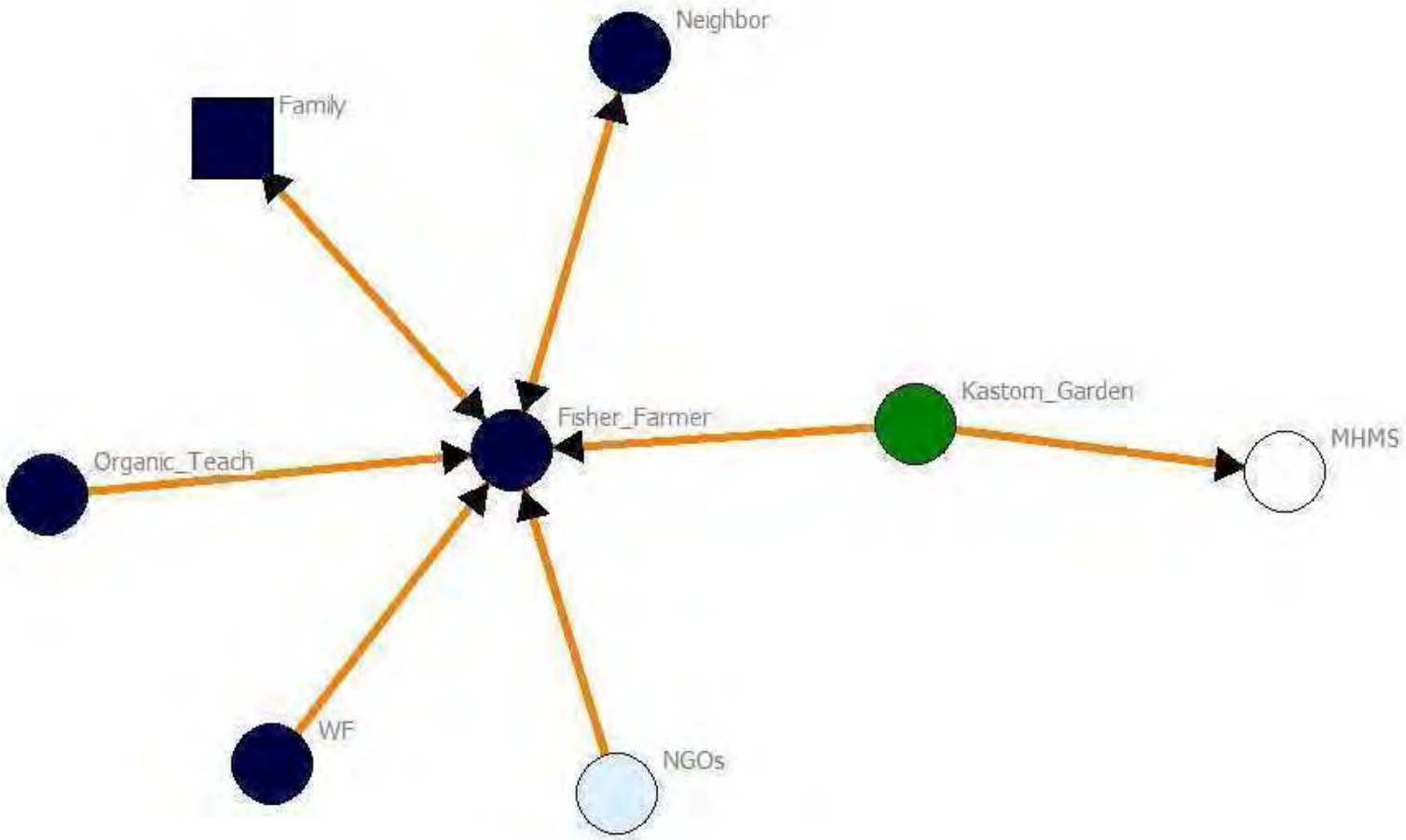


Figure 122: Services network created from data collected at the May workshop, and revised at the July workshop. This map was produced by the Right group

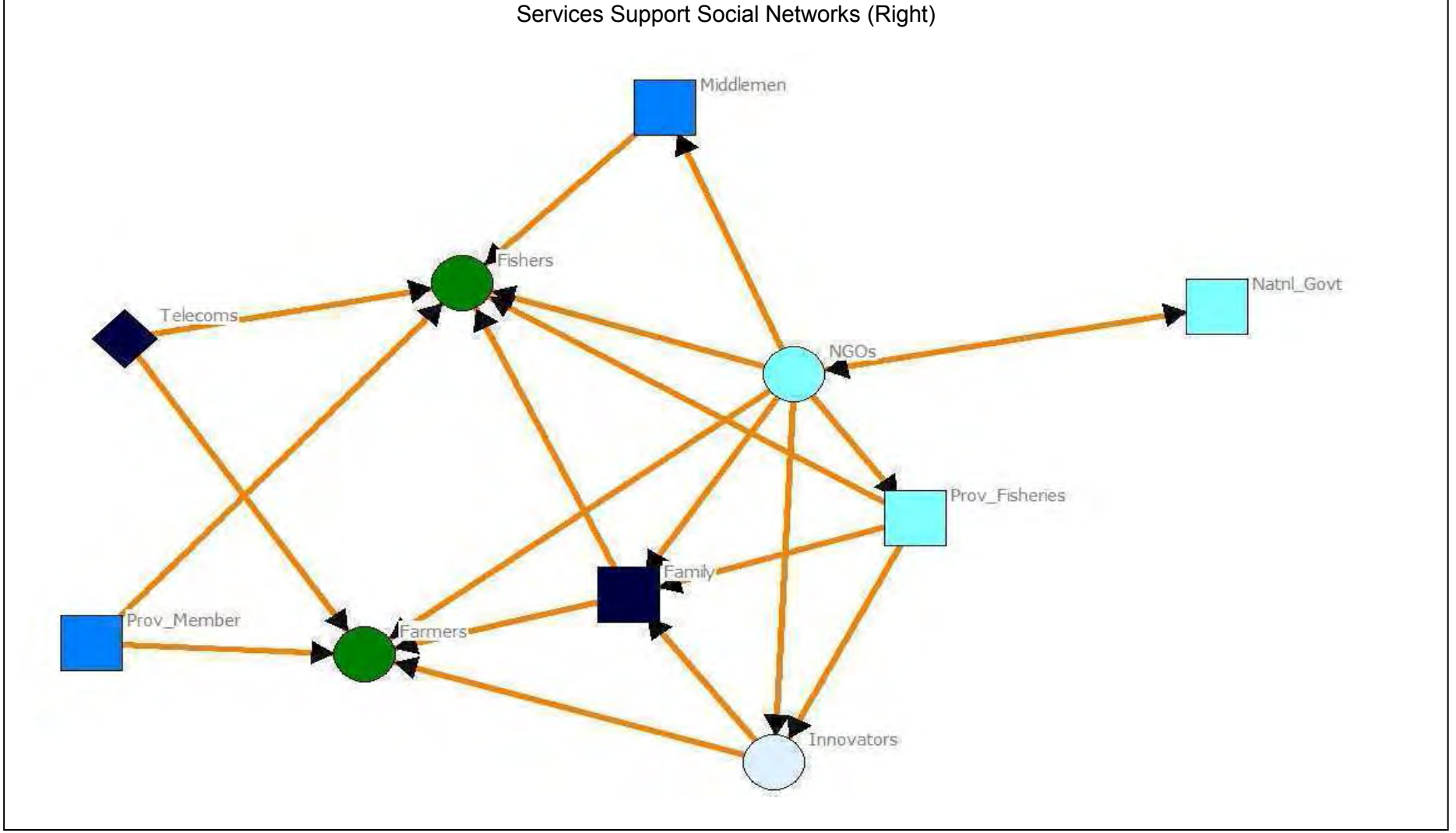


Figure 123: Problem solving networks created from data collected at the May workshop, and revised at the July workshop. This map was produced by the Left group

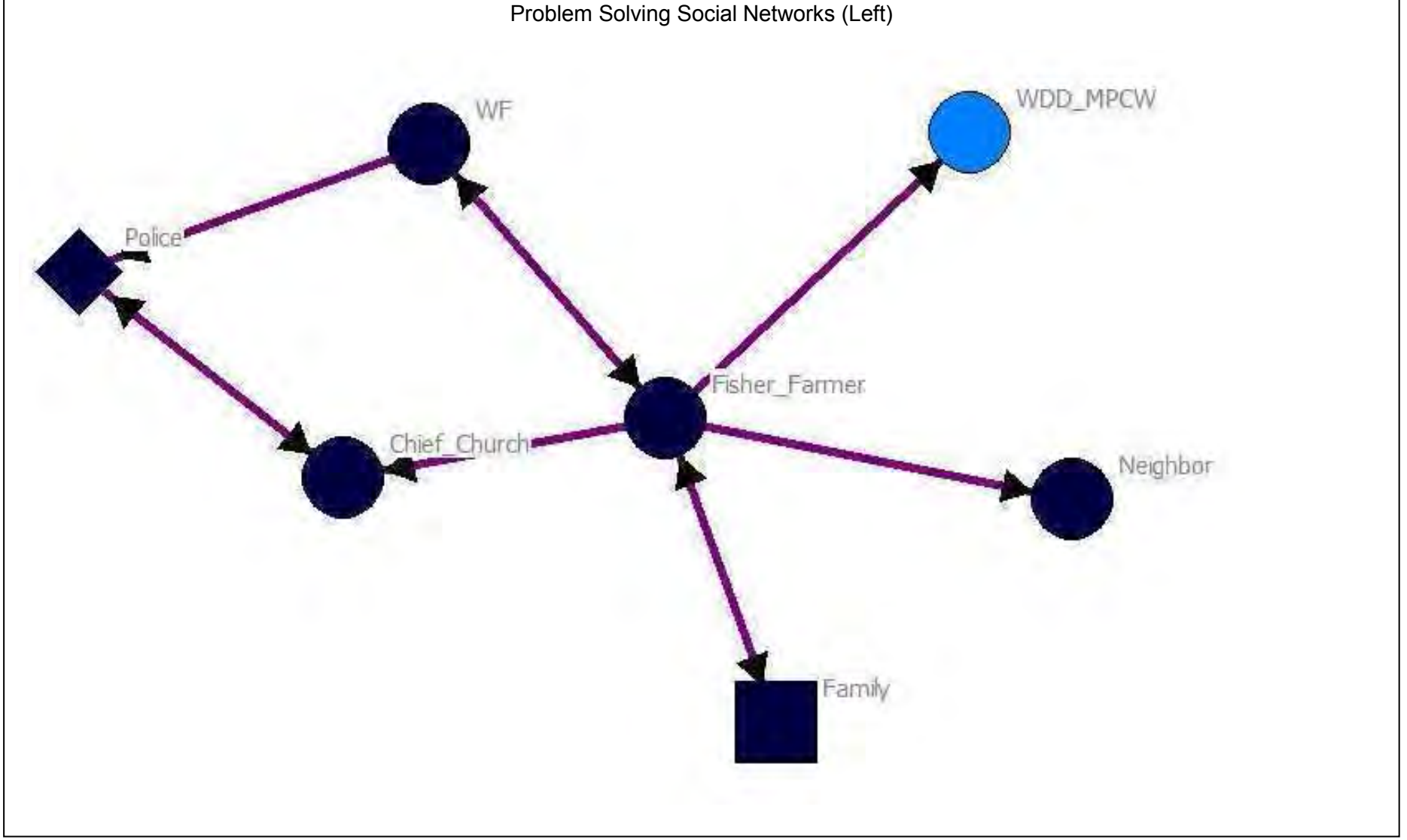
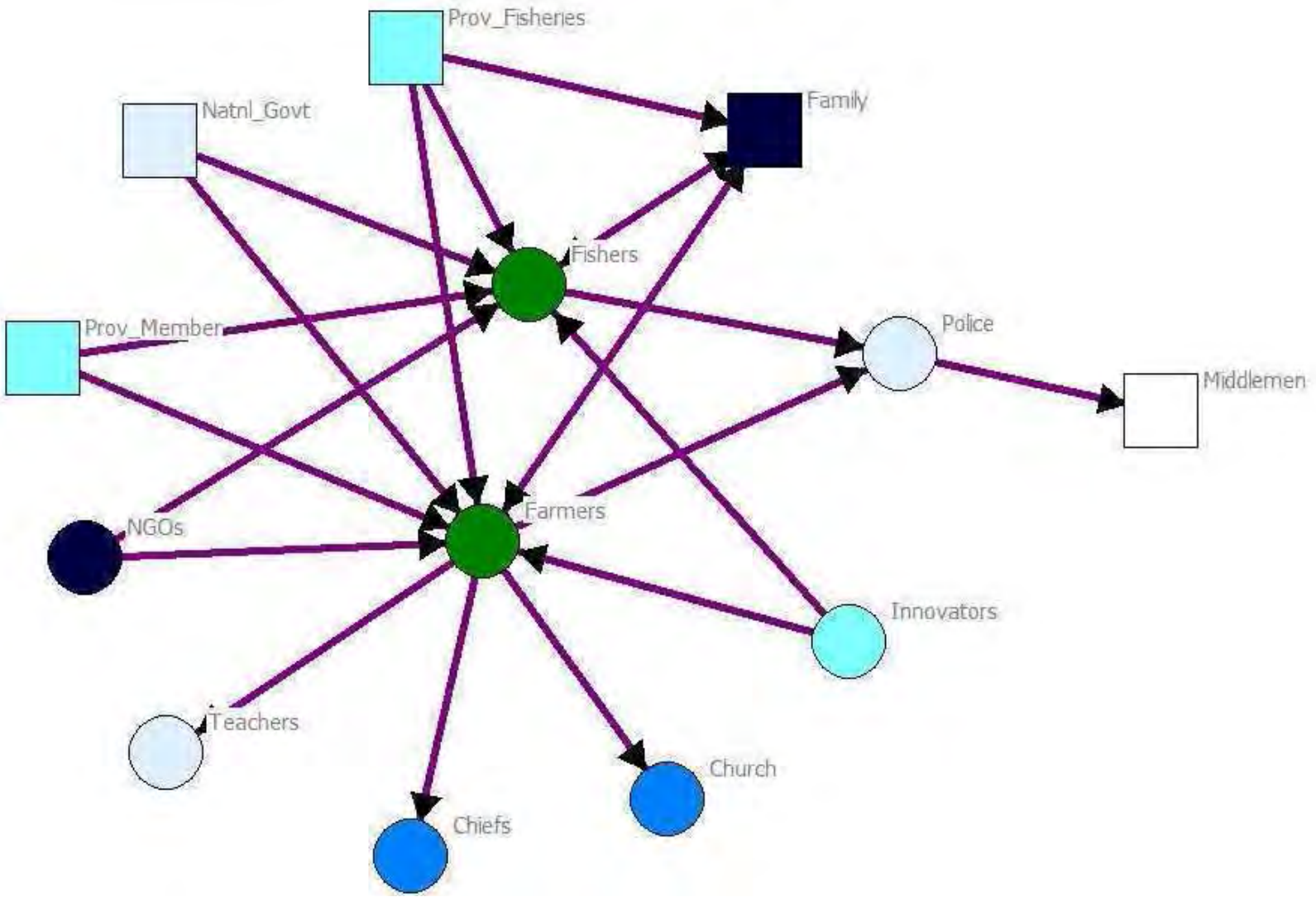


Figure 124: Problem solving network created from data collected at the May workshop, and revised at the July workshop. This map was produced by the Right group

Problem Solving Social Networks (Right)



G. Malaita community 'feedback' workshop, July 2013

Activity:	Feedback workshop and follow up on social network analysis
Aim/Key question:	Present to workshop participants and facilitate a review of the feedback report produced by WorldFish. Feedback report based on the information provided by the community in the first workshop, and focuses on the how potential changes in climate may impact livelihoods and reviewing pond aquaculture in light of climate change projections. Participants reviewed their social network maps, and refined them with additional detail on the actors and linkages needed to support the development of pond aquaculture on Malaita.
Key stages in method:	• Review conclusions drawn at May workshop on past climate trends and possible future scenarios. • Review ideas collated at May workshop regarding the possible development of pond aquaculture in Malaita. • Review potential effects of aquaculture on the environment. • Discuss recommendations for developing an aquaculture pond in light of future changes in climate. • Reflect on social network maps produced at May workshop; discuss networks in relation to implementing pond aquaculture, and consider where additional actors and linkages are needed to support the development of pond aquaculture on Malaita.
Key results (preliminary):	<u>General Feedback</u> <u>Left and Right groups' findings</u> • Local actors, such as families and neighbours are predominantly the primary support for fishing and farming communities and while these are seen to have the highest levels of capacity to provide support within the networks, other support from outside the community is necessary. <u>Group 3 findings</u> • There is the perception that some actors have the capacity to help support fishers and farmers, but their lack of willingness to do so (as measured by a rating of their attitude) means that they do not provide support to the full extent that is possible.

1. Methods

309. In July 2013, the second community workshop was held in Malaita to discuss and distribute the feedback booklet produced from the findings of the first workshop held in May 2013 (see 0 for a copy of the booklet). Thirty-four fishers attended the follow up workshop, with the majority again consisting of men who farm (twenty-six participants listed their occupation as farming, or farming and fishing) (Table 39). Also in attendance were three participants from the Ministry of Fisheries and Marine Resources in Honiara, the ADB Project management Unit in Honiara, the Youth Division in Malaita, and the University of the South Pacific. These three attendees were separated into a third group (referred to as "Group 3"). Again consent was gained from the workshop participants regarding the use and storage of data supplied by them.

Table 39: Attendees at community workshop in Malaita, July 2013

Total number		Farmer only		Fisher only		Fisher & Farmer	
Men	**Women**	**Men**	**Women**	**Men**	**Women**	**Men**	**Women**
31	3	23	3	5	0	3	0

310. <u>Review of feedback booklet.</u> Participants and the project team collectively reviewed the feedback booklet page by page (0), and group and plenary discussions were facilitated to consider the implications of the material produced for fishing and farming livelihoods in Malaita, and the potential expansion of pond aquaculture.

311. Review of social network maps. See Section F for a summary of this activity.

312. Evaluation activity. Each of the three groups of participants at the workshop discussed their feedback on the research conducted in Malaita by the WorldFish project team, and the material presented back to them. Each group was asked to respond to the following questions on butcher paper and then share their thoughts with all the workshop participants:

- Did you have any bright ideas or 'ah-ha' moments as a result of attending the workshops? If so, what were they?
- What were the good things about the workshops? What did you like?
- If the workshops were undertaken again, what should be changed to make them more effective? Was there anything we didn't cover that you thought we might?

2. Results

a) Review of feedback booklet

313. The past climate trends and potential future climate projections contained on pages 2-5 of the feedback booklet were discussed. Participants agreed that the climate they presently experienced was different to that of the past. Future projections were reviewed alongside the suggestions previous given by the participants as to how these might impact their livelihoods (see Section A, Figure 70 for a summary of these impacts). Impacts on the following were discussed: fisheries, shells, mariculture, estuarine habitats, mangroves, forests, freshwater streams, ponds and shifting agriculture. No changes were made to the original feedback given in the first workshop (held in May).

314. Next, the development of aquaculture in Malaita was discussed, with a focus on understanding why participants might be interested in exploring pond aquaculture (see Section A, Figure 69) for feedback from the participants of the workshop held in May). These were considered a good summary of their reasons for interest in pond aquaculture and no changes were made.

315. From here, consideration was made on how climate changes might specifically affect tilapia farming, and how farmers could plan for this in advance. To illustrate this, a climate change lens was used to consider past management recommendations (produced by a prior project) for building an aquaculture pond. The conclusion was drawn that past recommendations were still suitable for future projections of climate change, with specific consideration needing to be given to the siting of ponds so as to avoid flooding during the projected increasingly intense wet season rainfall events.

316. How aquaculture might be good for and conversely might negatively impact the environment if not managed carefully was examined. Discussions on how to identify suitable land for aquaculture as participants had specifically requested more information about this during the first workshop.

b) Evaluation feedback

317. *Ah ha moments.* Participants expressed very positive feedback about the climate change information provided as part of the workshops, especially as it was specifically related to aquaculture. They also found the information on how to farm and manage tilapia and crops quite helpful. Participants also appreciated the opportunity to learn from each other, citing the usefulness of the information provided by one of the participating farmers on using Vetever grass to manage soil erosion around aquaculture ponds. They expressed that

the social network mapping activity was a very useful way of illustrating the relationships between different stakeholders and they discussed how they may be able to use this knowledge to accomplish their goals.

318. *Good things about the workshop.* Participants appreciated the opportunity to come together and share information with each other and learn from “easy to understand” presentations given by the project team. They appreciated the chance to learn new skills and enjoyed a delicious meal at the same time. Special note was made of how interactive they felt the sessions were and they were pleased with the organization of the workshops.

319. *Changes for next time.* It was suggested that other workshops be held in different venues to enable more farmers to participate. Similarly, participants noticed the low ratio of female to male participants, and wanted to include more women in future workshops. Participants also felt that they would have benefited from including a field trip to look at several sites and see some of the techniques and ideas discussed. It was also stressed that provincial leaders needed to be continuously involved in these kinds of workshops and activities, to help sustain local initiatives. The participants also expressed a need for actors such as WorldFish to provide training on proposal writing as it would be a useful skill for communities.

III. Knowledge Products for Information Dissemination

320. WorldFish has produced a series of targeted outputs throughout the project stages. These outputs are varied and have been targeted towards different audiences. The appropriateness of the language and message contained in each output has been aligned to its specific audience. The outputs are described in Table 40 below.

Table 40: Knowledge Products

Output	Audience and Location	Message	Distribution	Location in this Report
5.1 Posters	Community workshop participants in Timor-Leste	Detailing of the steps that had been taken and activities that had been done since the project began in Timor-Leste.	Final workshop	0
5.2 Feedback report	Fishers and farmers? Who else? In Solomon Islands.	Ensure that fishers and farmers considering aquaculture projects provision for potential climate change impacts.	Final workshop	0
5.3 Brochures	NGOs, government officials involved in NRM, and other interested parties wishing to conduct community-focused assessment of climate change. For Timor-Leste and Solomon Islands.	The eight brochures provide illustrations of the assessment activities in the remit of this project (climate change analysis, assessment workshop, landscape function analysis, ecosystems service mapping, social network analysis, economic analysis evaluation)	See **Error! Reference source not found.** below	0
5.4 Policy brief	Policymakers in Timor-Leste, Solomon Islands, PNG, Fiji, Vanuatu specifically involved in community development, climate change and the environment.	Communicate findings from study in context of policy development in the five focal countries in relation to community focused climate change activities.	Text produced by WorldFish, awaiting ADB branding and distribution	Separate document
5.5 Journal paper	Scientific community	Explore scientific theory underpinning activities in the framework to communicate value of framework (and other community based adaptation assessment methods to scientific	Submitted to Global Environmental Change	

Output	Audience and Location	Message	Distribution	Location in this Report
		peers)		
5.6 Audio Visual Project	NGOs, development partners, and Government officials and ministries in Timor-Leste, Solomon Islands, Fiji, Vanuatu and PNG that are considering how to support communities' adaptation in response to climate change	Audio visual supplement to the eight brochures. Narrates stages of the project: scoping, identifying options, evaluation and planning implementation.		Section a)

321. Materials produced by the project have been made available via a number of online portals and databases such as in Peskador.org, the Pacific Disaster Net (SOPAC-SPC), Coral Triangle Initiative, Asia-Pacific Adapt, and the Coral Triangle Knowledge Network (see 0). Fifty packs, each containing eights methods brochures (collectively constituting a methods' manual), have also been distributed to the participating PDMCs (see 0), the TA focal agencies in each country such as the CEPA (formerly DEC) in PNG; MECDM & MFMR in SOL; DEPC in VAN; MAF/NDFA and MOE in TIM; and DOE in FIJ., as well as other relevant Government and non-government agencies in the TA countries (See Figure 125).

Figure 125: Brochures distributed to Batugade, Timor-Leste

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WorldFish (2011) Aquaculture and Food Security in the Solomon Islands – Phase 1 Final Report. Report provided for ACIAR project FIS/2009/061 "Aquaculture and Food Security in the Solomon Islands – Phase 1". 153 pp.

Appendix 1: Preparation activities conducted for in-country stakeholder engagement

Activity	Milestones	List of deliverables & month complete	Current status
2.1 Conduct review and compile findings of prior vulnerability analyses (VA) undertaken on coastal natural resources to climate change in five CTI countries, including proposed adaptation strategies;	**2.1** Literature reviewed and synthesis complete (mo 12);	**2.1** Draft report chapter detailing literature reviewed and key findings in readiness for inclusion in methods manual (mo 12);	**2.1** Literature review included in mid-term report.

Activity	Milestones	List of deliverables & month complete	Current status
2.2 Create and make publically available a database of VA studies;	**2.2** Database of VA studies created and available for public use (mo 12.5);	**2.2** Publically accessible database containing VA literature (mo 12.5);	**2.2** Material produced by project made available via a number of online portals and databases (see Section 5).

Activity	Milestones	List of deliverables & month complete	Current status
2.3 Identify feasible social, economic and environmental analyses for evaluating adaptation options in readiness for discussion with stakeholders;	**2.3** Evaluation analyses determined (mo 12);	**2.3** Draft report chapter detailing proposed evaluation analyses and data collection requirements in readiness for inclusion in methods manual (mo 12);	**2.3** A total of nine social, economic and environmental-focused assessment activities have been developed and trialed with community members and in-country partners. All methods have been applied in communities around two locations in Timor-Leste (Atauro and Batugade) (See Mid-Term report and Final report Section 3), and in Malaita Province in Solomon Islands (see Final Report Section 4).

Activity	Milestones	List of deliverables & month complete	Current status
2.4 Development of project monitoring and evaluation (M&E) activities (including gender consideration);	**2.4** M&E activities documented (mo 12);	**2.4** Draft report chapter of M&E activities produced in readiness for inclusion in methods manual (mo 12);	**2.4** Project evaluation undertaken in Atauro and Batugade, Timor-Leste (see Section 3) and Solomon Islands (see Section 4). As an additional evaluation, a further brief assessment has been conducted focusing on the efficacy of the project to contribute to enhancing adaptive capacity and resilience in communities (Section 6).

Activity	Milestones	List of deliverables & month complete	Current status
2.5 Development of governance mapping and stakeholder analysis activities;	**2.5** Stakeholder analysis activities documented (mo 12);	**2.5** Draft report chapter on stakeholder analysis activities produced in readiness for inclusion in methods manual (mo 12);	**2.5** Published outputs from governance mapping and stakeholder analysis activities conducted for communities in Atauro and Batugade (Mills et al., 2013) drawn on for use in this study. Summary details of the method detailed in Sections 3.5, 3.6 and 3.7 in the mid-term report). Similar analyses for Solomon Islands detailed in Section 4.3 and 4.5 in the final report.

Activity 3.0: In-country stakeholder engagement workshops and data collection

Activity	Milestones	List of deliverables & month complete	Current status
3.1 Identify and engage individuals (via governance mapping and stakeholder analysis activities) for participation in adaptation planning workshops;	**3.1** Stakeholders identified and invited to participate in first adaptation planning workshop (mo 14);	**3.1** Adaptation planning invites sent (mo 14);	**3.1** Timor-Leste: stakeholders identified and four workshops completed for Atauro, Batugade, and Dlli. Solomon Islands: stakeholders identified and two workshops completed for Malaita Province. Invitations co-ordinated with WorldFish in-country partners prior to engagement activities planned for February 2013. As detailed in project revision 2 (approved November 2013), no stakeholders were engaged in Fiji, Vanuatu, or Papua New Guinea.

Activity	Milestones	List of deliverables & month complete	Current status
3.2 Conduct M&E data analysis with workshop participants to determine current adaptation activities and adaptation needs;	**3.2** Baseline M&E activities conducted (mo 15);	**3.2** Draft documentation of baseline M&E data analysis (mo 15);	**3.2** Timor-Leste: evaluation activity undertaken in final community workshops in March 2013. Solomon Islands: evaluation activity undertaken in final community workshop in July 2013.

Activity	Milestones	List of deliverables & month complete	Current status
3.3 Conduct adaptation planning workshop to engage stakeholders and determine which (and how) adaptation activities to be evaluated;	**3.3** Adaptation planning workshop # 1 completed (mo 17);	**3.3** Draft documentation of workshop findings (mo 17);	**3.3** Timor-Leste: Adaptation planning workshops conducted in Atauro and Batugade in August 2012 and October 2012 (i.e., a total of four workshops have been conducted to date). Adaptation activities were identified by the communities and a selection of evaluations conducted from a social, economic and environmental perspective by the WorldFish project team. Solomon Islands: Adaptation planning workshops and evaluation analyses conducted between February and July 2013.

Activity	Milestones	List of deliverables & month complete	Current status
3.4 Adaptation strategies evaluated by project team;	**3.4** Adaptation actions evaluated (mo 19);	**3.4** Draft documentation of evaluation results (mo 19);	**3.4** Timor-Leste: Results from social, economic and environmental evaluations detailed in the mid-term report Solomon Islands: Results from social, economic and environmental evaluations detailed in Section 4 of the final report

Activity	Milestones	List of deliverables & month complete	Current status
3.5 Results of evaluation of strategies discussed with stakeholders during second adaptation planning workshop;	**3.5** Second adaptation planning workshop conducted (mo 21);	**3.5** Draft documentation of second adaptation workshop and stakeholder's determination of adaptation pathways (mo 21);	**3.5** Timor-Leste: Results of evaluation of strategies discussed with stakeholders, March 2013. Documented in Section 3 of the final report. Solomon Islands: Results of evaluation of strategies discussed with stakeholders, July 2013. Documented in Section 4 of the final report.

Activity	Milestones	List of deliverables & month complete	Current status
3.6 Repeat M&E data collection to assess impact of engagement activities on adaptation planning by stakeholders;	**3.6** M&E finalised (mo 22.5);	**3.6** Draft documentation of impact of stakeholder engagement activities (mo 22.5);	**3.6** Timor-Leste: The M&E activity conducted in a single activity in the final community workshop in each location. Documented in Section 3 of the final report. Solomon Islands: The M&E activity conducted in a single activity in the final community workshop. Documented in Section 4 of the final report.

Activity	Milestones	List of deliverables & month complete	Current status
3.7 Feedback obtained from stakeholders on utility of approach to adaptation planning;	**3.7** Stakeholder feedback received and incorporated in method manual (mo 24);	**3.7** Revised draft of methods manual produced and input incorporated from stakeholders and reviewers (mo 24);	**3.7** Stakeholder feedback reflected in methods manual (consisting of eight brochures), and distributed to Timor-Leste, Solomon Islands, Papua New Guinea, Vanuatu and Fiji contact points.

Activity 4.0 ADB reporting and completion workshop

Activity	Milestones	List of deliverables & month complete	Current status
4.1. Inception report produced (including proposed project revision);	**4.1** Inception report and proposed work plan submitted (mo 8);	**4.1**. Inception report cleared by ADB (mo 8);	**4.1** Inception report and proposed work plan submitted May 2012 and approved by ADB May 2012.

Activity	Milestones	List of deliverables & month complete	Current status
4.2 Mid-term report produced;	**4.2** Mid-point report produced and submitted (mo 12);	**4.2** Mid-term report cleared by ADB (mo 12);	**4.2** Mid-term report submitted 12 December 2012 and approved by ADB February 2013.

Activity	Milestones	List of deliverables & month complete	Current status
4.3 Final report produced (including methods manual);	**4.3** Final report of project results produced (including methods manual) (mo 24);	**4.3** Final report accepted by ADB (mo 24).	**4.3** Final report submitted 31 January 2014.

Activity	Milestones	List of deliverables & month complete	Current status
4.4 Policy brief produced;	**4.4.** Policy brief produced (mo 24);	**4.4** Policy brief cleared by ADB (mo 24);.	**4.4** Policy brief submitted 31 January 2014.

Activity	Milestones	List of deliverables & month complete	Current status
4.5 Journal paper produced for submission to peer-reviewed journal;	**4.5** Journal paper produced for submission to peer reviewed journal (mo 24);	**4.5** Journal paper submitted to peer-reviewed journal (mo 24).	**4.5** Journal paper submitted to ADB 31 January 2014.

Appendix 2: Project management related concerns

The project team was requested by ADB to provide details of project-management related concerns in order that future projects can be more effective and efficient. Over the course of the project various obstacles were encountered. These include:

- Personnel changes- Staffing changes at both ADB and WorldFish resulted in a changing form/style of engagement between WorldFish and ADB during the course of the project. This also seemed to bring a different set of expectations, which led to delays in receiving ADB approval to carry out activities. This in turn, often led to higher financial costs for activities. For example, delays to approve travel for a Project team member to Solomon Islands, resulted in having to book him on a more expensive last-minute flight via PNG.
    - Recommendation- While some change in project teams and management is unavoidable, steps can be taken to minimize this disruption. Outgoing staff should clearly indicate which version of the contract/budget/document is the current version.
- Clarity around review of outputs- Both ADB and WorldFish have put a lot of time and energy into agreeing on the details of each specific output. However, outputs seem to be reviewed by other staff or consultants, who have had little to no involvement in the prior discussions. This has led to multiple, often major, revisions to different outputs, such as both this mid-term report and the audio-visual production. In the specific case of the audio-visual production, ADB, WorldFish, and the production company went to great lengths and expense to agree on the specific details of the video, however we were recently informed that ADB intends to make significant changes to this video. If the preferences of the donor agency made when determining the ToR of this product had been held to, or if these revised expectation had been made explicit at the time of writing the ToR, then valuable time and money would have been much better spent.
    - Recommendation- The staff responsible for agreement on the detail over specific outputs should be the same staff that reviews that specific, as they will be best informed of the specifications agreed on for these outputs.
    - Recommendation- If the donor agency is unclear of the final specifications they should require, then either these specifications should be finalized prior to the work being carried out, or the donor should request just the information gathering (in the example of the video, this would have been the raw unedited footage) and the partner would not waste time and funds developing a product that would ultimately be changed or discarded.
- Project changes/ Contract variations- Over the course of this project a number of changes were made to the original proposal. These included changes to the activities, team, and budget. While some changes seemed to happen smoothly, many others seemed to be delayed by lack of clarity on the documentation needed and the length of time it took to approve these changes by ADB. These delays then caused further delays in the project implementation, eventually resulting in the need for a no-cost extension to the project.

    - Recommendation- Increased clarity over the exact documentation needed to approve: budget estimates, actual expenses reimbursement, trip plans, and contract variations.
    - Recommendation- Increased clarity over which department/person is responsible for granting approval each item.
    - Recommendation- Increased clarity over the length of time needed to approve each item.

- Clarity around specific forms and budget justification required- For example, Forms 6 and 7 are meant to be estimates, but expenses which had exceeded their estimated costs were routinely rejected. There were multiple instances of confusion over what expenses belonged on the fieldwork form 7 versus the workshop form 6. Formal justification for *estimates* of specific line items, such as ferry tickets in Timor-Leste, was regularly requested before approval of the workshop budget would be granted.
    - Recommendation- Increased clarity over the exact documentation needed to approve: budget estimates, actual expenses reimbursement.
    - Recommendation- Increased clarity over which form is required for which type of expense.

- Supporting documentation for claims- For many minor expenses, such as local taxi fares, reimbursement were regularly disallowed due to a lack of formal receipts; however, formal receipts are unavailable for many of these situations. In order to satisfy this requirement, WorldFish developed its own receipt form and had each individual taxi driver sign for their payment. Many of these 'vendors' are illiterate and expressed their discomfort at being asked to sign a document they were unfamiliar with or didn't understand.
    - Recommendation- Increased contextual awareness of local conditions/limitations.
    - Recommendation- Improve understanding of how to budget for and handle these types of claims from the outset of the project (for example, making use of the SOE procedures).

Appendix 3: Workshops in Batugade and Atauro

Plan of the workshop:

Step 1: Introduction

(i) Welcome from local NDFA officer and NDFA National representative. Introduction to all project team members and in-country partners.
(ii) Explain the aims of this third, and final, meeting, i.e., feedback, consideration of results in terms of developing an implementation plan, evaluation of usefulness of project outputs.

Step 2: Feedback of project findings

(i) Presentation of social, economic and environmental evaluation of a selection of adaptation actions.
(ii) Participatory activity focused on community members considering if and how they would implement each activity, including a discussion on thresholds (tipping points) likely to prompt implementation. Feedback session to enable community members to share their ideas.

Step 3: Evaluation of project outputs

(i) Participatory activity focused on community members providing feedback on the usefulness of the outputs produced during the project.

Workshop plan

Time	**Activity**	**Materials**
9.30 – 9.45	Welcome and introductions Aim of the meeting	Attendance and consent sheet
9.45 – 10.30	Presentation of social, economic and environmental evaluation of adaptation actions	Handouts Posters/presentation slides & projector
10.30 – 10.50	Morning tea	
10.50 – 12.15	Participatory activity considering if and how activities could be implemented (including thresholds). Feedback session from participants.	Butchers paper and pens Data collection sheets
12.15 – 12.30	Evaluation by participants	Data collection sheets
12.30 – 12.45	What next from WorldFish in Timor-Leste. Thanks you.	
12.45 – 1.30	Lunch	

Materials

Butchers paper, pens sticky tape, blue tack, cards (empty), camera, power cord, laptop, water, list of participants, cash for lunch, attendance list and consent form

Appendix 4: Workshop in Dili

Plan of the workshop:

Step 1: Introduction

(iii) Welcome from NDFA Head. Introduction to all project team members and in-country partners.
(iv) Explain the aims of this third, and final, meeting, i.e., feedback, consideration of results in terms of ongoing and future climate change projects and initiatives, evaluation of usefulness of project outputs.

Step 2: Feedback of project findings

(iii) Presentation of social, economic and environmental evaluation of the selection of adaptation actions and Community level ideas for utilizing this information.
(iv) Discussion amongst National level stakeholders regarding the program findings in light of in-country ongoing and future climate change projects and initiatives.
(v) Presentation of known projects and initiatives that may utilize the program findings. Presentation of program recommendations.
(vi) Feedback session from National level stakeholders.

Step 3: Evaluation of project outputs

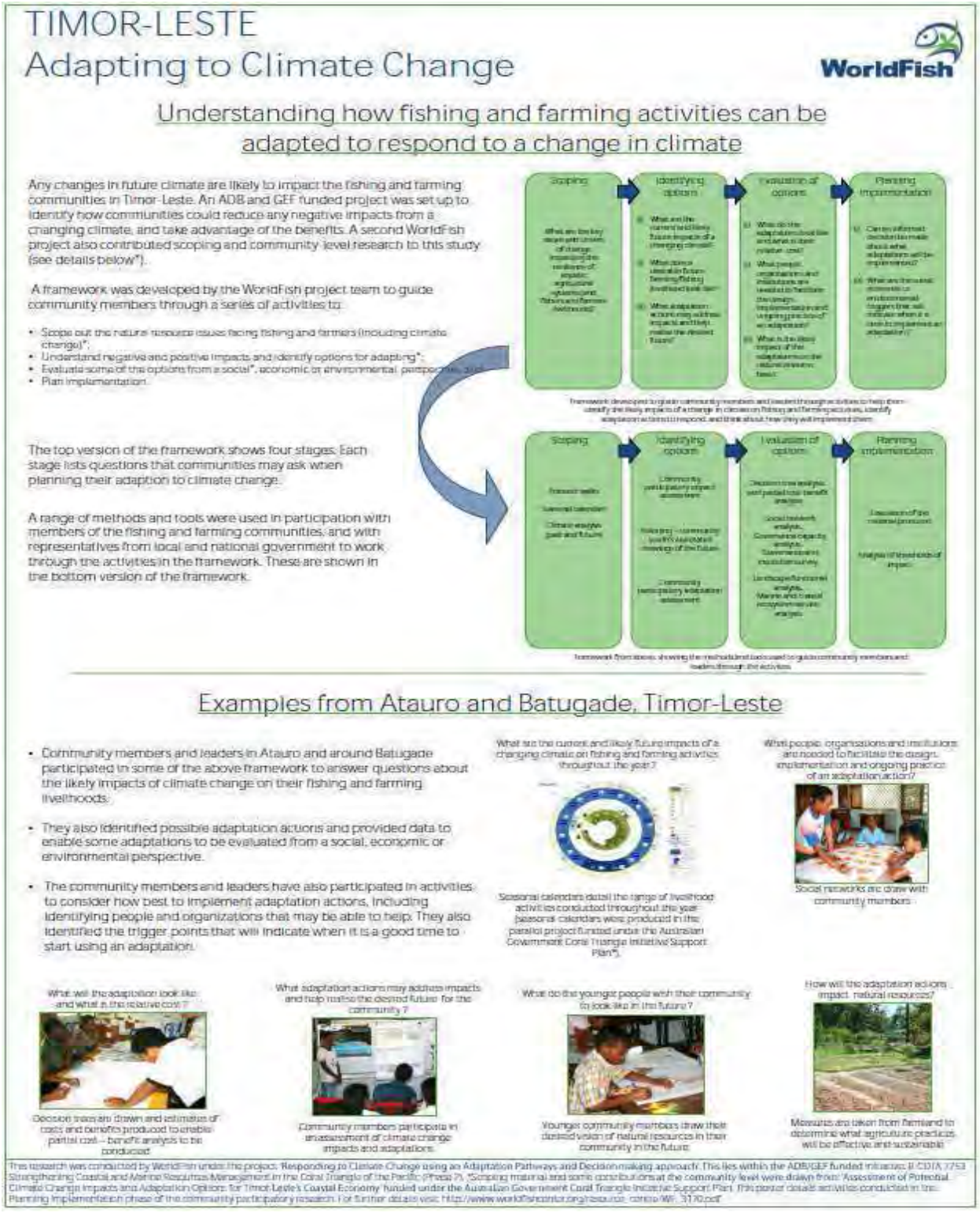
(ii) Participatory activity focused on national level stakeholders providing feedback on the usefulness of the outputs produced from the project.

Workshop plan

Time	Activity	Materials
9.30 – 9.45	Welcome and introductions Aim of the meeting	Attendance and consent sheet
9.45 – 10.30	Presentation of social, economic and environmental evaluation of adaptation actions and community ideas for utilizing this.	Handouts Posters/presentation slides & projector
10.30 – 10.50	Morning tea	
10.50 – 12.15	Participatory activity considering if and how activities could feed into in-country ongoing and future climate change adaptation projects and initiatives. Feedback session from participants.	Butchers paper and pens Data collection sheets
12.15 – 12.30	Evaluation by participants	Data collection sheets
12.30 – 12.45	What next from WorldFish in Timor-Leste. Thanks you.	
12.45 – 1.30	Lunch	

Materials: Butchers paper, pens sticky tape, blue tack, cards (empty), camera, power cord, laptop, water, list of participants, cash for lunch, attendance list and consent form.

Appendix 5: Results posters presented to each community



Poster 1 Understanding how fishing and farming activities can be adapted to respond to a change in climate.

TIMOR-LESTE
Climate Change Impacts and Adaptation Options for Communities

Summary of Results
Developing Timor Leste's coastal economy: Assessing potential climate change impacts and adaptation options

This poster summarizes results from the WorldFish Center's research trip to Ataúro sub-District in June and August 2012. Four main activities were carried out in order to better understand the impacts of climate change on seasonal livelihood activities and to identify adaptation options to current and future natural resource issues.

1. Land, water and sea issues facing communities

Objective: To identify what natural resource issues are affecting communities and how they may be impacted by climate change

- The top rated natural resource issue was lack of fish and income from fishing
- Second, was lack of access to fresh water
- The third, was low agricultural production

2. Seasonal livelihood activities for coastal and upland communities

Objective: To identify times of the year and activities that could be vulnerable to climate change

- The calendars show that there are times throughout the year when climate change could greatly impact fishing and agriculture
- Unpredictable rainfall will disrupt planting and harvesting seasons , particularly in the wet season (and increase risk of crop destruction and more pests)
- Calendars made in communities identified a time of year where access to income and food is difficult. In Usubemaco, it is from October to November, and in Ili Timur it is from November to January
- These difficult times of year are more difficult when there is low agricultural yield or reduced catch from fishing. This may be due to climate related events, or not. For example, more stormy weather and intense rainfall may reduce the amount of time fishers are able to spend at sea and reducing income and savings

4. Assessment of existing relationships important for implementing adaptation options

Objective: To analyse fishar relationships and identify who is needed to best implement climate change adaptation options in the future

- The diagrams show the important people and groups (circles) needed for providing information, help with solving problems and providing support to fishers so they can **achieve their goal of** "*earning enough income from fishing to support their daily lives and improve their family welfare*"
- The size of the circles show how important the groups are. In Usubemaco and Pala, the Chefe suco and the NDFA are very important. In Pala, the National NDFA is a main source of information and problem solving whereas in Usubemaco, the local NDFA is a main source.
- The lines show how the people and groups are linked. Pala has more links between groups than Usubemaco.
- The colour of the circles show who would be helpful for achieving the goal (dark red). Most of the groups were identified as being helpful.

3. Options for addressing climate change impacts on seasonal livelihoods

Objective: To identify different options to address climate change impacts on resources and livelihood activities

- Ataúro communities discussed the direct and indirect, negative and positive effects of climate change on fishing
- Negative impacts were potential reduction of time to fish due to more intense rainfall in the rainy season. The community suggested needing to diversify livelihoods and income sources. However, with a longer dry season, there may be more opportunity to fish longer throughout the year
- Adaptation options suggested by community members were to increase fisheries yields, though improving access to deep water fisheries. Examples included improving technology, training on new techniques, and using rampongs
- Communities are concerned that climate change will increase pressure on the reef which is already heavily fished. Looking at ways to manage reef resources was discussed. There were suggestions to ban poison fishing and catching depleted species; limiting gear use and increasing net sizes.

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Poster 2 Climate change impacts and adaptation options for communities in Ataúro (by K.Abernathy).

TIMOR LESTE
Climate Change Impacts and Adaptation Options for Communities

Summary of Results
Developing Timor-Leste's coastal economy: Assessing potential climate change impacts and adaptation options

This poster summarizes results from the WorldFish Center's research trip to Balibo sub-District in June and August 2012. Four main activities were carried out in order to better understand the impacts of climate change on seasonal livelihood activities and to identify adaptation options to current and future natural resource issues.

1. Land, water and sea issues facing communities

Objective: To identify what natural resource issues are affecting communities and how they may be impacted by climate change

- The top rated natural resource issue was lack of fish and income from fishing
- Second, was lack of access to fresh water
- The third, was limited access to cash for households
- Fourth was low agricultural production

2. Seasonal livelihood activities for coastal and upland communities

Objective: To identify times of the year and activities that could be vulnerable to climate change

- The calendar shows that there are times throughout the year when climate change could greatly impact fishing and agriculture
- Calendars made in communities identified a time of year where access to income and food is difficult. In Batugade it was identified as February
- These difficult times of year are more difficult when there is low agricultural yield or reduced catch from fishing. This may be due to climate related events, or not. For example, more stormy weather and intense rainfall may reduce the amount of time fishers are able to spend at sea and reducing income and savings
- Unpredictable rainfall may also disrupt planting and harvesting seasons (November for planting and June and September for harvesting)
- A longer dry season could also increase the damage caused by livestock eating crops (e.g. buffalo) as there is less food for them to forage

4. Assessment of existing relationships important for implementing adaptation options

Objective: To analyse fisher relationships and identify who is needed to best implement climate change adaptation options in the future

- The diagrams show the important people and groups (circles) needed for providing information, help with solving problems and providing support to fishers so they can achieve their goal of *"earning enough income from fishing to support their daily lives and improve their family welfare"*
- Aldeia Batugade has a larger number of people that can help them to achieve their goal, than **Nu'Badac**. **Nu'Badac** fishers have fewer people providing information, support or helping to solve problems.
- The size of the circles show how important the groups are. In both locations the middlemen are very important for financial support. In Batugade, the Fishing Coordinator and Chefe Suco are important for accessing information. In **Nu'Badac**, the local NDFA officer is important and is one of the only sources of information
- The lines show how the people and groups are linked. Batugade has more links between groups than **Nu'Badac**
- The colour of the circles show who would be helpful for achieving the goal (dark red). Most of the groups were identified as being helpful

3. Options for addressing climate change impacts on seasonal livelihoods

Objective: To identify different options to address climate change impacts on resources and livelihood activities

- Balibo communities discussed the direct and indirect, negative and positive effects of climate change on fishing
- Negative impacts were potential reduction of time to fish due to more intense rainfall in the rainy season, especially for small boats. There were concerns that less rain throughout the year would reduce the sardine stocks. The community suggested needing to diversify and improve income and food from non-fishing activities, such as aquaculture
- Adaptation options suggested by community members were to increase fisheries yields, though improving access to deep water fisheries. Examples included improving technology (larger boats and nets) and training on new techniques.
- Also, to try new ways to get more income from fishing. For example, using ice boxes to improve fish quality, creating a fishing co-operative to purchase gear in bulk and borrow credit, and creation of fish market on beach

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Poster 3 Climate change impacts and adaptation options for communities in Balibo (by K.Abernathy).

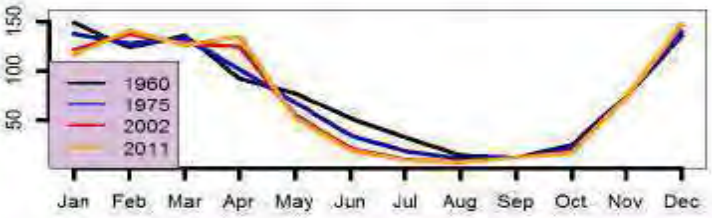
TIMOR LESTE- Atauro sub-district Adapting to Climate Change

WorldFish

Climate Impacts on Livelihood Activities & Adaptations

Rainfall and temperature information was collected for Timor-Leste and analyzed using statistical and data modeling software. This was then compared to observations gathered from fishers and farmers in Timor-Leste and projections of future climate from sources in Australia (ABoM and CSIRO). Using this information, impacts on fishing and farming activities were estimated. Additionally, children from the community came together to imagine the future of the natural resources in the community, drawing their ideas and sharing them with the community. These visions and thoughts on impacts were used by a selection of community decision-makers to identify which adaptations to climate change should be evaluated.

What climate trends have fishers & farmers seen over the past 60 years?



These graphs display monthly rainfall measured in Dili from 1960 to 2011. Each colored line represents an average of the rainfall pattern seen in each year. This graph shows that over the last 50 years, the dry season is starting earlier in the year.

The black line shows how much rain fell in each month of 1960. The lowest point of the line is in August – this shows when the dry season was happening in 1960. The yellow line shows how much rain fell in 2011.

See how the yellow line begins to drop around two months earlier than in 1960. This means the dry season has been starting earlier in the year in more recent times.

How do past trends align with future projections?

The following table shows climate trend analysis and future climate projections. Trend analysis is looking at the patterns of rainfall and temperature as they've changed over the years. Projections of climate change are estimates of how the weather may change in the future.

The left column shows climate trends observed since 1960; the right column shows projections for the future. As the past trends are similar to the projections for the future, we may expect these trends to continue in the future.

Trend analysis	Projections of climate change
Long-term trend in annual rainfall has been relatively stable over the past 60 years.	Little change in total annual rainfall over the course of the 21st century.
Average dry season rainfall has fallen quite substantially in recent decades.	Reduced quantity of rainfall in the dry season.
Average rainfall in the wet season has perhaps risen slightly.	Increased quantity of rainfall in the wet season.
On average, the start of the dry season (as defined by a monthly rainfall level of less than 20 mm), has shifted approximately 45 days earlier over the past 60 years.	No projections given for the onset of the dry season, however it is noted that El Niño events generally bring drier conditions to Dili and often lead to a late onset and early finish to the wet season. *There is no consistency in projections of future ENSO activity.*
There is a tendency for terrestrial air temperatures to be warmer during the wet season, than in the dry season months.	No projections provided for monthly temperatures.
The duration of the cooler season has contracted between 1900 and the present day for both sea surface and air temperature. This has coincided with an expansion of the warmer season in marine temperatures.	Increase in inter-annual surface air temperatures (and sea-surface temperature)
Marine temperatures (sea surface and air temperature) have increased over the past century, across almost all months.	Increase in annual surface air temperature (and sea-surface temperature)

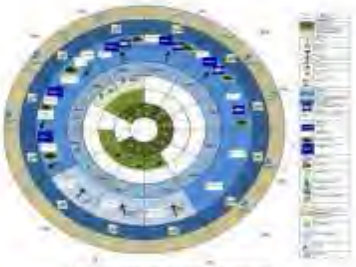
How does the current climate influence fishing & farming activities?

Atauro seasonal calendars

This calendar shows the type of weather, and fishing and farming activities for each month of the year. This helps us to estimate which fishing and farming activities may be affected by future climate changes.

Examples:

- Uaitamaco- During the wet season fish prices are high and emperor fish and surgeonfish are caught. If the wet season is shorter, this may limit the number and types of fish that can be caught, reducing fishers' ability to profit from higher prices.
- In Timor- Rainwater is collected and maize is farmed during the wet season. If the wet season becomes shorter, this may limit chances to collect water, and shorten the season for farming corn.
- As pests are common during the wet season in both communities, a shorter wet season may mean fewer pests.



Uaitamaco seasonal calendar

In Timor seasonal calendar

* This map was created as part of the 'Assessment of Potential Climate Change Impacts and Adaptation Options for Timor Leste's Coastal Economy' project.

This research was conducted by WorldFish under the project 'Responding to Climate Change using an Adaptation Pathways and Decision-making approach'. This lies within the ADB/GEF funded initiative 'RETA 7153 - Strengthening Coastal and Marine Resources Management in the Coral Triangle of the Pacific (Phase 2)'. *Scoping material and some contributions at the community level were drawn from 'Assessment of Potential Climate Change Impacts and Adaptation Options for Timor Leste's Coastal Economy' funded under the Australian Government Coral Triangle Initiative Support Plan. This poster details activities conducted in the 'Identifying Options' phase of the community participatory research (see the pink box in the small picture on the left, and Poster number 1 in this series). For further details visit: http://www.worldfishcenter.org/resource_centre/WF_3110.pdf

Poster 4 Climate impacts on livelihood activities & adaptations in Atauro, part 1.

TIMOR LESTE- Atauro sub-district
Adapting to Climate Change

WorldFish

Climate Impacts on Livelihood Activities & Adaptations

What are the likely impacts of projected future changes in climate on fishing and farming?

The communities of Atauro and Beloge each identified possible climate change impacts on fishing and farming activities. All the adaptations were about improving the management of natural resources essential to fishing and farming by:

- Using less of a natural resource, reducing the use of deadwood for fire.
- Improving the resilience of a resource, e.g. increasing the amount of nutrients in the soil.
- Increasing access to a limited resource so that more sustainable practices can be adopted, e.g. enabling fishing in deeper waters to relieve the pressure on inshore fisheries.

The adaptations identified by both communities are about improving the quality and sustainability of their natural resources, essential to their fishing and farming livelihoods.

How do the children of Atauro want their fishing & farming communities to look in the future?

The pictures drawn by the children of Atauro show how they would like their community's natural resources to look in the future.

How can fishers & farmers adapt to these impacts?

To decide which adaptations to evaluate further, local authority community members of Atauro considered:

- What adaptation themes would help build the youth's vision of their communities?
- Which adaptation themes had already been chosen by the communities as important for responding to climate change?

This led to two fishing-related and farming-related adaptations being evaluated from a social, economic or environmental perspective.

Atauro fisheries:

- Special regulation to improve the condition of nearshore coral fisheries.
- Enhanced utilization of deep water fisheries (e.g. using echo sounders and fish aggregating devices (FADS)), and including training and knowledge from courses and overseas trips.

Atauro agriculture:

- Better water management through improved collection during the wet season, storage and delivery to crops and animals.
- Enhanced knowledge and training for improved agricultural production techniques.

This research was conducted by WorldFish under the project: 'Responding to Climate Change using an Adaptation Pathways and Decision-making approach'. This lies within the ADB/GEF-funded initiative ID CDTA 7453: 'Strengthening Coastal and Marine Resources Management in the Coral Triangle of the Pacific (Phase 2)'. *Scoping material and some contributions at the community level were drawn from: 'Assessment of Potential Climate Change Impacts and Adaptation Options for Timor Leste's Coastal Economy' funded under the Australian Government Coral Triangle Initiative Support Plan. This poster details activities conducted in the 'Identifying Options' phase of the community participatory research (see the pink box in the small picture on the left, and Phase number 1 in the series). For further details visit: http://www.worldfishcentre.org/resource_centre/WF_3170.pdf

Poster 5 Climate impacts on livelihood activities & adaptations in Atauro, part 2.

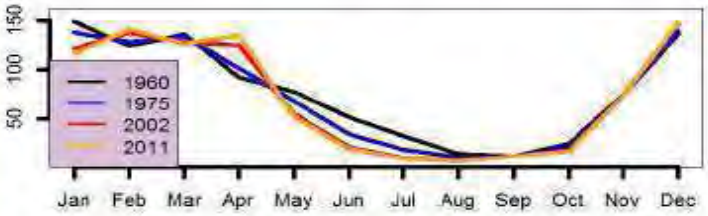
TIMOR LESTE- Batugade sub-district Adapting to Climate Change

WorldFish

Climate Impacts on Livelihood Activities & Adaptations

Rainfall and temperature information was collected for Timor-Leste and analyzed using statistical and data modeling software. This was then compared to observations gathered from fishers and farmers in Timor-Leste and projections of future climate from sources in Australia (ABoM and CSIRO). Using this information, impacts on fishing and farming activities were estimated. Additionally, children from the community came together to imagine the future of the natural resources in the community, drawing their ideas and sharing them with the community. These visions and thoughts on impacts were used by a selection of community decision-makers to identify which adaptations to climate change should be evaluated.

What climate trends have fishers & farmers seen over the past 60 years?



These graphs display monthly rainfall measured in Dili from 1960 to 2011. Each colored line represents an average of the rainfall pattern seen in each year. This graph shows that over the last 50 years, the dry season is starting earlier in the year.

The black line shows how much rain fell in each month of 1960. The lowest point of the line is in August – this shows when the dry season was happening in 1960. The yellow line shows how much rain fell in 2011.

See how the yellow line begins to drop around two months earlier than in 1960. This means the dry season has been starting earlier in the year in more recent times.

How do past trends align with future projections?

The following table shows climate trend analysis and future climate projections. Trend analysis is looking at the patterns of rainfall and temperature as they've changed over the years. Projections of climate change are estimates of how the weather may change in the future.

The left column shows climate trends observed since 1960; the right column shows projections for the future. As the past trends are similar to the projections for the future, we may expect these trends to continue in the future.

Trend analysis	Projections of climate change
Long-term trend in annual rainfall has been relatively stable over the past 60 years	Little change in total annual rainfall over the course of the 21st century.
Average dry season rainfall has fallen quite substantially in recent decades	Reduced quantity of rainfall in the dry season
Average rainfall in the wet season has perhaps risen slightly	Increased quantity of rainfall in the wet season
On average, the start of the dry season (as defined by a monthly rainfall level of less than 20 mm), has shifted approximately 45 days earlier over the past 60 years.	No projections given for the onset of the dry season, however it is noted that El Niño events generally bring drier conditions to Dili and often lead to a late onset and early finish to the wet season. "There is no consistency in projections of future ENSO activity."
There is a tendency for terrestrial air temperatures to be warmer during the wet season, than in the dry season months.	No projections provided for monthly temperatures.
The duration of the cooler season has contracted between 1900 and the present day for both sea surface and air temperature. This has coincided with an expansion of the warmer season in marine temperatures.	Increase in inter-annual surface air temperatures (and sea-surface temperature)
Marine temperatures (sea surface and air temperature) have increased over the past century, across almost all months.	Increase in annual surface air temperature (and sea-surface temperature)

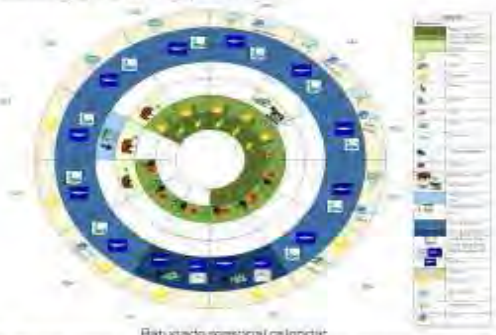
How does the current climate influence fishing & farming activities?

Batugade seasonal calendar

This calendar shows the type of weather, and fishing and farming activities for each month of the year. This helps us to estimate which fishing and farming activities may be affected by future climate changes.

Examples:

- Water related issues happen near the end of the dry season in October. If the dry season expands, then these water problems will also occur for a longer period of time.
- Pumpkin is farmed in November, the traditional start of the wet season. If the wet season starts later in the year then pumpkin farming will likely be delayed.
- As sardines are fished all year round, this activity is less likely to be impacted by changes in weather patterns. But other changes, such as sea temperature and acidity may impact all fish species in the future.



Batugade seasonal calendar

* This map was created as part of the 'Assessment of Potential Climate Change Impacts and Adaptation Options for Timor Leste's Coastal Economy' project.

This research was conducted by WorldFish under the project 'Responding to Climate Change using an Adaptation Pathways and Decision making approach'. This lies within the ADB/GEF funded initiative (Grant 7753 - 'Strengthening Coastal and Marine Resources Management in the Coral Triangle of the Pacific (Phase2)'). 'Scoping material and some conclusions at the community level were drawn from 'Assessment of Potential Climate Change Impacts and Adaptation Options for Timor Leste's Coastal Economy' funded under the Australian Government Coral Triangle Initiative Support Plan. This poster details activities conducted in the 'Identifying Options' phase of the community participatory research (see the pink box in the small picture on the left, and Poster number 1 in this series) For further details visit: http://www.worldfishcenter.org/resource_centre/WF_3170.pdf

Poster 6 Climate impacts on livelihood activities & adaptations in Batugade, part 1.

TIMOR LESTE- Batugade sub-district Adapting to Climate Change

WorldFish

Climate Impacts on Livelihood Activities & Adaptations

What are the likely impacts of projected future changes in climate on fishing and farming?

The communities of Atauro and Butagade, each identified possible climate change impacts on fishing and farming activities. All the adaptations were about improving the management of natural resources essential to fishing and farming by:

- Using less of a natural resource, reducing the use of deadwood for fire
- Improving the resilience of a resource, e.g. increasing the amount of nutrients in the soil
- Increasing access to a limited resource so that more sustainable practices can be adopted, e.g. enabling fishing in deeper waters to relieve the pressure on inshore fisheries

The adaptations identified by both communities are about improving the quality and sustainability of their natural resources, essential to their fishing and farming livelihoods.

How do the women farmers want their fishing & farming communities to look in the future?

"Visioning" can be a useful tool for building agreement amongst community members, and creating a shared understanding of the goals of undertaking adaptation actions.

Asking younger members of the community to provide their vision of a desirable future recognises the importance of managing natural resources for the next generation to use and enjoy.

The pictures drawn by the women farmers of Lotan show how they would like **their community's nature** resources to look in the future.

How can fishers & farmers adapt to these impacts?

To decide which adaptations to evaluate further, local authority community members of Batugade considered:

- What **adaptation themes would help build the women's vision of their communities?**
- Which adaptation themes had already been chosen by the communities as important for responding to climate change?

This led to two fishing-related and farming-related adaptations being evaluated from a social, economic or environmental perspective.

Batugade fisheries:
- Increase ability to fish different species using new technologies and skills.
- Improve income and food production from non-fishing activities like aquaculture.

Batugade agriculture:
- Increase production of trees, crops and animals using sustainable agriculture methods
- Improve income and food production from improved management of water collection, storage...

This research was conducted by WorldFish under the project 'Responding to Climate Change using an Adaptation Pathways and Decision-making approach'. This lies within the ADB/GEF funded initiative 'e-CORAL / RAS - Strengthening Coastal and Marine Resources Management in the Coral Triangle of the Pacific (Phase 2)'. *Scoping material and some contributions at the community level were drawn from: 'Assessment of Potential Climate Change Impacts and Adaptation Options for Timor Leste's Coastal Economy' funded under the Australian Government Coral Triangle Initiative Support Plan. **This poster details activities conducted in the 'Identifying Options' phase of the community participatory research (see the pink box in the small picture on the left, and Poster number 1 in this series).** For further details visit: http://www.worldfishcenter.org/resource_centre/WF_3740.pdf

Poster 7 Climate impacts on livelihood activities & adaptations in Batugade, part 2.

TIMOR LESTE
Adapting to climate change

WorldFish

Using Sustainable Agriculture Practices to adapt to climate change

Community members and leaders in Atauro and around Batugade have participated in a number of activities to answer questions about the likely impacts of climate change on their fishing and farming activities.

They also identified possible adaptation actions and provided information to enable some adaptations to be evaluated from a social, economic or environmental perspective. Here are the agriculture-related adaptations they considered:

Adaptations identified for Atauro:

- Improved collection of water (during the wet season), its storage, and delivery to crops and animals
- Enhanced knowledge and training for improved agricultural production techniques

Adaptations identified for around Batugade:

- Increase production of trees, crops and animals using sustainable agriculture techniques (including training)
- Improve income and food production from improved management of water harvesting, storage and distribution

Community members and leaders in Atauro participating in activities to answer questions about the impact of climate change and how to adapt.

Community members and leaders in Batugade participating in activities to answer questions about the impact of climate change and how to adapt.

Which sustainable agriculture practices will help farmers in Atauro respond to the challenges of a changing climate?

- Continue to manage perennial gardens for food and source of natural pest control, crop pollination, etc;
- Reduce bare ground with leaf litter and crop trash (e.g. use banana leaves as ground cover, mulch, or compost);
- Integrate livestock better (e.g. for manure, pest control, weed removal);
- Do not burn off crop trash after harvest;
- Improve capture, storage and distribution of water;
- Use woody debris (e.g. branches and tree stumps) to reduce flow of nutrients and soil away from gardens.

Branches used to block flow of nutrients and soils away from gardens.

Reduce bare ground nutrient loss caused by burning off ground cover after harvest.

Which sustainable agriculture practices will help farmers in Batugade respond to the challenges of a changing climate?

- Continue to manage perennial gardens for food and source of natural pest control, crop pollination, etc;
- Plant perennial and annual gardens closer together so natural predators, like spiders, move between them and control pests;
- Increase annual garden plant variety (e.g. more plant species, intercrop, add shade trees, reduce bare ground with leaf litter (e.g. collect from plantations), and crop trash compost;
- Improve use of plantations by growing a ground storey of shade tolerant perennial crops;
- Use chickens and other animals for manure and pest control;
- During wet season: improve water capture, storage and distribution in annual gardens;
- Do not burn off ground cover after harvest;
- Use more drought-tolerant crops, like maize;
- Avoid over-grazing with livestock in woodland;
- Use fences to manage livestock, avoid over-grazing and increase benefits from manure collection and pest control;
- Use leaf litter from plantations to make mulch and compost;
- Use woody debris (e.g. branches and tree stumps) to reduce the flow of nutrients and soil away from gardens.

Use fences to manage livestock, avoid over-grazing and increase benefits from manure collection and pest control

Use leaf litter from plantations to make mulch and compost.

This research was conducted by WorldFish under the project 'Responding to Climate Change using an Adaptation Pathways and Decision-making approach'. This lies within the ADB/GEF funded initiative (RETA 7153 'Strengthening Coastal and Marine Resource Management in the Coral Triangle of the Pacific (Phase 2)'. 'Scoping material and some contributions at the community level were drawn from 'Assessment of Potential Climate Change Impacts and Adaptation Options for Timor-Leste's Coastal Economy' funded under the Australian Government Coral Triangle Initiative Support Plan. This poster details activities conducted in the 'Evaluation of Options' phase of the community participatory research (see the pink box in the small picture on the left, and Poster number 1 in this series). For further details visit: http://www.worldfishcenter.org/resource_centre/WF_3170.pdf

Poster 8 Using sustainable agriculture practices to adapt to climate change, part 1.

TIMOR LESTE
Adapting to climate change

WorldFish

Using Sustainable Agriculture Practices to adapt to climate change

Who is necessary to facilitate the effective planning, implementation and on-going application of sustainable agricultural practices?

Community members and leaders in Ataúro and around Batugade participated in an activity to identify social networks in their community. The social networks can be used to identify who is necessary to help farmers plan, implement and maintain sustainable agricultural practices.

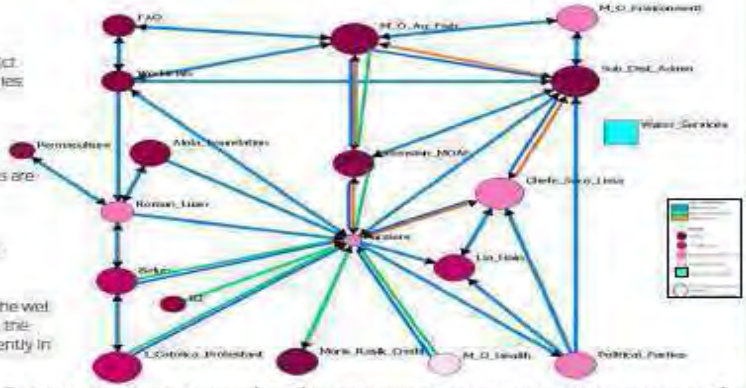
The social networks show the important people and groups (shown as circles on the diagram) needed for providing information and support, and help solving problems. A social network was produced by the community members and leaders for farmers whose aim is earning enough income from farming to support their daily lives and improve their family welfare.

Community members and leaders in Ataúro participating in drawing a social network for farmers.

Community members and leaders in Batugade participating in drawing a social network for farmers.

Ataúro:

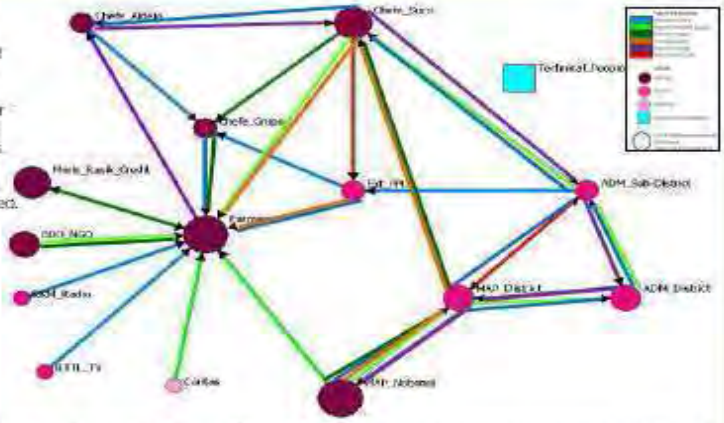
- Key people influencing farming in Ataúro are: the Sub-District Administrator, Suco Chief, Ministry of Agriculture and Fisheries and Catholic and Protestant Churches.
- The Sub-District Administrator and Suco Chiefs receive information from farmers and pass it to higher levels of governance, playing an important role in ensuring programs are implemented to address community needs.
- The Ministry of Agriculture and Fisheries provides useful programs, training and equipment, such as seeds and hand tractors.
- If farmers want to improve their collection of water during the wet season, its storage and transportation to crops and animals, the national water services will be important. They are not presently in the farmers' social network, so this link needs to be made.



Social network produced for farming in Ataúro. The size of the circles show how important each person or group is. The different coloured lines show how the people and groups are linked and what flows between them.

Batugade:

- Key people influencing farming in Batugade are: the Ministry of Agriculture at the national level and other farmers.
- The national level of the Ministry of Agriculture has control over making things happen for farmers, but decisions about how to undertake agriculture can be influenced by farmers themselves.
- If farmers want to improve the productivity of their agriculture, technical help from outside the farming social network is needed.



Social network produced for farming in Batugade. The size of the circles show how important each person or group is. The different coloured lines show how the people and groups are linked and what flows between them.

This research was conducted by WorldFish under the project 'Responding to Climate Change using an Adaptation Pathways and Decision making approach'. This ties within the ADB/GEF funded initiative (FCDRA 7153) 'Strengthening Coastal and Marine Resources Management in the Coral Triangle of the Pacific (Phase 2)'. *Scoping material and some contributions at the community level were drawn from 'Assessment of Potential Climate Change Impacts and Adaptation Options for Timor-Leste's Coastal Economy' funded under the Australian Government Coral Triangle Initiative Support Plan. This poster details activities conducted in the 'Evaluation of Options' phase of the community participatory research (see the pink box in the small picture on the left, and Poster number 1 in this series). For further details visit: http://www.worldfishcentre.org/resource_centre/WF_3170.pdf

Poster 9 Using sustainable agriculture practices to adapt to climate change, part 2.

TIMOR LESTE
Adapting to climate change
Adapting fishing activities to respond to a changing climate

What are the impacts of a continuation of past trends in climate and projections of future climate on fishing communities in Timor-Leste?

Workshop held in Ataúro with community members. Impacts of a changing climate on fishing and farming was considered, along with possible ways to adapt.

In workshops held in Ataúro and Batugade, community members identified 13 possible impacts that may result if many of the past trends in climate continue into the future, as projections suggest. The impacts include:

- increasingly earlier start date to the dry season
- increase in surface air temperature (and sea surface temperature);
- increase in rainfall in the wet season;
- trend for a longer dry season;
- increase in sea level;
- shorter wet season.

Workshop held in Batugade with community members. Impacts of a changing climate on fishing and farming was considered, along with possible ways to adapt.

The children in Ataúro drew pictures of what they wanted their communities' fishing and farming natural resources to look like in the future. Note that the large fish is a feature of this picture.

How can fishing communities adapt to a change in future climate?

Fisherman in Ataúro repairing a boat.

Communities in Ataúro and Batugade identified adaptations to respond to a changing climate. The following adaptations were later identified for economic and social evaluation:

Ataúro:

-Special regulation to enhance the condition of nearshore (coral) fisheries

-Enhanced utilisation of deep water fisheries (e.g. through the use of echo sounders and fish aggregating devices (FADS), including training and knowledge via courses and overseas trips)

Batugade:

-Increase ability to fish different species using new technologies and skills

-Improve income and food production from non-fishing activities, such as aquaculture

Fisherman in Batugade preparing for a fishing trip

This research was conducted by WorldFish under the project "Responding to Climate Change using an Adaptation Pathways and Decision making approach" This lies within the ADB/GEF funded initiative: R CDTA 7153 : Strengthening Coastal and Marine Resources Management in the Coral Triangle of the Pacific (Phase 2). "Scoping material and some contributions at the community level were drawn from "Assessment of Potential Climate Change Impacts and Adaptation Options for Timor Leste's Coastal Economy" funded under the Australian Government Coral Triangle Initiative Support Plan. This poster details activities conducted in the Evaluation of Options' phase of the community participatory research (see the pink box in the small picture on the left, and Poster number 1 in this series). For further details visit: http://www.worldfishcenter.org/resource_centre/WF_3170.pdf

Poster 10 Adapting fishing activities to respond to a changing climate, part 1.

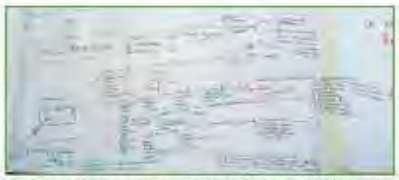
TIMOR LESTE
Adapting to climate change

WorldFish

Using fishing activities to adapt to climate change

What are the key decisions and design steps needed to enhance the practice of deep water fisheries?

Fishers in Atauro helped to evaluate if enhancing the ability of fishers to use deep water fisheries was a useful response to climate change impacts. First, the fishers determined the key decisions and design steps needed to fish in the deeper waters.



This decision tree for offshore fishing adaptation was developed by local authority level community members during a focus group discussion. It shows the different decisions and possible options involved in adapting present-day fishing activities to enable greater utilisation of deep water species.

Fishers need to decide if they will:

- Explore the rumpong (fish aggregating devices) fishing method;
- Use the pool landline fishing method;
- Use the modern net fishing method;
- Use the longline fishing method;
- Continue the traditional fishing method.

For each option, the fishers provided details of the possible costs of using the different fishing methods and the fish species that they might catch. From this the economic cost and benefits were estimated.

This one kind of modern fishnet

Costs and benefits calculated for different ways to fish offshore. This was produced by by fishermen in Biqueli village, Atauro

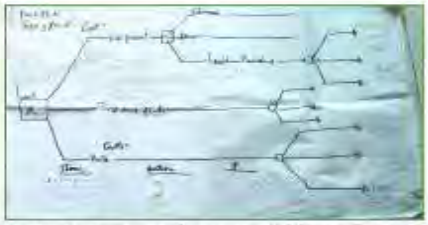
This table lists the cost and benefits of each fishing method. (further financial analysis is required before investments are made):

Method	Cost per year	Cost or benefit per dollar invested
Longline	$17,178	benefit of $0.41
Traditional fishing methods	$4,250	benefit of $0.33
Modern net fishing	$4,423	loss of $0.13
Pool landline fishing methods	$12,802	loss of $ $0.30
Rumpong	$23,880	

This first attempt at estimating costs and benefits shows traditional fishing methods are the cheapest, costing $4,250 per year. For each dollar invested in traditional fishing methods, there is a return of $0.33. The longline method provides a benefit of $0.41 for each dollar invested, costing $17,178 per year. This is four times more than the start-up costs for the traditional method. The rumpong method costs $23,880 per year. Due to the risks and uncertainties, the cost or benefit per dollar for this method could not be estimated.

What are the key decisions and design steps that need to be taken in order to develop aquaculture?

Adapting to climate change by developing aquaculture was evaluated together with fish farmers in Leohito village, Baibol. This suco was chosen, as there are already some aquaculture ponds established in Leohito. First, the fish farmers determined the key decisions and design steps needed to develop an aquaculture pond.



This decision tree for aquaculture development adaptation was developed by fish farmers during a focus group discussion in Leohito village, Baibo sub-district, Timor-Leste. It shows the different decisions and possible options involved in converting suitable land into aquaculture ponds.

Some land that could be used for aquaculture is already being used to grow rice, or could be used to grow rice in the future. Because of this, potential aquaculturalists need to firstly decide if they want to:

- use land for pond aquaculture;
- use land to grow rice;
- use land for rice and fish culture.

If they decide to develop aquaculture, they must determine if it will be:

- intensive aquaculture;
- semi-intensive aquaculture;
- the traditional aquaculture method.

For each combination of options, the fishers provided details of the possible start-up costs and the fish species likely to be used. From this, the economic cost and benefits were estimated.

Aquaculture ponds in Leohito village, Baibo

This table shows the cost and benefits for growing rice and fish (further financial analysis is required before investments are made):

Method	Cost per year	Cost or benefit per dollar invested
Fish pond (100m²)	$195	benefit of $0.28
Rice field (100m²)	$90	loss of $0.27

In these first estimates aquaculture appears to be the best financial option if there is land available, but more robust estimates of costs and benefits would help understand if aquaculture is a cost effective adaptation to a changing climate.

This research was conducted by WorldFish under the project "Responding to Climate Change using an Adaptation Pathways and Decision-making approach". This ties within the ADB/GEF funded initiative (RETA 7353 - "Strengthening Coastal and Marine Resources Management in the Coral Triangle of the Pacific (Phase 2)". "Scoping materials and some contributions at the community level were drawn from "Assessment of Potential Climate Change Impacts and Adaptation Options for Timor Leste's Coastal Economy" funded under the Australian Government Coral Triangle Initiative Support Plan. This poster details activities conducted in the 'Evaluation of Options' phase of the community participatory research (see the pink box in the small picture on the left, and Poster number 4 in this series). For further details visit: http://www.worldfishcentre.org/resource_centre/WF_3710.pdf

Poster 11 Using fishing activities to adapt to climate change.

TIMOR LESTE
Adapting to climate change

WorldFish

Adapting fishing activities to respond to a change in climate

Who is necessary to facilitate the effective planning, implementation and on-going use of adaptations to fishing practice?

Community members and leaders in Ataúro drawing a social network for fishers to consider who will help them adapt to climate change

Community members and leaders in Ataúro and around Batugade participated in an activity to identify social networks operating in their community. The social networks can be used to identify who is necessary to help farmers plan, implement and maintain fishing adaptations to respond to climate change.

The social networks show the important people and groups (shown as circles on the diagram) needed for providing information and support, and helping solve problems. A social network was produced by the community members and leaders for fishers whose aim is to earn enough income from fishing to support their daily lives and improve their family welfare.

Community members and leaders in Batugade drawing a social network for fishers to consider who will help them adapt to climate change

Who is necessary to facilitate the effective adaptation of fishing practices to climate change?

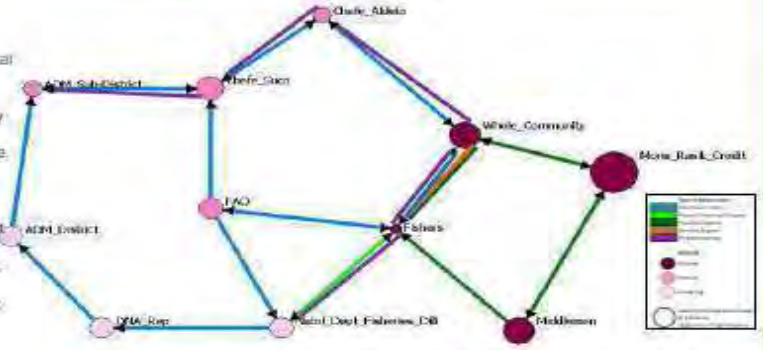
Ataúro:

- The National Environment Department, Suco Chiefs, Local Authority, Catholic Church, and Protestant Church are key actors within the Ataúro fishing network. They help fishers to achieve their goals.
- The Local Authority group includes District Administrator, Sub District Administrator, and National Sectors (education, health, police, rural development, fisheries and agriculture). They are a source of information for the community on agriculture and fisheries. They generally do not distribute money directly, but help in skills training.
- The Catholic and Protestant Churches are important for socializing information.
- International organisations, the Maritime Police and the Defence Force may need to be integrated into the fishing network if either special regulation was used to improve the condition of nearshore (coral) fisheries, or steps were taken to enhance the utilisation of deep water fisheries.

A social network was produced for fishing practices in Ataúro (produced by community members and leaders). The lines show the present flows of information, services (such as financial, physical and support services), and pathways for seeking help to solve problems.

Batugade:

- Mons Rasik are important in the fishing community social network in Batugade as they provide credit to women.
- Middlemen are also important in the fishing community social network, as is the support provided by the community in general. Both help the sale of fish, and the community helps to unload the catch when the haul is large.
- If the fishers wish to increase their ability to fish different species using new technologies and skills, and improve income and food production from non-fishing activities, such as aquaculture, they will need the support and cooperation of middlemen and the broader community.



A social network was produced for fishing in Batugade (similar to above).

This research was conducted by WorldFish under the project "Responding to Climate Change using an Adaptation Pathways and Decision-making approach". This lies within the ADB/GEF funded initiative (RETA 7753 - Strengthening Coastal and Marine Resources Management in the Coral Triangle of the Pacific (Phase 2)). "Scoping historical and some contemporary (at community level) were drawn from 'Assessment of Potential Climate Change Impacts and Adaptation Options for Timor-Leste's Coastal Economy' funded under the Australian Government Coral Triangle Initiative Support Plan. This poster details activities conducted in the Evaluation of Options phase of the community participatory research (see the pink box in the small picture on the left, and Poster number 1 in this series). For further details visit: http://www.worldfishcenter.org/resource_centre/WF_3170.pdf

Poster 12 Adapting fishing activities to respond to a changing climate, part 2.

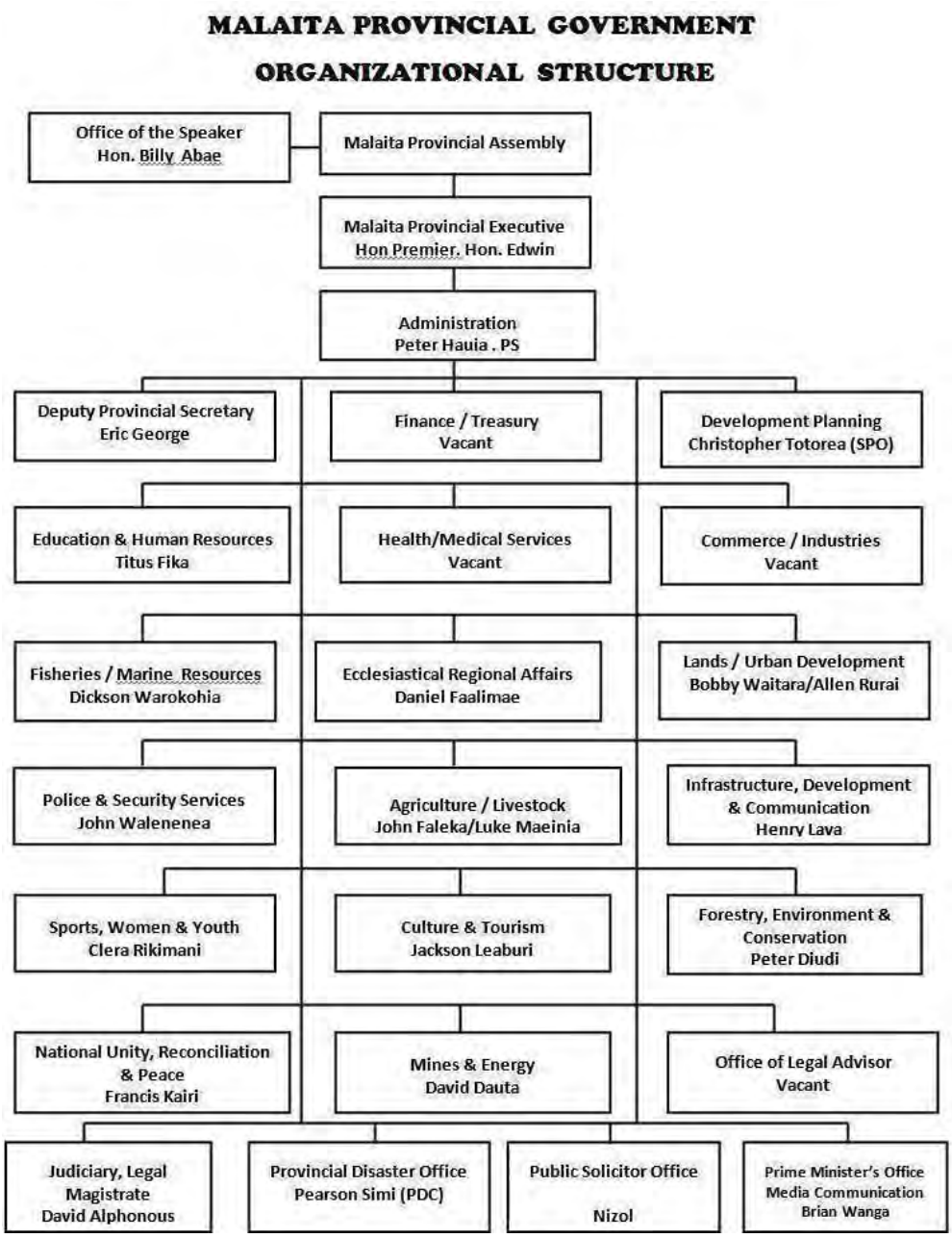
Appendix 6: Workshop details for Auki, Malaita, Solomon Islands

Time	Activity
0900h	**1. Arrival and introductions** • **Complete consent form** • **Ask participants to make location on map (adding sheet number)** • **Make label with name written on it**
0915h	**2. Official Opening**
0925	**3. Welcoming remarks and introduction of partners, staff and participants.** Consent – read out and get verbal agreement Project team introduce themselves and explain their interest in providing information on climate and particularly exploring aquaculture as one of many ways to respond to changes in climate. Very quick run through of what we did in TL as an example of the activities planned for today and next few days around Auki
0945	**4. Climate change** 4(a)Introduction to climate change – what does this mean? [Aim: explain why the climate is change slowly over time] 4(b) How the climate in Solomon Islands is changing (observed data) [Based on work put together by the Solomon Islands government and the Australian government prepared and presented by the HQ team – is this observed or projected???] - show analysis of what temperature and rainfall has been doing around the Maliata region over the past decades. [Aim: bring the idea of climate change down to regional scale for participants] Plenary question: *Has anybody seen changes happening in climate (temperature, rainfall, wind, etc) or sea level since they were a child? Please describe the changes and how your farming has changed in response.* 4(c) Projections of future climate [Aim: to show what climate scientists think is likely to happen with climate in the future]. Plenary question: *How do you think any future changes in climate (temperature, rainfall, wind, etc) or sea level may affect how you farm or how people fish?*
1030	Coffee/Tea break
1100	**5. Aquaculture and climate change** Orientation to this next session (and rest of day) [Aim: acknowledge shift in focus to aquaculture and need to explain where we are going with this] Need to introduce this session by: (a) briefly mentioning aquaculture as being one of the many ways people in the region are exploring to respond to changes, such as climate, and others (decline in availability of fish from coral fisheries, increasing population demand for fish); (i) colleagues in WF have been providing technical info – we will explore how climate change may impact aquaculture and what can be done to respond;

	Aquaculture and climate change participatory session [Aim: Activity to explore how aquaculture might be impacted by, or respond to, the challenges of a continuation of past trends in rainfall and temperature, and projected changes.] Talk through slide showing '***generic***' direct and indirect impacts and poss ways to adapt (draw from SP/SS literature review) Focus group session: Ask participants to split into two groups and for the each of the past trends/projections, state what they think will be the impact/adaptation for their ***specific context***.
1100	**5. Aquaculture and climate change continued** Continuation of focus group session Feedback session: A member from each group to present key points from their discussion
1200	**LUNCH (**Payment for transport)
1245	**6. Different scenarios (visions) for aquaculture development [Aim: explore different ways that aquaculture may develop through the region and get participants feedback on these, with a view to amending where necessary]** Two scenarios presented: (a) Progression of skills/experiences going from (i) Mozambique tilapia, *Oreochromis mossambicus*; (ii) milk fish (*Chanos chanos*); (iii) Nile **tilapia**, *Oreochromis niloticus*; (b) Nikera et al. (2011) Focus group session: Divide into groups, with each group considering one scenario and consider if it needs refining – NT to design questions to be posed during this session Feedback session: One member from each group nominated to feedback response to scenarios.
1345	**7. Evaluation of Aquaculture session** Orientation to this next session (and rest of day) [Aim: acknowledge shift in focus to evaluating aquaculture from a social and environmental perspective] Need to introduce this session by saying that we are going to explore 2 things: (i) The different people that may be needed to help aquaculture be successful (social network analysis – refer to results poster from TL); (ii) How good management of the environment may need to be considered if aquaculture is to be a viable long-term activity (ecosystem services – refer to results poster from TL) But we cannot fit in both activities, so will ask the group to split into two different groups, and each take a task. Focus group 1: Social Network Analysis Focus group 2: Mapping of natural assets important for the long-term viability of aquaculture (and other livelihood activities) Feedback session: One member from each group nominated to feedback details of

	social network (Group 1) and natural assets mapping (Group 2) to the workshop.
1530	**Afternoon Tea**
1545	**What next?**
1600	Wrap up of the day, Closing

Appendix 7: Staffing structure of Malaita Provincial Government



Appendix 8: Excerpts from Govan et al 2013, the preliminary governance assessment

Issues and opportunities raised are framed using the modified PROFOR tool distinguishing the levels of governance to which they pertain and the features discussed in the characterization. (From Govan et al 2013).

Analysis of AAS governance issues using PROFOR (2011) framework at the community level as discussed in the text. Features and issues raised by participants in the SCW or CCW are italicized, others were identified during scoping. Symbols: strengths (+),weaknesses (-) and Priority Issues.

	Policy, regulatory, institutional and legal frameworks	Planning and decision-making processes	Implementation, enforcement and compliance
Community level	*+Strong recognition of customary tenure and rights over resources.* *+Traditional and community leadership institutions recognized though eroding* +Customary reciprocity and benefits sharing mechanisms *-Tenure and leadership undocumented and areas of confusion or dispute increasingly arising* *-Little representation of communities in policy development and higher level planning* -Hard to control financial incentives towards unsustainable resource exploitation	*+Relatively strong customary and community processes for planning and decision making* +Traditional and local knowledge is a major asset *+Some communities have NGO support for planning* *+/-Customary conflict management processes vary in effectiveness and are eroding under pressure* *-Lack of participation of government or provincial authorities* *-Lack of information provision from higher levels of government (eg mangrove management)* *-Some areas of traditional knowledge concerning management of resources under pressure are inadequate (need education, info etc)* *-Lack of participation of women in marine resource and garden planning decisions*	*+Customary and community enforcement, conflict resolution and sanctions is carried out in many / some communities without external support* +Local observations and knowledge used for M+E *-Local enforcement faces challenges from some community members and from commercial / artisanal fishing interests from other communities.* -Local management is not necessarily supported by government or police – though it can in legal principle *-Little or no support from national or provincial agencies* *-Increasing land disputes and lack of land use planning hard to handle at local level* *-Local courts needs more support or encouragement*

Analysis of AAS governance issues using PROFOR (2011) framework at sub-national level as discussed in the text. Features and issues raised by participants in the SCW or CCW are italicized, others were identified during scoping. Symbols: strengths (+),weaknesses (-) and Priority Issues.

	Policy, regulatory, institutional and legal frameworks	Planning and decision-making processes	Implementation, enforcement and compliance
"District" level	*+Traditional networks and relations between communities* -No formal district political institutions- potentially ward development committees -Often large differences between coastal and terrestrial social groups	*+Some informal or civil society mechanisms for discussion (church, traditional links, NGO projects or networks, councils of chiefs/leaders)* -No formal district level processes – potentially under forthcoming provisions for ward development plans	*+Some use of traditional and revived networks (e.g., council of chiefs, church) to address wider area issues and rule breaking from outside individual communities [alluded to slightly by CCW]* *-In some places, no functioning Council of chiefs although a recognized desire amongst some for this to be formalised*
Provincial level	*+ Provincial government with delegated responsibilities on fisheries and natural resources* *-Provincial government lacks*	+Increasing commitment of donors and government to strengthen provincial governments -Inadequate provisions	+Increasing capacity and budgets an opportunity for a greater role for in resource management +Provincial and sub provincial networks(mainly civil society)

	Policy, regulatory, institutional and legal frameworks	Planning and decision-making processes	Implementation, enforcement and compliance
	resources *-Lack of provincial ordinance and/or integrated management plans* -Inadequate revenue raising provisions esp. from natural resources	and resources for management planning *-Inadequate flow of information from government and communities*	provide avenues for information sharing and some collaboration on enforcement *-Little current provincial coordination or support for resource management, land use planning, extension services*

Analysis of AAS governance issues using PROFOR (2011) framework at national level as discussed in the text. Features and issues raised by participants in the SCW or CCW are italicized, others were identified during scoping. Symbols: strengths (+),weaknesses (-) and Priority Issues.

	Policy, regulatory, institutional and legal frameworks	Planning and decision-making processes	Implementation, enforcement and compliance
National level	+Clear legal recognition of terrestrial customary tenure +Supportive policy emerging in fisheries, environment and climate change sector for community governance of resources +National civil society networks (church, NGOs, SILMMA) +/- developing impact assessment frameworks -Institutions for coastal resource management lack capacity and appropriate structures *-Lack of functioning coordination mechanisms for government and donor support (poss. excep. NCC)* -Legislation in support of coastal resource governance inadequate or stalled -Forest and other natural resource policies only just beginning to move towards sustainable development -Weak or inexistent marine resource management plans -Inadequate safeguards against corruption and perverse economic incentives -Ministry of Fisheries has not implemented gender in Fisheries strategy or policy	+Relatively strong civil society organizations for support and oversight +/-Emerging but still inadequate processes for national consultation and planning (eg NCC, recent fisheries policy meetings) -Government procedures for supporting coastal resource management do not exist(lack of capacity and resources) -Deficient mechanisms for transparency and access to information *-Weak provision of information and sharing of experiences by government to citizens* -No formal functional oversight mechanisms -Deficient corporate responsibility eg logging companies or sea food buyers	+Government support of partnerships and networks to local achieve resource management aims +National ministries of fisheries and environment undergoing institutional strengthening to provide better local services +Ministry of Agriculture established a network of women extension officers throughout the Provinces -Little capacity of ministry and police to enforce national or local resource management rules *-Little to no capacity of judicial system to enforce local coastal resource management rules* *-Challenges to handling of land disputes* -No cross sectoral collaboration mechanisms/ no formal co-ordination between agriculture and fisheries (e.g., both currently have aquaculture initiatives)

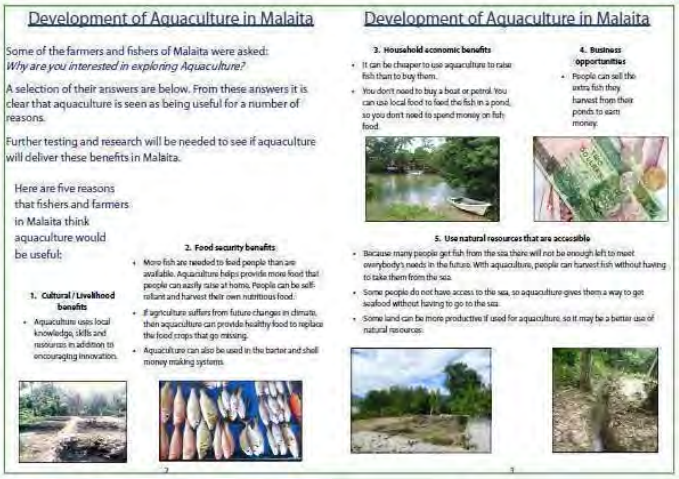
Appendix 9: Feedback booklet produced for Community of practice in Malaita interested in pond aquaculture, Workshop July 2013


Responding to climate change using an adaptation pathways and decision-making approach

A component of project ADB/GEF project R-CDTA 7753: Strengthening Coastal and Marine Resources Management in the Coral Triangle of the Pacific (Phase 2)

Synthesis of material collated from a workshop held in Auki, Malaita, Solomon Islands on Monday 13 May 2013

WorldFish, Penang, Malaysia


Development of Aquaculture in Malaita

Some of the farmers and fishers of Malaita were asked:
Why are you interested in exploring Aquaculture?

A selection of their answers are below. From these answers it is clear that aquaculture is seen as being useful for a number of reasons.

Further testing and research will be needed to see if aquaculture will deliver these benefits in Malaita.

Here are five reasons that fishers and farmers in Malaita think aquaculture would be useful:

1. Cultural / Livelihood benefits
- Aquaculture uses local knowledge, skills and resources in addition to encouraging innovation.

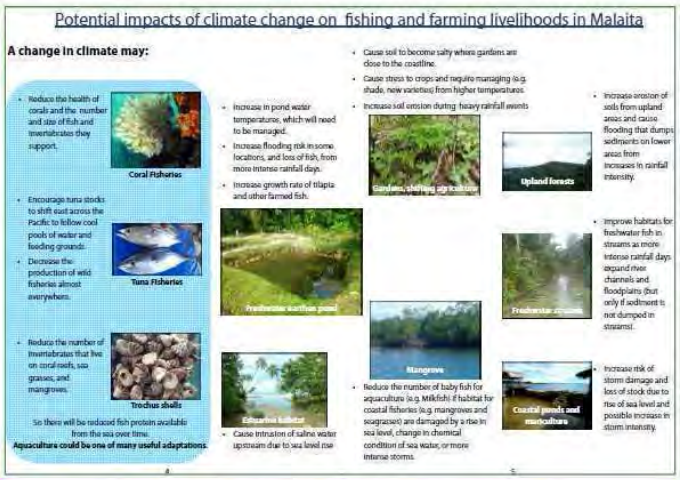
2. Food security benefits
- More fish are needed to feed people than are available. Aquaculture helps provide more food that people can easily raise at home. People can be self-reliant and harvest their own nutritious food.
- If agriculture suffers from future changes in climate, then aquaculture can provide healthy food to replace the food crops that go missing.
- Aquaculture can also be used in the barter and shell money making systems.

Development of Aquaculture in Malaita

3. Household economic benefits
- It can be cheaper to use aquaculture to raise fish than to buy them.
- You don't need to buy a boat or petrol. You can use local food to feed the fish in a pond, so you don't need to spend money on fish food.

4. Business opportunities
- People can sell the extra fish they harvest from their ponds to earn money.

5. Use natural resources that are accessible
- Because many people get fish from the sea there will not be enough left to meet everybody's needs in the future. With aquaculture, people can harvest fish without having to take them from the sea.
- Some people do not have access to the sea, so aquaculture gives them a way to get seafood without having to go to the sea.
- Some land can be more productive if used for aquaculture, so it may be a better use of natural resources.


Potential impacts of climate change on fishing and farming livelihoods in Malaita

A change in climate may:

- Reduce the health of corals and the number and size of fish and invertebrates they support.

Coral Fisheries

- Encourage tuna stocks to shift east across the Pacific to follow cool pools of water and feeding grounds.
- Decrease the production of wild fisheries almost everywhere.

Tuna Fisheries

- Reduce the number of invertebrates that live on coral reefs, sea grasses, and mangroves.

Trochus shells

So there will be reduced fish protein available from the sea over time.

Aquaculture could be one of many useful adaptations.

- Increase in pond water temperatures, which will need to be managed.
- Increase flooding risk in some locations, and loss of fish, from more intense rainfall days.
- Increase growth rate of tilapia and other farmed fish.

Freshwater earthen pond

Estuarine habitat

- Cause intrusion of saline water upstream due to sea level rise
- Cause soil to become salty where gardens are close to the coastline.
- Cause stress to crops and require managing (e.g. shade, new varieties) from higher temperatures.
- Increase soil erosion during heavy rainfall events

Gardens, shifting cultivation

Upland forests

- Increase erosion of soils from upland areas and cause flooding that dumps sediments on lower areas from increases in rainfall intensity.

Freshwater streams

- Improve habitats for freshwater fish in streams as more intense rainfall days expand river channels and floodplains (but only if sediment is not dumped in streams).

Mangrove

- Reduce the number of baby fish for aquaculture (e.g. Milkfish) if habitat for coastal fisheries (e.g. mangroves and seagrasses) are damaged by a rise in sea level, change in chemical condition of sea water, or more intense storms.

Coastal ponds and mariculture

- Increase risk of storm damage and loss of stock due to rise of sea level and possible increase in storm intensity.


Taking account of climate change in tilapia farming

Climate Change – more intense rainfall days
- Need to locate ponds close to water source (as higher temperature may increase loss of water), but avoid sites that are likely to see an increase in flooding.

Climate Change – continuation of dry season with only small amounts of rain
- Build ponds deep (>1m) for water collection in the wet months.
- Use ponds for watering home gardens in the dry season.

Climate Change – ↑ temperature
- Tilapia is a tough fish and may be able to tolerate warmer temperatures (better than other fish) if managed properly .

Climate Change – increase in sea level
- Need to locate ponds away from areas likely to be flooded by the sea during king tides.

Climate Change – ↑ temperature
- Warmer pond water temperatures can be managed by allowing cool fresh water to flow into the pond and mix with warm water, but care must be taken to keep pond green with (good) plankton to feed the fish.

Tilapia farming in Solomon Islands

Climate Change – ↑ temperature
- May experience an increase in pond temperature, low oxygen and (unhelpful) algal blooms.
- Tilapia can tolerate low oxygen for only a short time.
- Fish can suffer heat stress in shallow ponds, but escape to lower, cooler waters in deeper (1m) ponds.

Climate Change – ↑temperature
- Growth rate of tilapia may increase in warmer temperature, so you may need to harvest more regularly in time.

Climate Change – ↑ temperature
- Warmer pond water temperatures may increase diseases and pests in the fish. Sick fish should be removed and safely disposed to stop diseases and pests being passed to other fish.

Looking after the environment as you plan for and manage aquaculture and climate change

How might aquaculture be good for your environment?

- Aquaculture can help farming. Some of the water from ponds can be used on crops (as if it were irrigation).
- Ponds can be a good place to capture and store rain water during the wet season, and allow you to use it in the dry season. This may help you cope with hotter dry seasons in the future.
- Storing water in ponds may help fish keep fish cool during times of with higher temperatures.

How might aquaculture damage your Environment?

- Waste from fish and uneaten food might build up in ponds and harm fish, or run into nearby waterways and reduce water quality there.
- More water, feed and fertiliser may be needed with greater numbers of fish. Therefore, you should think about how many fish you keep in a pond, and how much water, feed and chicken manure this uses. More of these inputs could lead to lower water quality in the pond and nearby waterways.
- Leaving dead fish in ponds can lead to poor health in live fish and lower water quality and more risk of disease in your ponds. It is important to check ponds often and remove any dead fish.

8

How to make aquaculture better for the environment

- Consider where best to put fishponds — pick a good site with suitable water and soil.
- Avoid steep slopes for ponds. This can lead to soil erosion during heavy rainfall.
- Look after your pond to store water— collect rainwater, repair leaks, use pond water for irrigation of crops (nutrients in the pond water may fertilise crops).
- For crops that need lots of water (such as taro), consider planting down the slope from fishponds, so that any leaks will provide water to plant roots.
- Feed fish efficiently, so that no food is leftover and allowed to collect in ponds or nearby waterways.

9

Which land is good for aquaculture now and as the climate continues to change?

Land that is good for aquaculture now and in the future as the climate continues to change:

- Has a good water supply (streams, rivers, rainwater collection), but is unlikely to get flooded during heavy rainfall.
- Is on flat or gently sloping land (less soil erosion or water loss).
- Is close to villages with many people (closer to houses, so better security and easier to visit and manage ponds).
- Has a road or bush track nearby (better access).

Gently sloping land is a good place for aquaculture ponds

Streams and rivers provide a good supply of water

Flat and gently sloping land reduce soil erosion

Nearby roads provide access to markets

It is helpful to site aquaculture ponds close to villages

But land that is suitable for aquaculture may also be good for other livelihood options like gardening, farming and plantations. So, it is important to have a land use plan for the future when thinking about where to build your ponds.

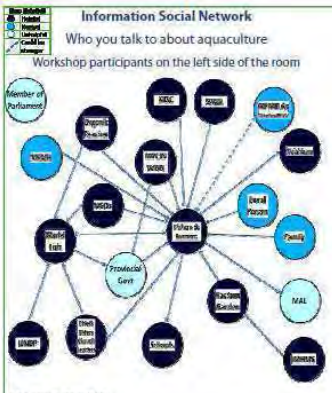
Think about how you can have enough fresh water for ponds and farmland, plantations and gardens. Also think about how you can manage for an increase in temperature and more heavy rainfall days (for example, how can you capture and store rainwater and use ponds as part of your crop irrigation).

10 11

Information Social Network

Who you talk to about aquaculture

Workshop participants on the left side of the room



This group identified:

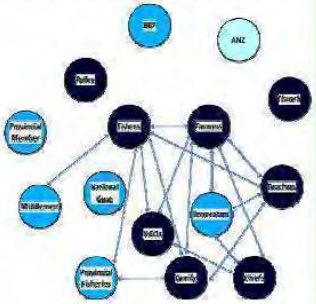
- Fishers and farmers give and receive information from lots of people.
- Additional sources of information come from MFMR, SIBC, SIWA, and neighbors

12

Information Social Network

Who you talk to about aquaculture

Workshop participants on the right side of the room



This group identified:

- A lot of information is shared between fishers and farmers themselves.

13

Appendix 10: Workshop Brochures

WorldFish has produced a series of eight brochures which taken together constitute a complete 'Methods Manual' for conducting a community-focused assessment of climate change. The eight brochures provide illustrations of the assessment activities in the remit of this project, using Timor-Leste and Solomon Island case studies as examples.

The full brochures are also available via the following links:

http://www.worldfishcenter.org/resource_center/Assessing.adaptation.to.CC.Assessment.process.pdf

http://www.worldfishcenter.org/resource_center/Assessing.adaptation.to.CC.Climate.analysis.pdf

http://www.worldfishcenter.org/resource_center/Assessing.adaptation.to.CC.Impact.and.adaptation.assessment.workshop.pdf

http://www.worldfishcenter.org/resource_center/Assessing.adaptation.to.CC.Decision-tree.and.partial.cost-benefit.analyses.pdf

http://www.worldfishcenter.org/resource_center/Assessing.adaptation.to.CC.Social.network.analysis.pdf

http://www.worldfishcenter.org/resource_center/Assessing.adaptation.to.CC.Landscape.function.analysis.pdf

http://www.worldfishcenter.org/resource_center/Assessing.adaptation.to.CC.Ecosystem.services.mapping.pdf

http://www.worldfishcenter.org/resource_center/Assessing.adaptation.to.CC.Implementation.planning.pdf

Appendix 11: Table of actor descriptions for May 2013 SNA in Malaita

Actor name Left group	**Actor name Right group**	**Attitude?**	**Description**
Fishers and Farmers	Fishers, Farmers (*listed separately*)	Helpful	• Produce food- either by growing or fishing • Influence of different individuals often relates to whether or not they have land
	Middlemen	Neutral	• Provide information to Fishers on keeping fish fresh • Negotiate prices between fishers and buyers; can be a source of credit, which must later be paid back
NGOs	NGOs	Helpful	• Work with training in rural areas around sanitation, forestry, gardening • Work on the ground with people, NGOs go to the communities more often than the government so fishers and farmers feel the NGOs are doing something • Have power to approve or reject projects, more powerful than the government (and able to influence government) • (Left group)- this actor group refers to international/national level NGOs • Examples: Solomon Islands Development Trust (SIDT), Save the Children, Red Cross, Live & Learn, Dorcas, Mother's Union
WorldFish		Helpful	• WorldFish is a research center focusing on Aquatic Agricultural Systems with offices in Honiara and Auki
MPCW WDD		Helpful	• Local women's groups that run workshops and trainings • Malaita Provincial Council of Women (MPCW) • Women's Development Division (WDD)
Kastom Gardens		Helpful	• National NGO focusing on agriculture with a community-level approach • Very active in Malaita with Lead Farmers/Extension Officers and passing information to schools • Receives funding from AusAid, Ministry of Agriculture and able to provide funds for trainings
Chiefs, Elders, and Church leaders	Chiefs, Church (*listed separately*)	Helpful	• Organizers, in some areas this is more effective than in others • No financing, but support fishers and farmers with problems or disputes
Family	Family	Neutral (*Left group*), Helpful (*Right group*)	• Provide labor • Can greatly influence the actions and decisions of other family members
Neighbors		Helpful	• Support each other with advice, help, and sometimes money as either a gift or a loan • First line of support for fishers and farmers
Schools	Teachers	Helpful	• Local schools educate the youth about the environment and conservation using the curriculum and information provided to them by the community
Organic	Innovators	Helpful	• Refers to a local farmer who has several

Actor name Left group	Actor name Right group	Attitude?	Description
Teacher			aquaculture ponds and has been especially active in both teaching/training/helping other fishers and farmers, and working with WorldFish • Shares information widely and is trusted by community
Local Person		Neutral	• Another individual in the community who shares information
SIBC		Helpful	• Solomon Islands Broadcasting Company • Local radio station that makes announcements on radio about events in town • Though not everyone has a radio, it is a good place to hear about things
	Police	Helpful	• Provide law and order, solve problems
MFMR_AQ fisheries official	Provincial Fisheries	Neutral	• Encourage good fishing and work on policies • Funding for projects seems to be diverted away sometimes • Some information from this actor has been unreliable • Fishers and farmers see the individuals in this office as generally unresponsive and unreliable
Member of Parliament		Not Helpful	• Meant to disperse community funds to the communities, but this only seems to happen around elections and to certain individuals
Provincial Govt	Provincial Members	Not Helpful (*Left group*), Neutral (*Right group*)	• Money should pass through this actor to local NGOs, but this is often unreliable • More visible to communities around elections
MFMR	National Govt	Neutral	• Ministry of Fisheries and Marine Resources • Supports provincial level MFMR offices
MAL		Not Helpful	• Ministry of Agriculture and Livestock • Fishers and farmers have given some information on projects to MAL, but otherwise this actor is not well integrated into the social networks
MHMS		Helpful	• Ministry of Health and Medical Services • Work with Kastom Gardens to create a garden at the hospital
SIWA		Helpful	• Solomon Islands Water Authority • Has worked with some fishers and farmers about land available for farming
UNDP		Helpful	• United Nations Development Program • Has programs on Climate Change and Coral/Clam farming • Can fund projects for community based organizations, but process is slow
	ANZ	Not Helpful	• Australia and New Zealand bank • If you have capital, they can be helpful; if you do not have capital then they are nor helpful
	BSP	Neutral	• Bank South Pacific • Provide funds for training; different role than ANZ

Appendix 12: Proposal for additional social network analysis workshop at the level of national and international NGOs and national government ministries

Background:

The purpose of the final project workshop in Dili on Friday 8 November was to provide a summary of activities in Timor-Leste and Solomon Islands to the attending NGO and government representatives, introduce the methods brochures, and work through an example brochure to highlight how they can be used with communities to plan climate change adaptation activities. The social network analysis brochure was selected as an example from the set of eight brochures produced by WorldFish. The plan for this activity was to work through the sections in the brochure and then to focus in on the results produced. This latter activity consisted of reflecting on the social network maps previously created by fishers and farmers in the communities of Atauro and Batugade, and discussing why the maps may be a valuable resource for communities when planning their adaptations, and the steps involved in facilitating the activity.

As we introduced the social network analysis brochure during the workshop, the participants took on board very quickly the usefulness of social network analysis as a tool for understanding the links and resources exchanged between individuals and organizations. After a short time of reviewing the fishers and farmers' social network maps, a number of participants expressed their desire to produce their own NGO and government network map. Their rationale was that if they could focus on how their various groups connected to each other, and how these connections then extend to fishing and farming communities, they would be better able to see how they could support fishers and farmers to adapt to climate change. Though this meant a rapid re-organization and expansion of the activity on the day of the workshop, the participants and facilitators agreed to trial the activity. Using the draft social network analysis brochure the participants started to construct their social network map by identifying the actors they exchanged information with in relation to their work on fishing, farming, and climate change.

As the workshop had been scheduled as a half-day event and largely aimed at socializing the brochures, and given the ad-hoc introduction of a participatory activity focused on constructing a social network map at the level of NGO and government, a complete social network map was unable to be completed on the day. The participants expressed disappointment that they were unable to complete the map and include links for the exchange of physical, support and financial services, and for problem solving. In addition, they were keen to providing their own ranking of the influence of individual actors in their network and each actor's attitude (as either helpful or not helpful) to supporting the adaptation of farmers and fishers. It was therefore requested by a number of participants that the activity be continued so as to provide an additional output from the project. This output was viewed as being valuable due to its complementarity to the work already conducted at the community level. Key supporters of this activity are noted in the table below. A few of the participants at the workshop who suggested an additional social network activity be conducted by the project and expressed particular enthusiasm to be involved.

Name	Title	Organization
Rui Pinto	Policy Manager	Conservation International
Dr. Peter Pechacek	Senior Advisor for Safeguarding Biodiversity; Associate Professor at the University of Freiburg, Germany	Timor-Leste Ministry of Commerce, Industries, & Environment, Secretariat for Environment Center for International Migration & Development
Mirko Gamez Arias	CBA Project Manager	CARE International, in Timor-Leste
Avelino Fernandes	Director	Roman Luan
Osias Soares	Executive Director	Move Forward
Samuel Bacon	Climate Change Advisor	Seeds of Life, Timor-Leste Ministry of Agriculture & Fisheries

Proposal

Local, national, and international NGOs and government departments have specifically requested assistance in creating their own social network maps so that they may better understand how to work together and facilitate resilience building in fishing and farming communities in Timor-Leste. Given an approximate underspend of US$98K of project funds as a result of project revision #2 (approved November 2013) (and including funds presently residing in the contingency line of the budget and unused flights), we propose to facilitate a social network analysis of the NGO and government departments working on climate change adaptation and resilience with fishing and farming communities in Timor-Leste in early 2014. This network will help to identify where high level institutions can support adaption of the focal communities of Atauro and Batugade.

This activity will be undertaken by two of the current project team members, Dr. Sarah Park and Dr. Simon Attwood, and two international specialists, Ms. Sharon Suri and Dr. Jon Ensor. Both Dr. Attwood and Ms. Suri undertook the last workshop in Dili, and both have considerable experience of the current WorldFish project having participated in activities in both Timor-Leste and Solomon Islands. Dr. Ensor is an expert in governance and institutional analysis for building adaptive capacity to respond to climate change, and has assisted in co-authoring a peer-reviewed journal paper drawing on material produced in this project (submitted for approval to ADB in November 2013). Dr. Park and Dr. Ensor will provide guidance, experience, and insight into the planning of the activity, while Dr. Attwood and Ms. Suri will facilitate the workshop in addition to planning and coordinating research analysis with Dr. Park and Dr. Ensor. All four project team members will participate in analyzing the national level social network map in relation to the community maps, and producing a peer-reviewed journal paper.

The project team will organize a 2-day workshop in Dili around the first quarter of 2014, with the aim of bringing together local, national, international NGOs, and government departments within Timor-Leste to complete a social network map similar to those produced at the community level in 2012. This workshop will invite the participants from the workshop in November 2013, and other national level institutions of relevance. In addition to this workshop, funds have been included for Dr. Park to travel to Manila to finalize outputs.

Rationale of activity in relation to RETA 7753:

This activity will contribute to the overarching RETA's outputs to help ensure food security for the population in Pacific Coral Triangle Initiative (CTI) countries, resulting from the increased resilience of coastal and marine ecosystems by supporting the introduction of more effective management of coastal and marine resources. More specifically, this activity will contribute to Output 1:

> Output 1: Capabilities of national and local institutions strengthened in sustainable coastal and marine resources management, through the (i) national- and local-level

training courses on resource management and climate adaptation and (ii) institutionalizing effective integrated coastal resources management (ICRM) and ecosystem-based fisheries management (EBFM).

In addition to contributing to Output 1 of the RETA, this activity will directly address a specific need identified by key stakeholders working in Climate Change Adaptation in Timor-Leste. The above mentioned individuals (see Table 1) made particular mention of how they wanted to participate in this activity to contribute to their organizations' work in climate change adaptation for fishing and farming communities in Timor-Leste

Outputs/ Deliverables:

a) Social network map for local/national/international NGOs operating in Timor-Leste, and government departments in Timor-Leste relevant to the task of climate change adaptation;
b) Brief report of findings from Social Network Analysis at national level, considered in relation to community level mapping conducted in 2012-2013 (8-12 pages);
c) Peer-review Journal paper submitted

Schedule:

Sharon Suri would fly to Penang in late January 2014 to assist in organizing the workshop details/research methods in collaboration with Dr. Park, Dr. Attwood and Dr. Ensor. Ms. Suri and Dr. Attwood would fly out to Timor-Leste in the first or second week of February 2014, spending seven to twelve days in country. After this, Ms. Suri and Dr. Attwood would return to Penang to complete the analysis, write the findings into a brief report and assist Dr. Park and Dr. Ensor in producing a paper for submission to a peer reviewed scientific journal.

Budget:

Budget remaining from original project:

Code	What	How much 'saved'
1156	International per diems (unused)	$15,526
1172	Air travel (unused)	$12,490
1182	MTE (unused)	$1,655
1192	Communications SOE (unused)	$2,000
1183	Transportation SOE (unused)	$4,000
1300	Seminars, Workshop F6 (unused)	$38,065
1400	Studies, Surveys, Reports F7 (unused)	$2,334
	Contingency	$22,623
	Total amount remaining after Variation 2	**$98,693.00**

Budget for proposed activity:

Services in Home & Field					
	What	**Quantity**	**Unit**	**Unit cost**	**Amount**
1100	person months SP	1.36	month	$ 16,955.00	$ 23,058.80
1100	person-months SA	1.00	month	$ 14,018.00	$ 14,018.00
1100	SS person days	2.00	month	$ 11,422.00	$ 22,844.00
1100	JE person days	0.32	month	$ 14,018.00	$ 4,485.76
					$ 64,406.56

Out-of Pocket Expenses					
	What	**Quantity**	**Unit**	**Unit cost**	**Amount**
1156	Singapore per diem (transit)	2	days	$ 344.00	$ 688.00
1156	Timor-Leste per diem	26	days	$ 155.00	$ 4,030.00
1156	Philippines per diem	5	days	$ 168.00	$ 840.00
1172	flight PEN to DIL	2	flight	$ 1,400.00	$ 2,800.00
1172	flight SFO to PEN	1	flight	$ 3,000.00	$ 3,000.00
1172	flight to Manila	1	flight	$ 900.00	$ 900.00
1182	MTE (International)	4	trips	$ 200.00	$ 800.00
1183	Transportation (SOE)		lump		$ 1,500.00
1192	Communications (SOE)		lump		$ 1,200.00
1300	Seminars, Workshop, Training (F6)		lump		$ 6,500.00
1400	Fieldwork, Reports (F7)		lump		$ 1,000.00
	Sub-total				$ 23,258.00
	Contingency		10%		$ 2,325.80
	Total				$ 25,583.80

	Services in Home & Field				$ 64,406.56
	Out-of-Pocket Expenses				$ 25,583.80
	Total Cost				**$ 89,990.36**

Appendix 13: Distribution of knowledge products

Portal/Database And URL	Mid-term report	Timor-Leste results posters	Article on Timor-Leste	Solomon Islands workshop feedback report	Methods manual (series of 8 brochures)
Peskador.org http://peskador.org/	X	X			X
Pacific Disaster Net (SOPAC-SPC) http://www.pacificdisaster.net/pdn2008/	X	X			
Coral Triangle Initiative http://www.coraltriangleinitiative.net		X			
Asia Pacific Adapt http://www.asiapacificadapt.net/resource/responding-climate-change-using-adaptation-pathways-and-decision-making-approach	X	X			
Coral Triangle Knowledge Network http://www.ctknetwork.org/catch-of-the-week/timor-leste-coastal-communities-adapt-to-climate-change/			X		Sent via email

Fifty packs, each containing eights methods brochures (collectively constituting a methods' manual), have been distributed as detailed in the following table:

Country	Contact person	Address	Email
Papua New Guinea	Madi Geita Senior Program & Finance Manager	Conservation and Environment Protection Authority (CEPA), Level 1, B-Mobile Building, Waigani Drive, Box 6601 Boroko, National Capital District, Papua New Guinea	madigeita@gmail.com
Timor-Leste	Aleixo Leonito Amaral Senior Program & Finance Manager	National Directorate of Fisheries and Aquaculture, Ministry of Agriculture and Fisheries, Rua Presidente Nicolau Lobato No. 5, Comoro-Dili, Timor-Leste	aleixo_la@yahoo.com
Fiji	Mafa Qiolele Senior Program & Finance Manager / Procurement Manager	19 McGregor Road, Suva, Fiji	mafa.wilson@gmail.com
Solomon Islands	Peter Ramohia Senior Program & Finance Manager	Ministry of Environment, Climate Change, Disaster Management and Meteorology (MECDM), Vavaya Ridge, Honiara, P.O. Box 21 Solomon Islands	pgino2011@gmail.com
Vanuatu	Albert Williams, Director of DEPC	Department of Environmental Protection and Conservation, Private Mail Bag 9063 Port Vila, Vanautu	awilliams@vanuatu.gov.vu

The above contacts were further requested to distribute the hard copy brochures.

Appendix 14: Project Finances

FINAL STATEMENT OF ELIGIBLE COSTS

(TO BE PREPARED BY THE CONSULTANT AFTER ALL ELIGIBLE INPUTS AND EXPENDITURES HAVE BEEN COVERED BY THE EXISTING CONTRACT AND VARIATIONS. PLEASE SUBMIT THIS FORM AND A COPY OF YOUR FINAL MONTHLY STATEMENT OF CONSULTANT INPUTS TO THE BANK'S TECHNICAL ASSISTANCE SUPERVISING UNIT WITHIN 90 CALENDAR DAYS UPON SUBMISSION OF FINAL REPORT)

NAME OF CONSULTING FIRM:		CONTRACT NO.:
		LATEST CONTRACT VARIATION NO.:
PROJECT DETAILS:		
TA NO. - COUNTRY	PROJECT NAME	BANK TA SUPERVISING UNIT (TASU):

FOREIGN CURRENCY COST ESTIMATES

C - 1 REMUNERATION

FIELD SERVICES (IN PERSON-MONTHS/INCLUDING TRAVEL TIME) [1]

Expert Name	Existing Contract plus Approved Variations Section One				Reductions [3] to reflect unutilized person-months Section Two			Actual Inputs and Expenditures Claimed (must not exceed Section One) Section Three		
	No. of Person-months	Agreed Monthly Rate	Estimated Amount	Equivalent (US$)	No. of Person-months	Estimated Amount	Equivalent (US$)	No. of Person-months	Estimated Amount	Equivalent (US$)
Edward Hugh Allison	0.67	22,100	14,807	14,807				0.67	14,807	14,807
Edward Hugh Allison	0.36	15,187	5,467	5,467				0.36	5,467	5,467
Sarah Park (R)	3.64	16,955	61,716	61,716				3.64	61,716	61,716
Kirsten Elizabeth Abernethy	1.36	6,114	8,469	8,469				1.36	8,469	8,469
Nhuong Tran (R)	1.14	10,285	11,725	11,725				1.14	11,725	11,725
Douglas Beare (N)	0.59	18,066	10,659	10,659				0.59	10,659	10,659
Simon Attwood (N)	1.95	14,018	27,335	27,335				1.95	27,335	27,335
Hugh Govan (N)	1.95	14,018	27,335	27,335				1.95	27,335	27,335
	0.00	0	76,700	76,700				0.00	76,700	76,700
No Details Required (partial lump sum)	0.00	0	109	109				0.00	109	109
				244,322			0			244,322

HOME OFFICE SERVICES (IN PERSON-MONTHS) [2]

Expert Name	Existing Contract plus Approved Variations Section One				Reductions [3] to reflect unutilized person-months Section Two			Actual Inputs and Expenditures Claimed (must not exceed Section One) Section Three		
	No. of Person-months	Agreed Monthly Rate	Estimated Amount	Equivalent (US$)	No. of Person-months	Estimated Amount	Equivalent (US$)	No. of Person-months	Estimated Amount	Equivalent (US$)
Sarah Park (R)	6.85	16,955	116,142	116,142				6.85	116,142	116,142
Kirsten Elizabeth Abernethy	1.28	6,114	7,825	7,825				1.28	7,825	7,825
Marie-Caroline Badjeck	0.17	12,320	2,094	2,094				0.17	2,094	2,094
Nhuong Tran (R)	1.97	10,285	20,261	20,261				1.97	20,261	20,261
Douglas Beare (N)	0.13	18,066	2,349	2,349				0.13	2,349	2,349
Simon Attwood (N)	1.23	14,018	17,242	17,242				1.23	17,242	17,242
Hugh Govan (N)	-	14,018	0	0				0.00	0	0
				165,914						165,914

TOTAL FOREIGN REMUNERATION	$ 410,236	$ 0	410,236

[1] Include travel time. For periods in the field of less than one person month the basis of calculation is one calendar day = 1/30 of month (0.0333).

[2] For periods of less than one person month in the home office, the calculation is on the basis of 176 hours per month i.e. 8 hours = 1/22 of month (0.0454). Unless otherwise specified in the contract.

[3] Please indicate Reductions as negative.

FINAL STATEMENT OF ELIGIBLE COSTS

FOREIGN CURRENCY COST ESTIMATES

(1, 2) OUT-OF-POCKET EXPENSES	Existing Contract plus Approved Variations Section One					Reductions [1] Section Two					Actual Invoice and Expenditures Claimed (must not exceed Section One) Section Three				
	No.	Unit	Unit Cost	Amount	Total	No.	Unit	Unit Cost	Amount	Total	No.	Unit	Unit Cost	Amount	Total
No.	Category/Item			(US$)	(US$)	(US$)			(US$)	(US$)	(US$)			(US$)	(US$)	(US$)
1100	International Per Diem					29,600					(14,780)					24,820
1101	SOI	36	day	185	6,660		(12)	day		(2,220)		24	day	185	4,440	
1102	PNG	30	day	220	6,600		(15)	day		(3,300)		15	day	220	3,300	
1103	FIJI	6	day	171	684		(2)	day		(342)		4	day	171	684	
1104	TIM	125	day	125	15,625		(44)	day		(5,500)		81	day	125	10,125	
1105	VAN	28	day	248	6,972		(16)	day		(4,026)		12	day	248	2,946	
1106	Manila	11	day	168	1,848			day				11	day	168	1,848	
1107	Kuala Lumpur	1	day	37	37		(1)	day		(37)		2	day	37	74	
1108	Brisbane, AUS	1	day	294	294			day				1	day	294	294	
1109	Singapore	2	day	344	688			day				2	day	344	688	
1110	Darwin, AUS	1	day	146	146		(1)	day		(146)		2	day	146	292	
1111	International Air Travel Cost					21,850					(11,650)					16,220
1112	-E.G.Allison (UK-SOI-UK)															
1113	-E.G.Allison (UK-SOI-UK)	1	RT	3,401	3,401			RT				1	RT	3,401	3,401	
1114	-K.E.Abernathy (ITG-SOI-ITG)															
1115	-S.Park (PG-SOI- PG)															
1116	-S.Park (PG-SOI- PG) May 2013	1	RT	1,990	1,990			RT		(1)		1	RT	1,989	1,989	
1117	-S.Park (PG-SOI- PG) July 2013	1	RT	2,600	2,600			RT		(6)		1	RT	2,594	2,594	
1118	-S.Park (PG-Manila-PG) sept 2012	1	RT	390	390			RT		(1)		1	RT	389	389	
1119	-S.Park (PG-Manila-PG) april 2013	1	RT	622	622			RT		(1)		1	RT	621	621	
1120	-S.Allwood (PG-SOI- PG)															
1121	-S.Allwood (PG-PNG-PG)	1	RT	3,400	3,400		(1)	RT		(3,400)			RT			
1122	-S.Allwood (PG-Van-PG)	1	RT	2,000	2,000		(1)	RT		(2,000)			RT			
1123	-S.Allwood (PG-Timor - PG) Late 2012	1	RT	1,270	1,270			RT		(27)		1	RT	1,299	1,299	
1124	-N.Tran (PG-SOI- PG)															
1125	N.Tran (PG-SOI- PG) May 2013	1	RT	4,600	4,600			RT		(1)		1	RT	4,603	4,603	
1126	D. Ekeni (PG-SOI-ITG)															
1127	D. Ekeni (PG-Manila-PG) April 2013	1	RT	622	622			RT		(1)		1	RT	623	623	
1128	-S.Park (PG-PNG-PG)	1	RT	3,400	3,400		(1)	RT		(3,400)			RT			
1129	-S.Park (PG-Van-PG)	1	RT	2,000	2,000		(1)	RT		(2,000)			RT			
1130		DRT														
1131	Regional Air Travel Cost					3,442					(27)					15,187
1132	-E.G.Allison (Regional)															
1133	-E.G.Allison (Regional)	2	RT	1,171	2,342		(2)			(0)		1	RT		2,342	
1134	-K.E.Abernathy (Regional)															
1135	-K.E.Abernathy (Regional)															
1136	-K.E.Abernathy (ITG-TL-PG)	1	RT	1,247	1,247					0		1	RT		1,247	
1137	-S.Park (Regional)															
1138	-S.Park (PG-TL-PG) march 2013	1	RT	1,254	1,254					(0)		1	RT		1,254	
1139	-S.Park (PG-TL-PG) oct 2012	1	RT	1,296	1,296					(0)		1	RT		1,296	
1140	-S.Park (PG-TL-PG) aug 2012	1	RT	1,271	1,271					(0)		1	RT		1,271	
1141	-S.Park (AUS-Van-AUS) feb 2012	1	RT	1,156	1,156					(0)		1	RT		1,156	
1142	-S.Allwood (PG-TL-PG) aug 2012															
1143	-S.Allwood (PG-TL-PG) aug 2012	1	RT	1,296	1,296					(97)		1	RT		1,200	
1144	-H.Gibson (Regional)															
1145	-H.Gibson (Fiji-TL-Fiji) Oct 2012	1	RT	3,000	3,000					(0)		1	RT		2,000	
1146	-H.Gibson (Fiji-Honiara-Fiji) May 2013	1	RT	1,456	1,456					(0)		1	RT		1,456	
1147	D. Ekeni (PG-TL-PG) Aug 2012	1	RT	1,359	1,359							1	RT		1,359	
1148	-N.Tran (Regional)															
1149	N. Tran (PG-TL-ITG) Oct 2012	1	RT	1,654	1,654					(0)		1	RT		1,654	
1150	-N. Tran (PG-NZ- PG) Apr 2013	1	RT	151	151		(1)			(151)			RT			
1151	Miscellaneous Travel Expenses					4,200					(277)					734
1152	International	2	RT	200	3,400					(200)		1	RT	200	3,200	
1153	Regional	40	RT	150	2,000					(2,000)		2	RT	150	(1,800)	
1154	Communications	2	MT	1,000	2,000	2,000				(1,981)	(1,981)				19	19
1155	Transportation	2	MT	2,000	4,000	4,000				(4,000)	(4,000)					
1200	Seminars, Workshops, Training (MEDU-11)				45,234	45,234				(50,107)	(50,107)				35,231	35,231
1400	Studies, Surveys and Reports (MEDU-17				6,000	6,000				2,196	2,196				8,196	8,196
1600	Contingency				24,029	24,029				(24,029)	(24,029)					
	TOTAL FOREIGN OUT OF POCKET EXPENSES					189,764					(88,763)					101,001

[1] Please indicate Reductions as negative.

FINAL STATEMENT OF ELIGIBLE COSTS

LOCAL CURRENCY COST ESTIMATES

C - 3 : REMUNERATION

FIELD SERVICES (IN PERSON-MONTHS/INCLUDING TRAVEL TIME) [1]

Expert Name	Existing Contract plus Approved Variations Section One				Reductions [3] to reflect unutilized person-months Section Two			Actual Inputs and Expenditures Claimed (must not exceed Section One) Section Three		
	No. of Person months	Agreed Monthly Rate	Estimated Amount	Equivalent (US$)	No. of Person months	Estimated Amount	Equivalent (US$)	No. of Person months	Estimated Amount	Equivalent (US$)

HOME OFFICE SERVICES (IN PERSON-MONTHS) [2]

Expert Name	Existing Contract plus Approved Variations Section One				Reductions [3] to reflect unutilized person-months Section Two			Actual Inputs and Expenditures Claimed (must not exceed Section One) Section Three		
	No. of Person months	Agreed Monthly Rate	Estimated Amount	Equivalent (US$)	No. of Person months	Estimated Amount	Equivalent (US$)	No. of Person months	Estimated Amount	Equivalent (US$)

TOTAL LOCAL REMUNERATION

[1] Include travel time. For periods in the field of less than one person month the basis of calculation is one calendar day = 1/30 of month (0.0333).

[2] For periods of less than one person month in the home office, the calculation is on the basis of 176 hours per month i.e. 8 hours = 1/22 of month (0.0454). Unless otherwise specified in the contract.

[3] Please indicate Reductions as negative.

FINAL STATEMENT OF ELIGIBLE COSTS

LOCAL CURRENCY COST ESTIMATES

C - 4: OUT-OF-POCKET EXPENSES		Existing Contract plus Approved Variations Section One					Reductions [V] Section Two					Actual Inputs and Expenditures Claimed (must not exceed Section One) Section Three				
		No.	Unit	Unit Cost	Amount	Total	No.	Unit	Unit Cost	Amount	Total	No.	Unit	Unit Cost	Amount	Total
No.	Category/Type			(US$)	(US$)	(US$)			(US$)	(US$)	(US$)			(US$)	(US$)	(US$)
	TOTAL LOCAL OUT-OF-POCKET EXPENSES															

[V] Please indicate Reductions as negative.

FINAL STATEMENT OF ELIGIBLE COSTS

C - 5: SUMMARY	Existing Contract plus Approved Variations (A)			Reductions (B)			Actual Inputs and Expenditures Claimed (A – B)		
	Foreign Currency	Local Currency	Total	Foreign Currency	Local Currency	Total	Foreign Currency	Local Currency	Total
REMUNERATION	410,236		410,236	-			410,236		410,236
OUT-OF-POCKET EXPENSES	165,735		165,735	(64,286)			101,448		101,448
GAIN/LOSS IN FOREIGN CURRENCY FLUCTUATION			-				-		-
CONTINGENCY			-				-		-
Foreign Contingency	24,029		24,029	(24,029)			-		-
Local Contingency			-				-		-
TOTAL	600,000	-	600,000	(88,315)			511,684	-	511,684

C - 6: PAYMENT SCHEDULE	Existing Contract plus Approved Variations (A)	Reductions (B)	Actual Inputs and Expenditures Claimed (A – B)
PROGRESS PAYMENT NO.	Equivalent Total US$	Equivalent Total US$	Equivalent Total US$
1-Mobilization Payment	50,030	0	50,030
2-Submission of Inception Report	50,030	0	50,030
3-Submission of Mid-Term Report	100,060	0	100,060
4-Submission of Video and Methods Manual Brochure	76,700	0	76,700
5-Submission of Draft Final Report	83,386	0	83,386
6-Submission of Final Report and Policy Brief	50,030	0	50,030
Total Progress Payments	410,236	-	410,236
OTHER PAYMENTS			
1172 International Air Travel (at cost/RT)	27,851	(11,630)	16,220
1172 Regional Air Travel (at cost/RT)	18,459	(272)	18,187
1156 International/Regional Per Diem	39,600	(14,780)	24,820
1182 Miscellaneous Travel Expenses	4,500	(3,716)	784
1183 Communications	2,000	(4,000)	(2,000)
1192 Transportation	4,000	(1,976)	2,024
1300 Seminars, Conferences, Workshops, Trainings	63,324	(30,107)	33,217
1400 Studies, Surveys and Reports	6,000	2,196	8,196
Contingency	24,029	(24,029)	-
Total Other Payments	189,764	(88,315)	101,448
TOTAL PAYMENTS			
CONTINGENCY			
MAXIMUM CONTRACT AMOUNT	600,000	(88,315)	511,684

CONSULTANT CERTIFICATION		CONFIRMATION BY PROJECT DIVISION OR TASU	
I certify that the inputs and amounts claimed are correct.		This Final Report is acceptable to ADB and that the person-months claimed tally with the person-months substantiated by Monthly Statements of Consultant Inputs.	
..... (Signature over Name and Title)	..... (Date)	..... (Signature over Name)	..... (Date)