Assessing adaptation options for climate change:
A guide for coastal communities in the Coral Triangle of the Pacific

6. Landscape Function Analysis

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Introduction

Assessing options for adapting to climate change is an important part of building resilient fishing and farming communities.

This brochure is part of a series that collectively detail how a community-based assessment of climate change was used in partnership with coastal communities and provincial and national-level stakeholders in Timor-Leste and Solomon Islands. The assessment contains four distinct, but related, steps (Fig 1) focused on supporting community-level decision-making for adaptation through a series of participatory action research activities. Each brochure in this series details a specific activity in the four-step assessment.

This series of eight brochures is primarily aimed for use where resources are limited or where it is more appropriate to use a rapid, qualitative and non-data intensive method of assessment. Community leaders, local NGOs and regional and national-level government representatives in developing countries may find this series useful.

In this brochure we provide details of an activity relating to the 'Evaluation of options' step of the assessment, namely Landscape Function Analysis (LFA). This activity was conducted with community members to measure the ecological function of different types of home garden production systems (Figs 2-5).

More specifically, the following questions were posed:

- How well do different home garden types function ecologically (using soil condition as an indicator)?
- Which parts of a home garden (e.g., leaf litter, crop residue) provide the most benefits in terms of ecological functioning?
- How might these functions change due to the introduction of adaptation actions?
- How can communities improve ecological function of agricultural land to enhance resilience to climate change?

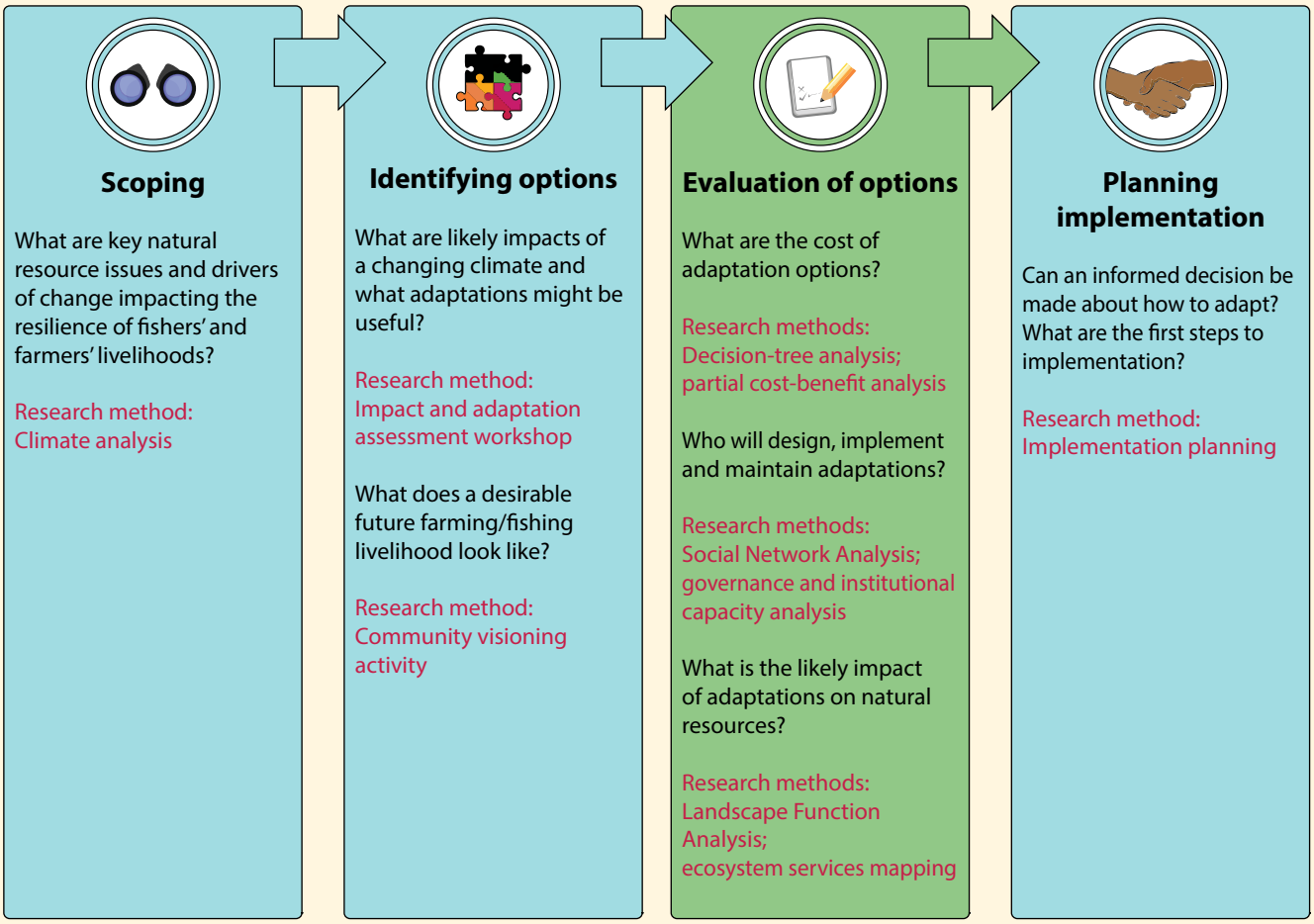

Fig 1: The four steps taken by community, local NGOs and regional and national government representatives in developing a plan to respond to climate change. Each step addresses specific questions likely to be asked by community members needing to adapt.




Figs 2-5: Home gardens are a very common production system throughout the tropics. There are many different types of gardens, ranging from those growing annual crops to those growing mostly perennials. Some gardens are close to the family home, while others are situated some distance away in the hills. Understanding the soil condition in each garden type is important when designing sustainable agricultural practices to enhance resilience to climate change.

What Is Landscape Function Analysis (LFA)?

LFA is a rapid method of assessing soil structure, soil nutrient levels and water infiltration/run-off.

It is used to explore issues related to the management of agricultural land, such as loss of soil nutrients. LFA helps show which land uses and aspects of those land uses provide the most benefit in terms of ecological functioning. LFA can be used to identify the potential land management actions needed for adapting agricultural production systems in response to changes in climate.

The LFA Method

Landscape Function Analysis measures 'patches' (distinct areas of leaf litter or crop residue, for example) and inter-patch spaces (bare ground) in the landscape (Fig 6). Understanding the patches along a transect (straight line running down a slope) is helpful, because patches trap resources like nutrients, keeping them in the farm system (Fig 7). On the other hand, inter-patch spaces 'leak' resources from the system. By measuring the type of patch, its characteristics and the areas it covers, an assessment of the functioning of a site can be made.

LFA consists of two methods:
1. type, number, length and width of each patch along a transect
2. function of each patch in terms of soil structure, soil nutrient levels and water movement

In Timor-Leste, LFA was conducted in two locations: on Atauro Island and at Batugade. Local community members helped in conducting the LFA in different home garden types. The home garden is a familiar source of food, fiber and building materials throughout Timor-Leste. The different types of home gardens vary in their structure, numbers of annual or perennial plants and frequency/intensity of management. As well as assessing each garden type as a whole, the ecological functioning of each part of the garden was also measured using LFA.

In Atauro we compared function in:
- i) perennial gardens in the village;
- ii) perennial gardens in the hills; and
- iii) perennial gardens in an extended fallow (rest) period.

In Batugade we compared function in:
- i) annual crop gardens;
- ii) perennial gardens;
- iii) a hardwood plantation; and
- iv) native woodland.

These were the most common garden and land use types in each region.

The main steps in conducting the LFA were as follows:

1. Finding a site to lay down a transect
   - An area of land in the agricultural landscape (running across home gardens) was identified and the location for laying down a transect randomly selected, but following the slope of the land where possible. The slope was necessary, as it picks up the direction that resources flow (Fig 6). The measurement area needed to be long enough to capture a range of patches in the garden; for example, 50 m.
2. Measuring patches along the transect
   - Moving along the transect, we described each patch type we came across and measured its length and width (Figs 7 & 8). This provided a map of the transect. This mapping was made for each transect in each home garden type.
   - For each patch type, a range of soil and vegetation structure measures were taken (Fig 9). These included percentage cover of leaf litter, canopy cover, soil structure and soil erosion. Each measure relates to soil stability, nutrient cycling and water retention. (To do these measurements, please refer to the full LFA method manual at: http://www.csiro.au/Organisation-Structure/Divisions/Ecosystem-Sciences/EcosystemFunctionAnalysis.aspx)

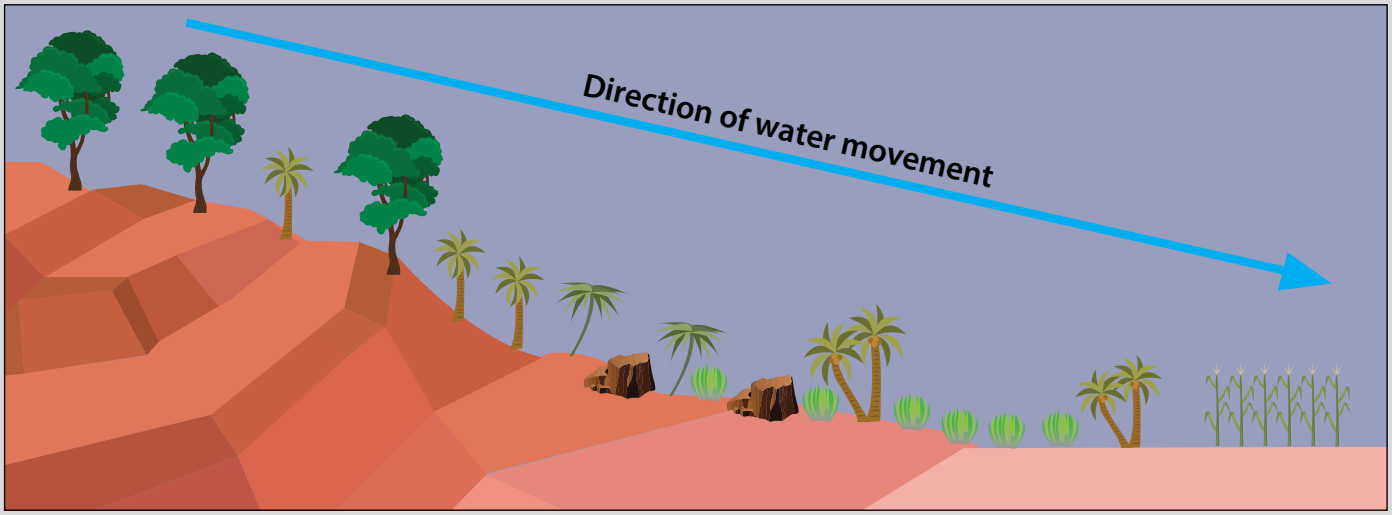

Fig 6: A landscape, showing the direction of resource flow, along which a transect could be located.

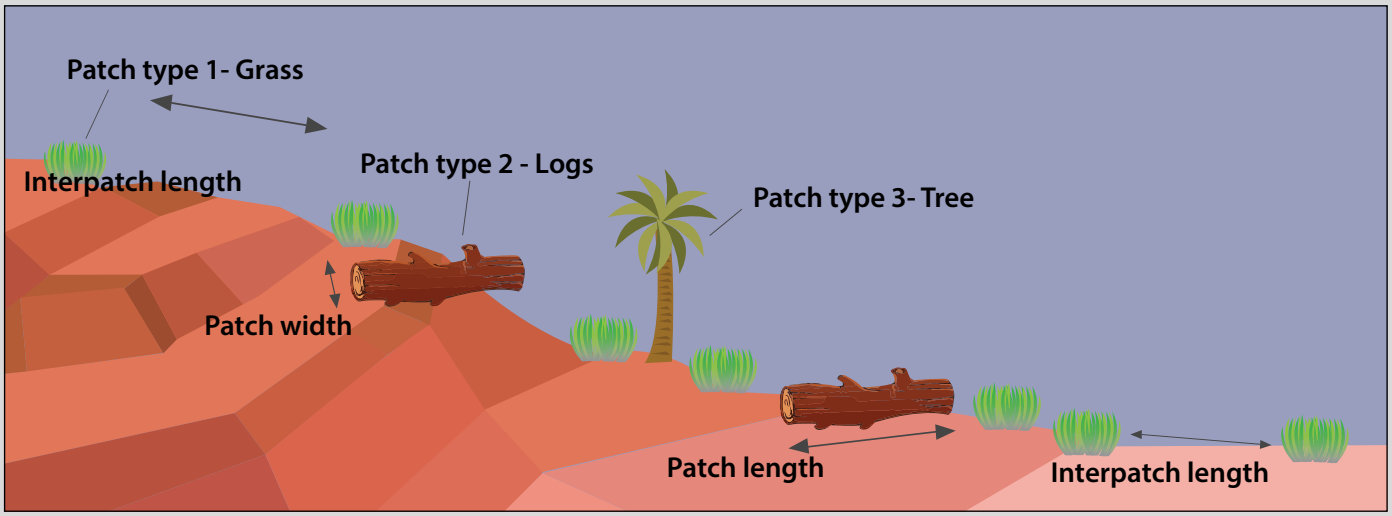

Fig 7: Different patch types and inter-patch spaces occur along a transect. The more patches a land use has, the better it is at retaining resources and providing good ecological function.

3. Calculating the function score for a home garden type
   - The score for each patch was summed to produce a 'function score' for each transect in the home garden type. The function score calculation is built into a spreadsheet that is downloadable from the LFA method manual website and is called 'EcosystemFunctionAnalysis.aspx'.
   - The higher the function score for the home garden, the better the ecological functioning it has.

4. Repeating the transects and function score calculations for other land use types
   - Because home gardens and other land uses are variable over short distances, we did three transects in each garden and combined the results (Fig 10).
   - As well as assessing home gardens, we also included a hardwood plantation and native woodland in the assessment at Batugade. This enabled a broader comparison. LFA is suitable for measuring many types of land uses.

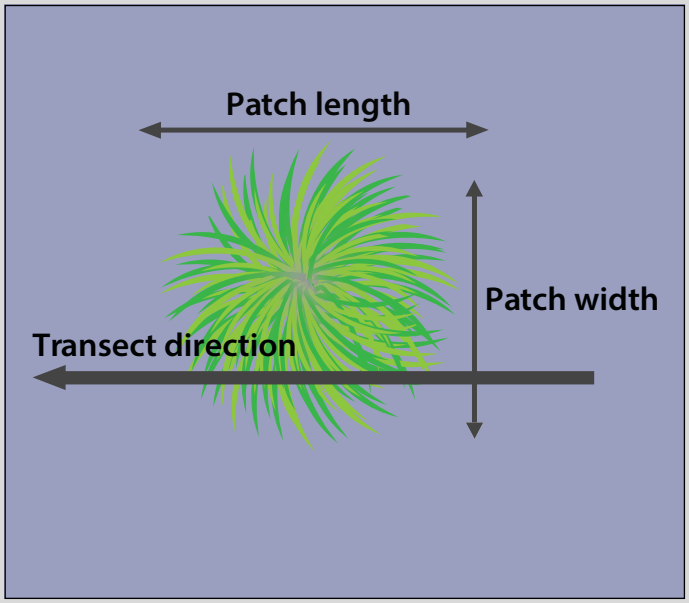

Fig 8: Taking measurements of an individual patch along a transect. Both the width and length of the patch are recorded, as well a range of other measures relating to ground cover and soil condition.

Fig 9: A local NGO officer in a home garden land use type in the foothills of Atauro, collecting data on patch measurements and characteristics along a transect.

Fig 10: LFA was a quick, easy and effective way to assess home garden function in Timor-Leste. Because it assesses the individual parts of a garden, the results could be used to advise communities on which agricultural practices they should encourage or discourage in their home gardens. This method could be easily communicated to, and learned by, community members for long-term monitoring.

Tips for Implementing LFA

- Collect all the equipment needed before going into the field (e.g., field sheets, 50 m measuring tape, pencils, camera).
- Practice the LFA transect method before conducting the research.
- Some land uses, such as home gardens, are patchy and variable, so do at least two transects and combine the results.
- If possible, take a reading of the start and finish points of transects, using a Global Positioning System.
- Take photographs of each site for later reference.
- If using LFA for monitoring the condition of the same sites over time, always take measurements at same time of year, as scores during wet and dry seasons will differ.
- By working closely with community members, researchers were able to interpret the LFA results in relation to community concerns, such as reduced soil nutrients and periodic water shortages in home gardens.

Key LFA Documents

The CSIRO website has everything you'll need to get started with LFA, including detailed method description and spreadsheet calculator templates. Please note that Landscape Function Analysis is also sometimes referred to as Ecosystem Function Analysis. Go to: http://www.csiro.au/Organisation-Structure/Divisions/%20Ecosystem-Sciences/EcosystemFunctionAnalysis.aspx

Results and Recommendations in Timor-Leste

Batugade:

- Perennial gardens function better than annual gardens (Figs 11 & 12).
- The ecological function in annual crop home gardens in Batugade could be improved. Farmers may consider any of the following practices to improve function and soil condition:
  - Increase ground and canopy cover in annual crops to reduce soil temperature and retain moisture.
  - Increase nitrogen and carbon in the soil by planting leguminous crops and returning crop residues to the soil.
  - Increase habitats close to the crop that support beneficial insects and spiders that eat crop pests.

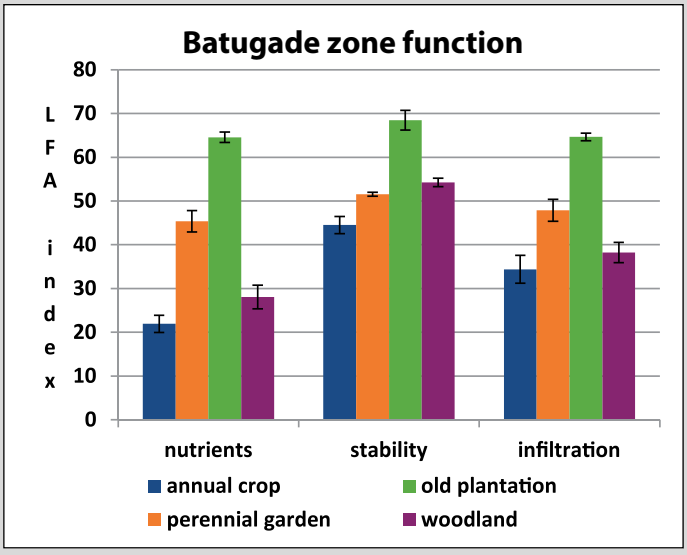

Fig 11: In Batugade, the relative ecological function of each garden type and other land uses such as native woodland can be seen. For all three soil functions measured (nutrients, stability and infiltration), the perennial garden performed better than the annual garden. Growing tree and shrub crops enables soil conditions to improve.

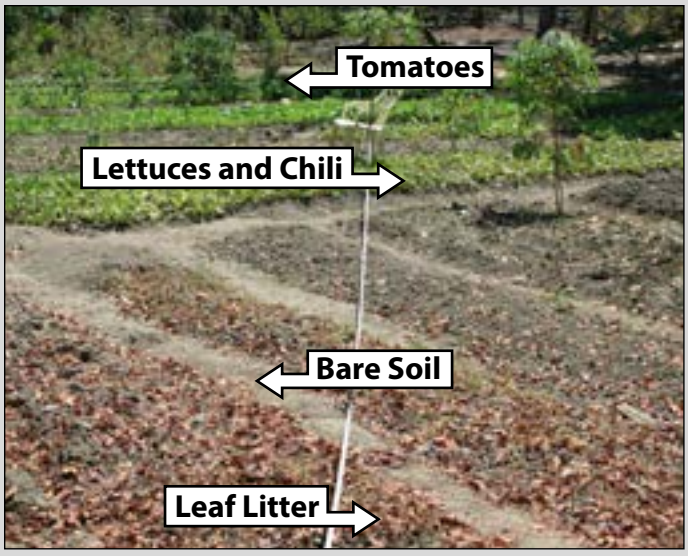

Fig 12: A home garden in Batugade dominated by annual crops. Some parts of the garden such as leaf litter retain resources, while others such as bare soil leak resources from the system.

Atauro:

- Bare soil reduces ecological function in the home garden (Fig 13).
- Leaf litter, crop residue, dead wood and palm leaves all increase ecological function of home gardens (Fig 14).
- Banana leaves, in particular, increase soil nutrients.
- Farmers may consider any of the following practices to improve soil condition on Atauro:
  - Reduce bare soil and the possibility of erosion.
  - Increase ground cover by collecting and distributing leaf litter onto the soil surface and composting leaf litter to add nitrogen back to the soil.
  - Increase use of banana litter to add both nitrogen and carbon to the soil.
  - Avoid burning crop residues after harvest and losing valuable nutrients.

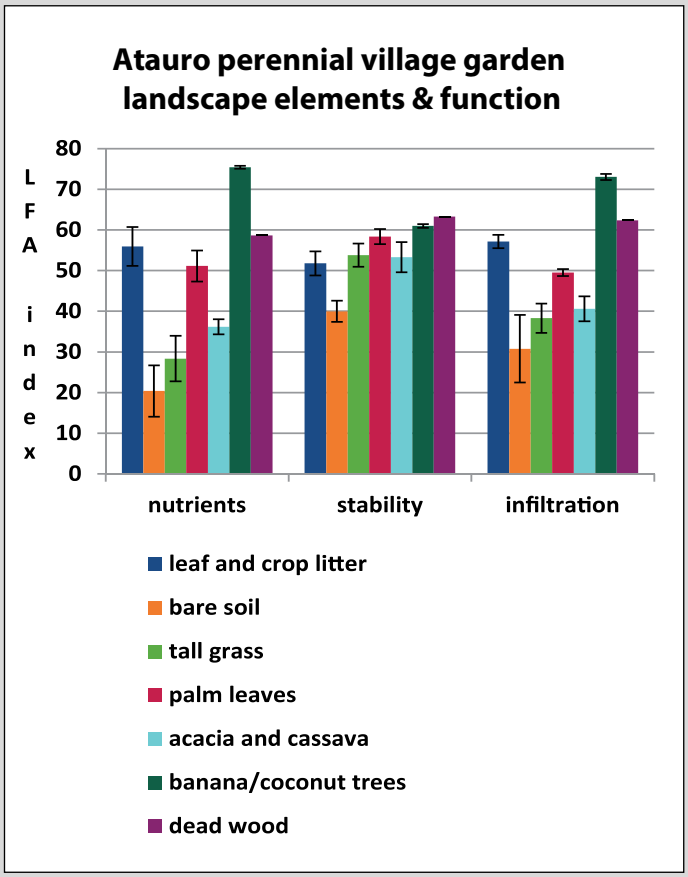

Fig 13: In Atauro, the relative functions of different parts of a perennial garden were assessed. Bare soil results in loss of function and therefore should be minimized by retaining ground cover throughout the year.

Fig 14: A perennial home garden in the village of Beloi in Atauro. Parts of the garden that contributed most to ecological function are highlighted.

This research was conducted by WorldFish under the project "Responding to Climate Change Using an Adaptation Pathways and Decision-Making Approach", pursuant to the Asian Development Bank and Global Environment Facility cofunded initiative R-CDTA 7753-Strengthening Coastal and Marine Resources Management in the Coral Triangle of the Pacific (Phase 2).

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For further details on this project, visit http://www.ctknetwork.org/ and http://www.worldfishcenter.org/ongoing-projects/adaptationpathways-responding-climate-change