Scaling up EbA actions in Guadalcanal, Solomon Islands

Unlocking the potential of urban gardens as a local resilience strategy
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Pacific Community
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Cover Photos: John Clemo and Lorraine Livia, 2021

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Executive Summary

As is happening to other Melanesia cities, Honiara is rapidly urbanizing due to significant rural-urban migration. This is leading to the growth of informal settlements and increasing numbers of urban poor in the city. In such urban environments, people continue to rely heavily on forest and garden crops for both subsistence and cash income. It is therefore critically important to protect the remaining productive urban and peri-urban open spaces in order to enhance local food security in the context of urbanisation and a changing climate (as well as other shocks, as Covid restrictions in 2021 all too clearly demonstrated).

In Honiara, it is predominantly women who are involved with urban and peri-urban farming, as well as the selling of produce at markets. Produce from home (sup sup) and bush gardens are therefore integral to their, and their families, sustainable livelihoods. The aim of this project was therefore to better understand the local relationships between women and their urban gardens, the daily challenges they faced, and to promote urban agriculture good practice with women's groups in order to enhance local food security in the context of urbanisation and a changing climate.

In the first instance, satellite imagery was interrogated to get a picture of productive space in the city. This involved GIS analysis of temperature and vegetation, including an examination of the health of vegetation over a period of time. This research activity, conducted remotely, was then supplemented by workshops, site visits and urban garden surveys in two of three informal settlements: Wind Valley and Jabros. Due to the recent Covid outbreak, Ontong Java is yet to be analysed. Analysis for the two settlements considered the types of crops grown and any visible damage.

The findings indicate that vegetation health is being negatively impacted by development pressures, increasing temperatures, and problems like pests, and that targeted interventions in the form of best practice training, seeds, equipment and materials are needed to maintain the productivity of urban gardens in Honiara that are critical for peoples' wellbeing.

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1. Introduction

This project was part of the EU-funded Intra-ACP GCCA+ Pacific Adaptation to Climate Change and Resilience Building initiative (PACRES). It is implemented jointly by the Secretariat of the Pacific Environment Programme (SPREP), the Pacific Islands Forum Secretariat (PIFS), the Pacific Community (SPC) and the University of the South Pacific (USP). The aim is to scale-up adaptation pilots in five Pacific ACP countries – Samoa, Vanuatu, Solomon Islands, Papua New Guinea, and Timor Leste.

This project, focusing on women and urban gardens in Honiara, Solomon Islands, focused on three informal settlements (see Figure 1):

- Ontong Java (high density, inner city, with no open space for gardens),
- Wind Valley (inland, within municipal boundaries), and
- Jabros (peri-urban, outside the municipal boundary with bush gardens on customary land).

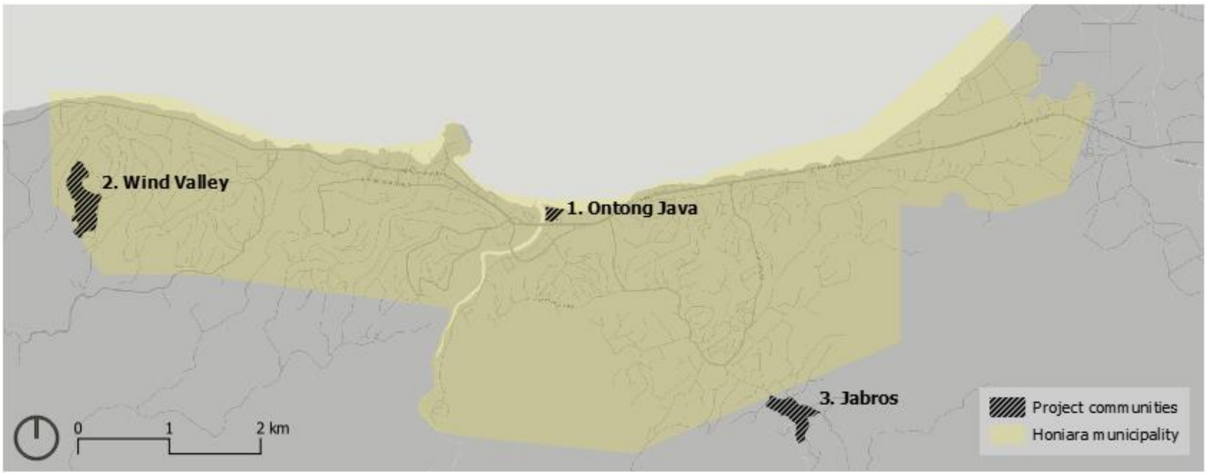


Figure 1. Spatial distribution of 'hotspot' communities.

Work previously carried out for the Climate Resilient Honiara project[1] in 2019-2020, e.g. community profiling and urban agriculture, highlighted the need to better understand the role of urban gardens and their importance for local food security. This report summarises the main findings from city-wide GIS analysis and urban gardens surveys conducted in the three case study informal settlements.

[1] Funded by the UNFCCC Adaptation Fund, administered by UN-Habitat, with RMIT University providing scientific support (2018 – 2022).

1.1. Methodology

A rapid survey was designed for execution on Survey123 as this re-used the platform, GNSS receivers, and tablets procured for the Climate Resilient Honiara project (see Figure 2). The short survey targeted 'sup sup' gardens, which are gardens planted next to houses, managed by families themselves, and almost always within community boundaries. The survey captured the following physical information about gardens: location, size, crops planted, visible damage to crops (if any), and photos of gardens and crops. A total of 89 gardens were surveyed by the team.

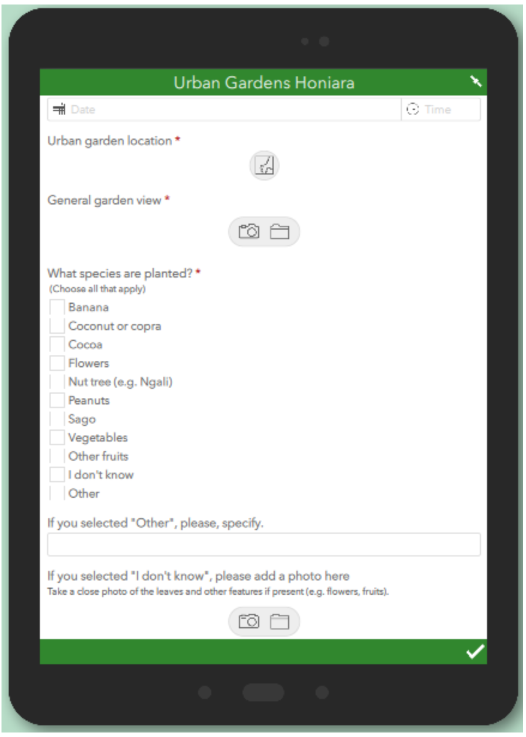


Figure 2. Survey123 survey (left); project researchers, Lorraine Livia and John Clemo, conducting the garden survey (Source: J. Clemo).

2. Environmental analysis

To better understand the environmental conditions for vegetation in Honiara, and in particular to gain some insight into changes over time in the city due to climate, two types of analysis were undertaken which are relevant to vegetation health: land surface temperature (LST) and Normalized Difference Vegetation Index (NDVI). An overview and rationale for using these calculations are provided in section 2.1.

The analysis was undertaken using freely available Landsat 8 satellite imagery, specifically for the information collected by its Thermal Infrared Sensors (Bands 10 and 11). Table 1 provides an overview of Landsat 8's bands and resolutions. To understand change over time, two epochs of data were selected: 31 May 2013 and 6 June 2021, with datasets filtered for a maximum of 30% cloud cover over the scene. A combination of cloud cover and where the cover occurred (minimum cover over the city itself) were the main reasons in selecting the final imagery. The two datasets are shown in Figure 3.

Table 1. Landsat 8 bands[2].

Bands	Wavelength (micrometers)	Resolution (meters)
Band 1 - Coastal aerosol	0.43-0.45	30
Band 2 - Blue	0.45-0.51	30
Band 3 - Green	0.53-0.59	30
Band 4 - Red	0.64-0.67	30
Band 5 - Near Infrared (NIR)	0.85-0.88	30
Band 6 - SWIR 1	1.57-1.65	30
Band 7 - SWIR 2	2.11-2.29	30
Band 8 - Panchromatic	0.50-0.68	15
Band 9 - Cirrus	1.36-1.38	30
Band 10 - Thermal Infrared (TIRS) 1	10.6-11.19	100
Band 11 - Thermal Infrared (TIRS) 2	11.50-12.51	100

May 31, 2013
Land Cloud Cover: 13.56%
Scene Cloud Cover: 11.30%
Acquisition time: 10:26AM AEDT

June 6, 2021
Land cloud cover: 11.96%
Scene cloud cover: 29.56%
Acquisition time: 10:24AM AEDT

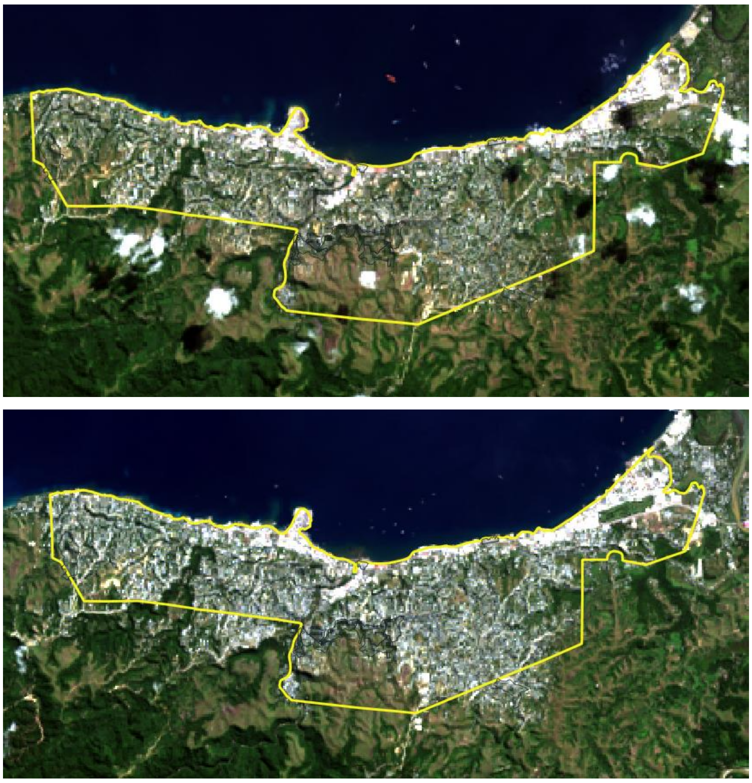


Figure 3. Landsat 8 scenes: 2013 (top) vs. 2021 (bottom).

[2] https://www.usgs.gov/faqs/what-are-band-designations-landsat-satellites?qt-news_science_products=0#qt-news_science_products

2.1. Overview of Land Surface Temperature (LST) and Normalized Difference Vegetation Index (NDVI) analyses

LST is commonly used to understand the ambient environmental temperature. It is measured using the amount of thermal radiance emitted from the land surface or vegetated surfaces (e.g. canopies). In cities, LST is useful for understanding urban heat islands (and their extents and intensity), which in turn is a key driver of ecological stress. As there is a negative correlation between LST and vegetation[3], it is also useful for understanding the impact of the environment on plant health. In this study, LST is calculated as:

LST = K2/ln(K1/Radiance+1)

Where:

- **Radiance = Radiance_Mult_Band_10 x B10 +Radiance_Add_Band_10** *(where the rescaling values of Radiance_Mult_Band_10 and Radiance_Add_Band_10 are provided in the satellite imagery metadata)*
- *K2 and K1 are TIRS thermal constants provided in the satellite imagery metadata*
- To convert the outcome of the equation from Kelvin to Celsius requires a subtraction of 273.15 (i.e. LST = K2/ln(K1/Radiance+1) – 273.15).

NDVI is a common index derived from remotely sensed data (in this case Landsat 8 data). It provides an index of greenness (or green density in the landscape) by calculating how much more near infrared light is reflected by plants as compared to visible (red) light). It is calculated as:

NDVI = (NIR-Red)/(NIR+Red)

where NIR and Red refers to the spectral reflectance values acquired by the satellite in the red (visible) and near infrared bands (i.e. Bands 5 and 4).

The NDVI ranges from -1 to 1 where higher values indicate healthy and dense vegetation while lower values indicate bare ground, stressed or sparse vegetation.

2.2. LST and NDVI findings

2.2.1 A rapidly warming city

Minimum and maximum temperatures were similar between 2013 and 2021 with both scenes showing minimum temperatures of just over 19C and maximum temperatures of just over 27C; however, the spatial distribution of those temperatures changed significantly in an 8-year period. Figure 4 shows the city (and the ocean itself) becoming significantly warmer by 2021, with the hottest parts of the city being its coastal fringe, extending inland. These regions correspond to built-up areas of the city, especially the main road traversing east-west, Kukum Highway, the National Hospital and the dense area of Chinatown along the eastern bank of the Mataniko river (see Figure

[3] Goetz, S. J. (1997). Multi-sensor analysis of NDVI, surface temperature and biophysical variables at a mixed grassland site. International Journal of Remote Sensing, 18(1), 71–94. https://doi.org/10.1080/014311697219286

5). Figure 6 shows the spatial distribution of changes in temperature across the 8-year period where parts of the city heated up by as much as 2.5C (and the ocean heating up by around 1C).

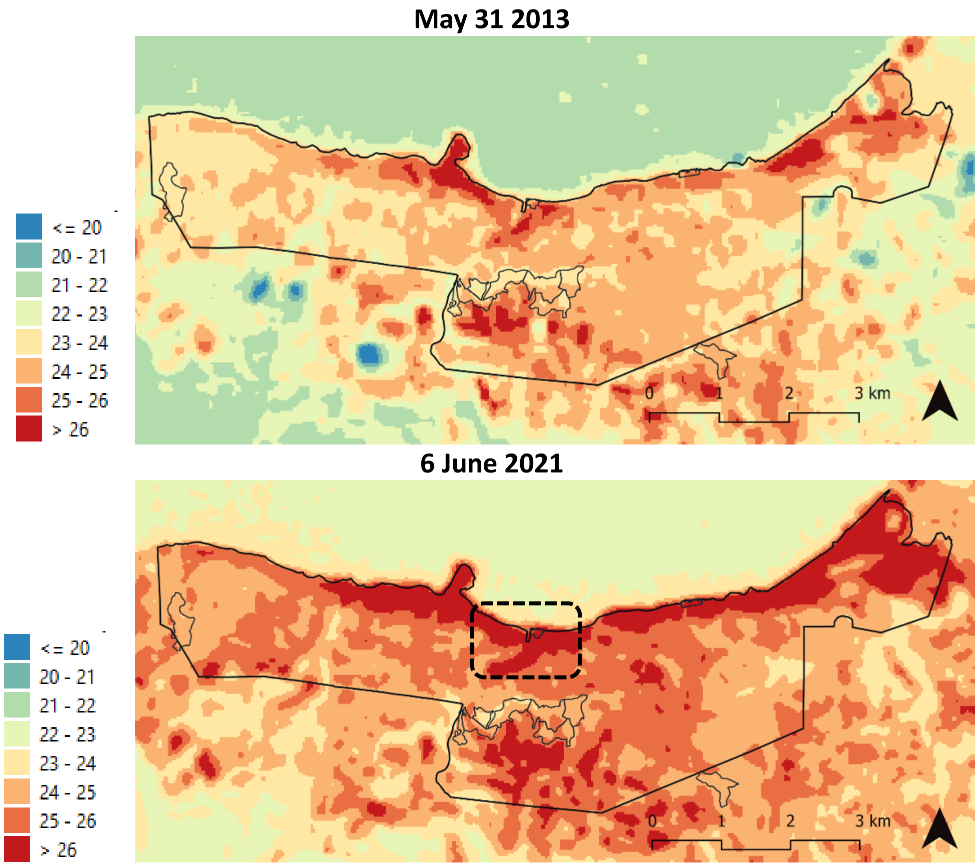


Figure 4. Land surface temperature over Honiara, 2013 vs. 2021.

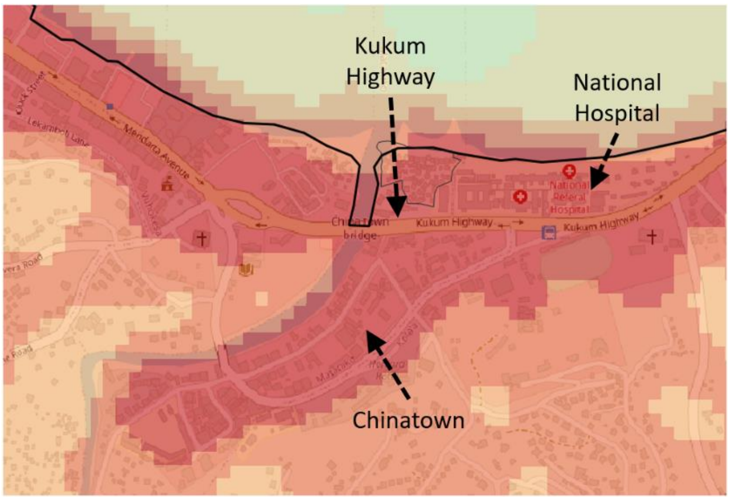


Figure 5. Zoom-in to area outlined by dashed box in Figure 4: parts of Kukum Highway, the National Hospital and Chinatown

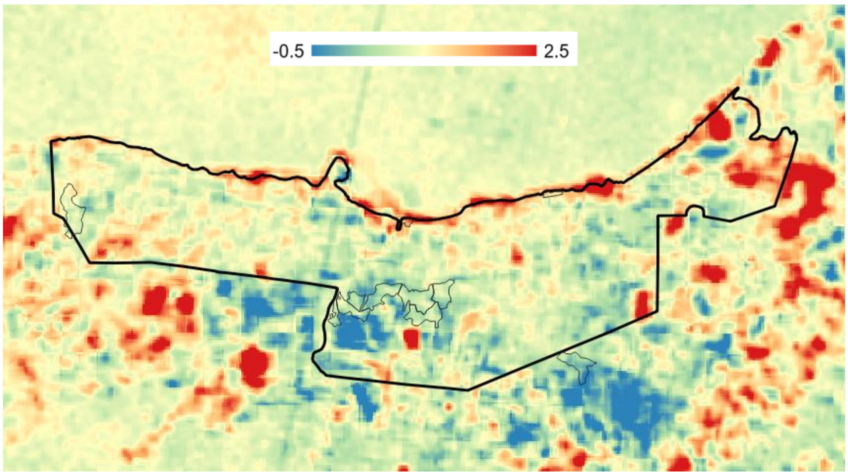


Figure 6. Temporal changes in land surface temperatures across Honiara city.

2.2.2 Vegetation health

The NDVI analysis in Figure 7 shows built-up areas and bare ground in red. The analysis also shows that, over the 8-year period, vegetation throughout the city is generally becoming more stressed, with a wider spatial distribution of yellow areas; in both epochs, there are few areas in Honiara where the vegetation can be considered as healthy.

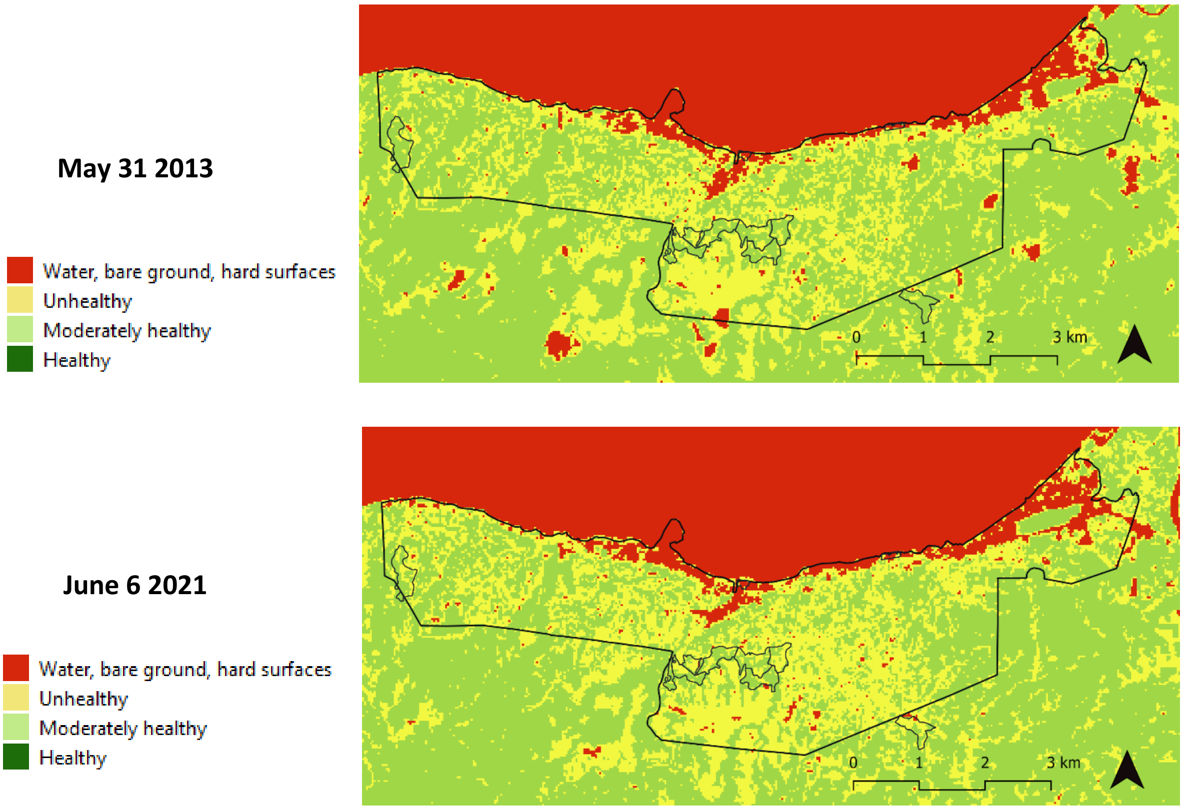


Figure 7. Changes in vegetation health, 2013 vs. 2021.

The NDVI and LST analysis of 2021 confirms that areas that have become warmer correspond to areas where vegetation health has degraded.

3. Urban gardens characteristics

3.1. Settlement overview

Ontong Java is a high-density coastal settlement near the city centre. Wind Valley and Jabros are both peri-urban communities that are located on and beyond the city's boundaries respectively (see Figure 1).

Wind Valley is an inland urban settlement located in West Honiara, in the White River suburb of Ngossi Ward. Wind Valley measures approximately one kilometre in length and half a kilometre in width and is characterised by steep slopes with a stream running through the middle of the settlement. The density of the settlement has approximately doubled in the past decade, with houses increasingly built on the steep slopes or where space might still be available on the flatter areas of the valley. Known climate hazards for Wind Valley are flood risks, especially along the local stream (up to three metres in some areas), and landslides. Figure 8 shows a view of part of the settlement from higher ground.

Figure 8. View of Wind Valley settlement (Credit: J. Clemo, 2021).

Jabros Community is situated just outside the boundary of Panatina Ward and the municipality itself. Its location in the city's foothills translates to a gentle topography ranging between 50-80m above sea level, with the midpoint of the settlement generally being its lowest point. There are several key water sources in the settlement: a creek running in a north-west direction along the boundary, and a creek that runs in a north-south direction through the middle of the community. The soil in this area consists of rich, clay-like material that inhabitants noted to be good for plant growth but challenging to traverse in rainy periods. Figure 9 shows the view across Jabros community, looking north.

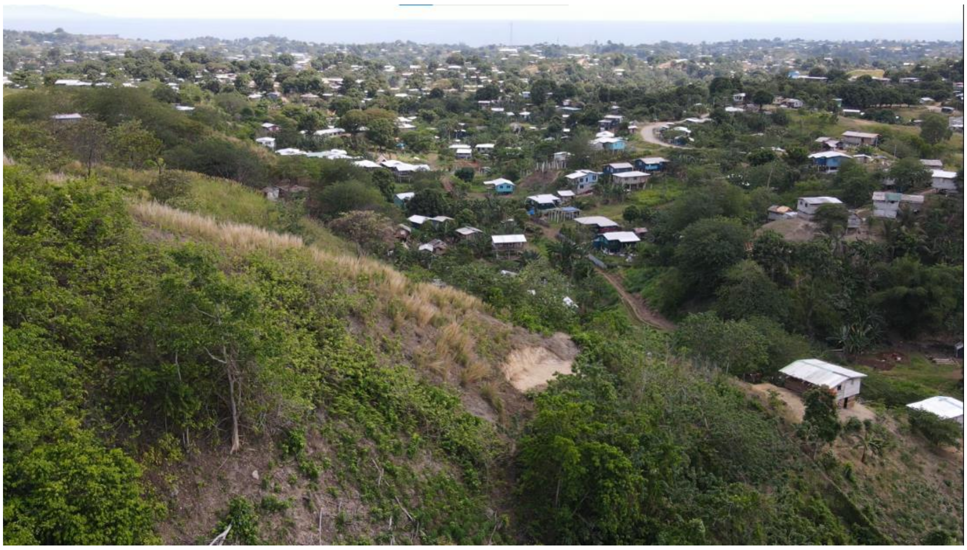


Figure 9. View looking north over Jabros community (Credit: S. Yeo, 2021).

3.2. Size and distribution of gardens

A total of 36 and 53 gardens were surveyed in Wind Valley and Jabros respectively. Between the communities, there were variations in garden sizes with gardens in Jabros generally larger (see Table 2), which is expected since Wind Valley is more constrained by its steep topography on eastern and western sides of the settlement. Figure 2 shows most common garden size in Wind Valley to be 25 to 50m^2 while in Jabros, the most common garden size is likely to be greater than 100m^2.

Table 2. Variations in sizes of 'sup sup' gardens in Jabros and Wind Valley.

	Smallest	Largest	Median	Average
Jabros	37.68m^2	307.02 m^2	105.36 m^2	119.92 m^2
Wind Valley	10.02 m^2	264.21 m^2	56.01 m^2	77.26 m^2

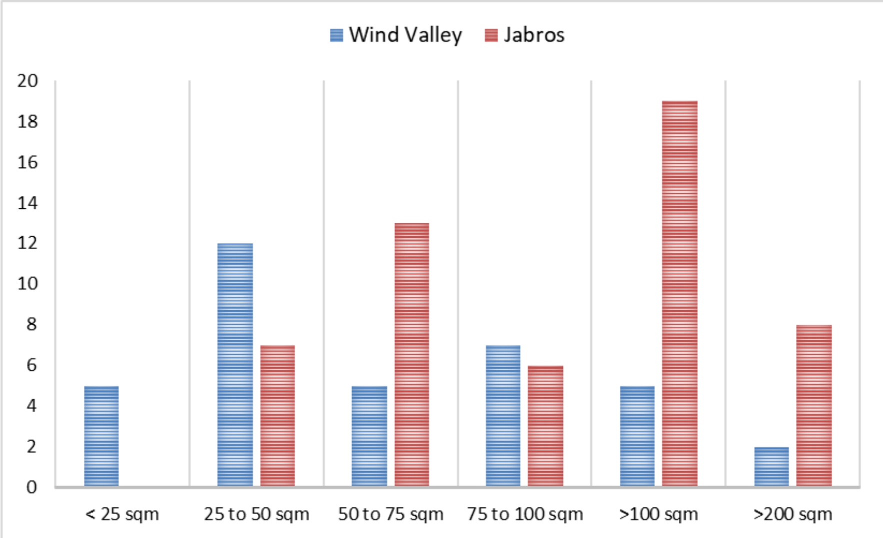


Figure 10. Comparative distribution of gardens according to area.

In Wind Valley, most of the gardens surveyed were located along the main creek that runs north-south through the settlement where the topography also tends to be less steep. Some images of house gardens are shown in Figure 11.

Figure 11. House gardens in Wind Valley.

Figure 12 shows the distribution of the gardens, significant water sources (Strahler stream order greater than 5[4]) in Wind Valley settlement, as well as gradient (using 5m contour lines) and areas of extremely steep topography where the gradient exceeds 45 degrees (red areas).

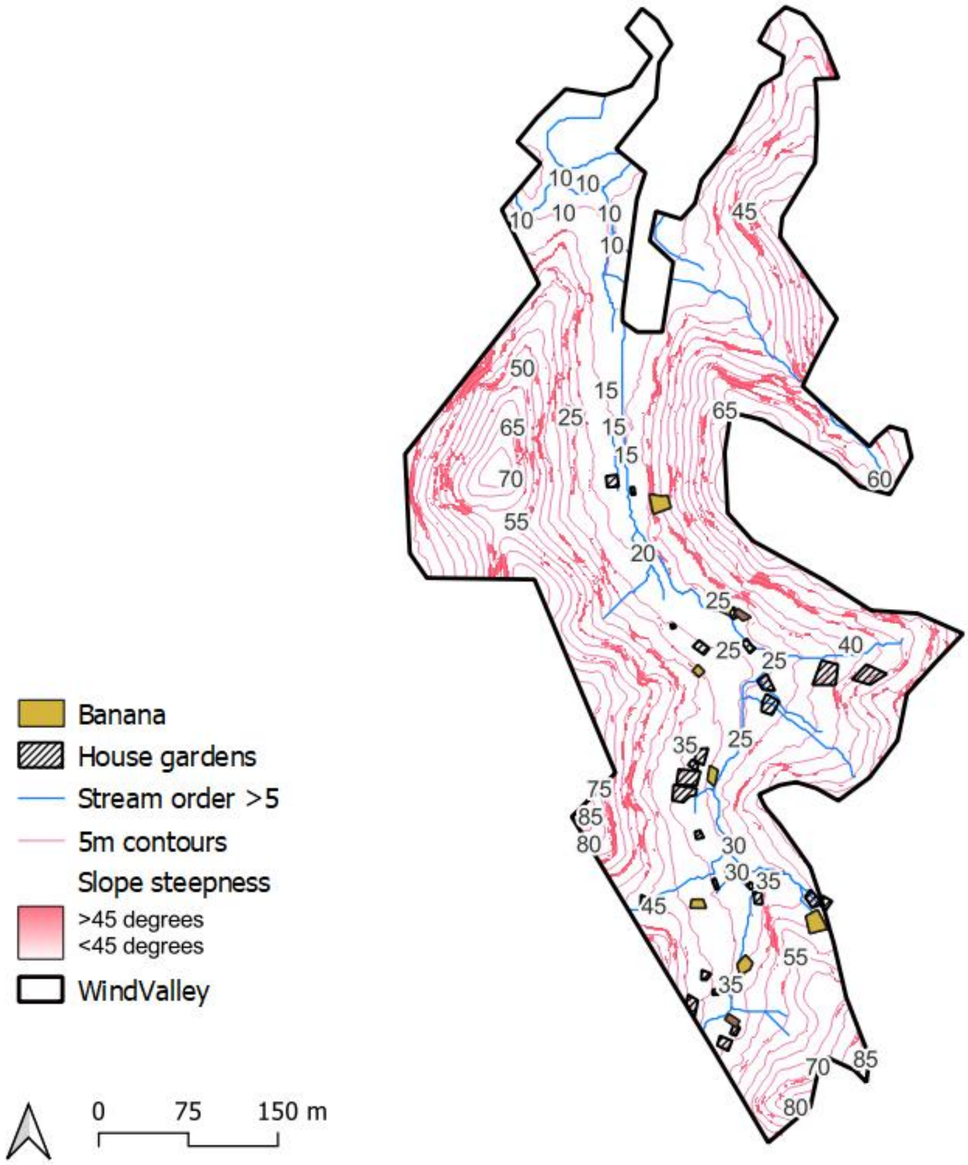


Figure 12. Topography of Wind Valley and distribution of surveyed house gardens.

In comparison, Jabros community has a generally gentle gradient and gardens tend to be planted either in flat areas, or areas where a gentle slope provides good drainage. Figure 13 shows some examples of gardens in the community.

[4] Strahler's stream order was used to classify streams in this analysis, which categorises the relative sizes of streams from 1 (small) to 12 (largest). Streams of orders 1-3 tend to be smaller headwater streams (i.e. occurring in the upper reaches of the watershed); streams of orders 4-6 tend to be medium streams that have higher volumes of water, are usually less steep and flow more slowly. Any stream of order 7 and above is classified as a river.

Figure 13. Examples of house gardens in Jabros.

Figure 14 shows the topographic conditions in the settlement and the distribution of gardens. The figure also shows some of the larger house gardens are located just outside of the settlement's boundaries.

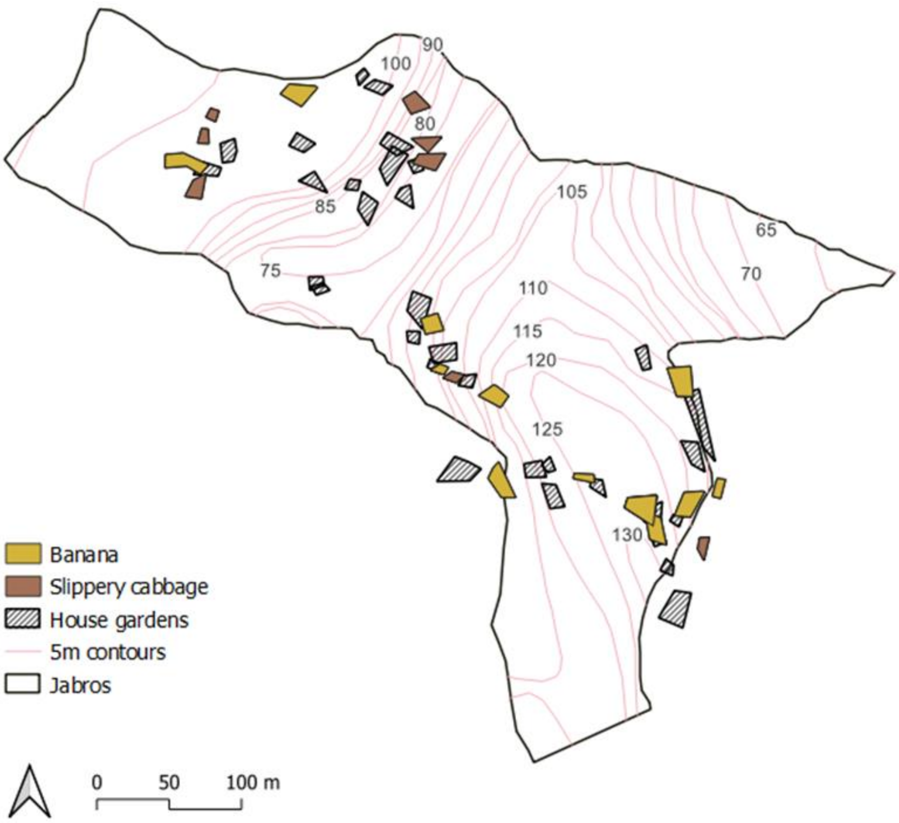


Figure 14. Distribution of house gardens in Jabros (including those growing most common crops, banana and slippery cabbage).

3.3. Crop variety

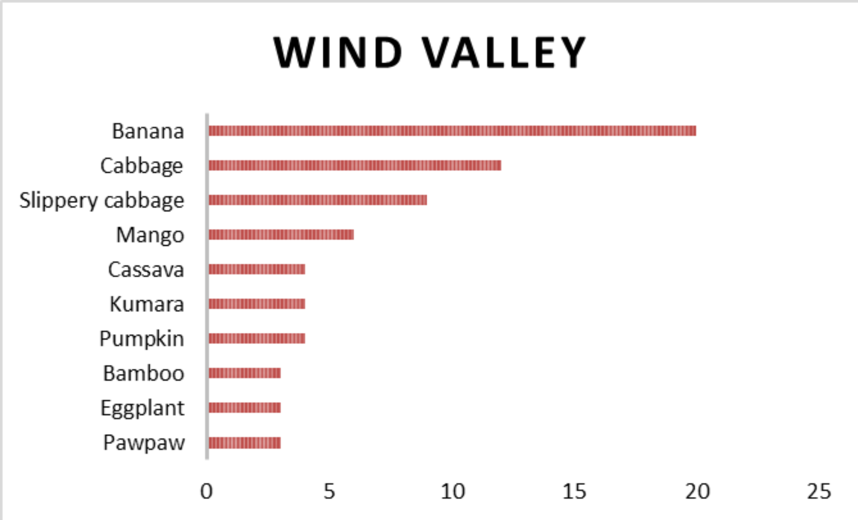
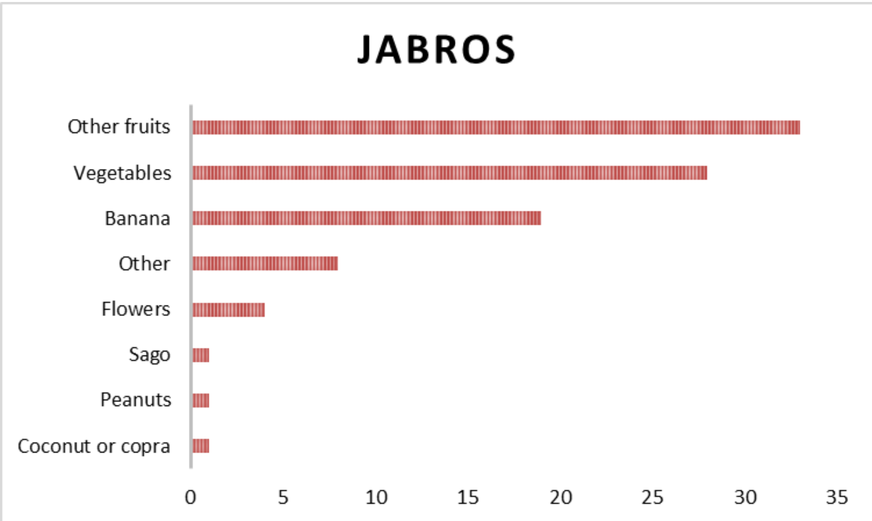


Figure 15. Types of crops planted in house gardens in Wind Valley.



Other crops	
Pawpaw	3
Slippery cabbage	2
Pineapple	2
Noni	2
Guava	2
Vetiver	1
Beans	1
Saladia	1
Shallot	1
Melon	1

Figure 16. Types of crops planted in house gardens in Jabros (left) and variety of crops identified under 'Other' (right).

Both settlements had a mix of vegetables, fruit and flowers grown in house gardens. In both communities, banana was a dominant crop, likely due to ease of propagation and short production cycles. They are easy to transport and are also a common produce in markets. Staples like slippery cabbage and root vegetables like cassava and kumara were also common. Growing these vegetables for home consumption in house gardens are likely to lead to household savings as crops like banana, cassava, eggplant, slippery cabbage, and pawpaw all tend to cost around SBD10/kg at the market.

Figures 15 and 16 illustrate the variety of crops grown in house gardens in both settlements Figure 17 shows images of crops like slippery cabbage and noni grown in Jabros.

Figure 17. Examples of slippery cabbage (*abelmoschus manihot*, left) and noni fruit (*morinda citrifolia*, right) grown in Jabros.

3.4. Threats to crops

Threats to crops were experienced across both settlements with gardens in Wind Valley (64%) having more visible signs of damage or poor health than those in Jabros (53%). Threats from pests and poor plant health were the most common signs of threats, as shown in the graphs in Figures 18 and 19.

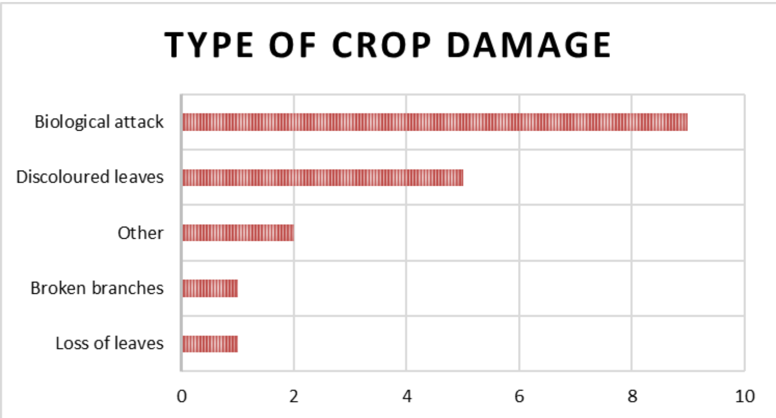
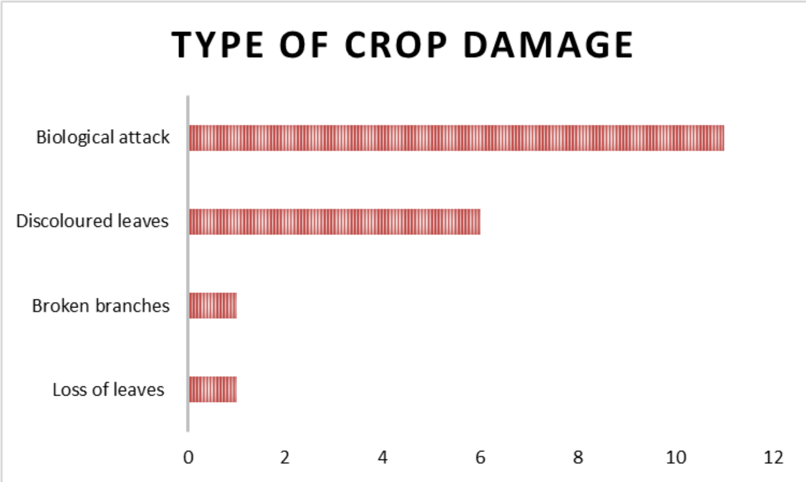


Figure 18. Types of crop damage in Wind Valley.



Some examples of damaged crops in both settlements are shown in the images in Figures 20-22.

Figure 20. African snail (left) and signs of pests in crops in Wind Valley.

Figure 21. General poor plant health in crops in Wind Valley.

Figure 22. Examples of damaged crops in Jabros.

Figures 23-24 show the spatial distribution of gardens in both communities with visible crop damage, and alongside this are the NDVI analysis for each settlement. Although the coarse resolution of the satellite imagery and the small size of house gardens makes it difficult to gain dependable insight into correlations between overall vegetation health with crop health, the NDVI analysis does indicate that house gardens in Jabros may potentially benefit from more inputs to be productive.

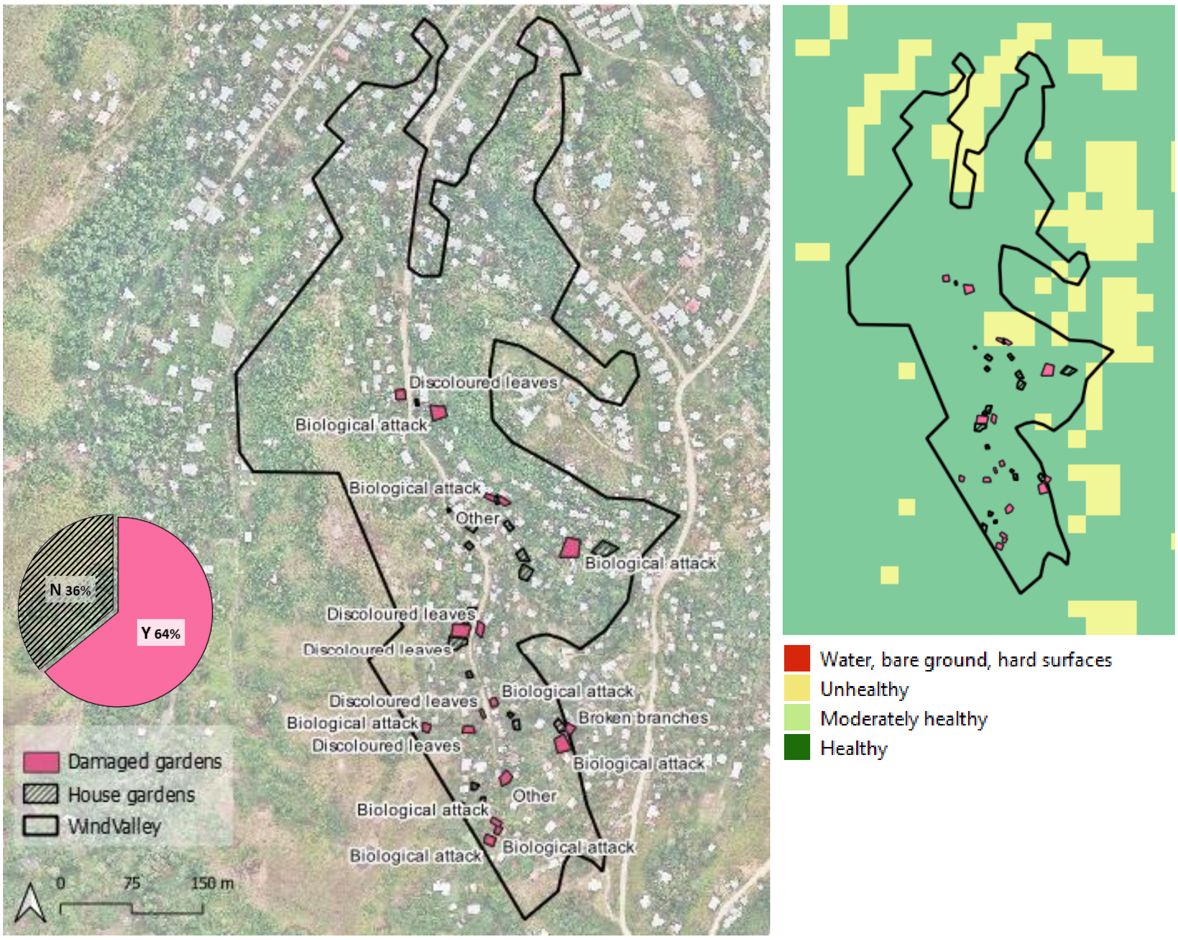


Figure 23. Distribution of damaged gardens in Wind Valley and correlation to NDVI analysis.

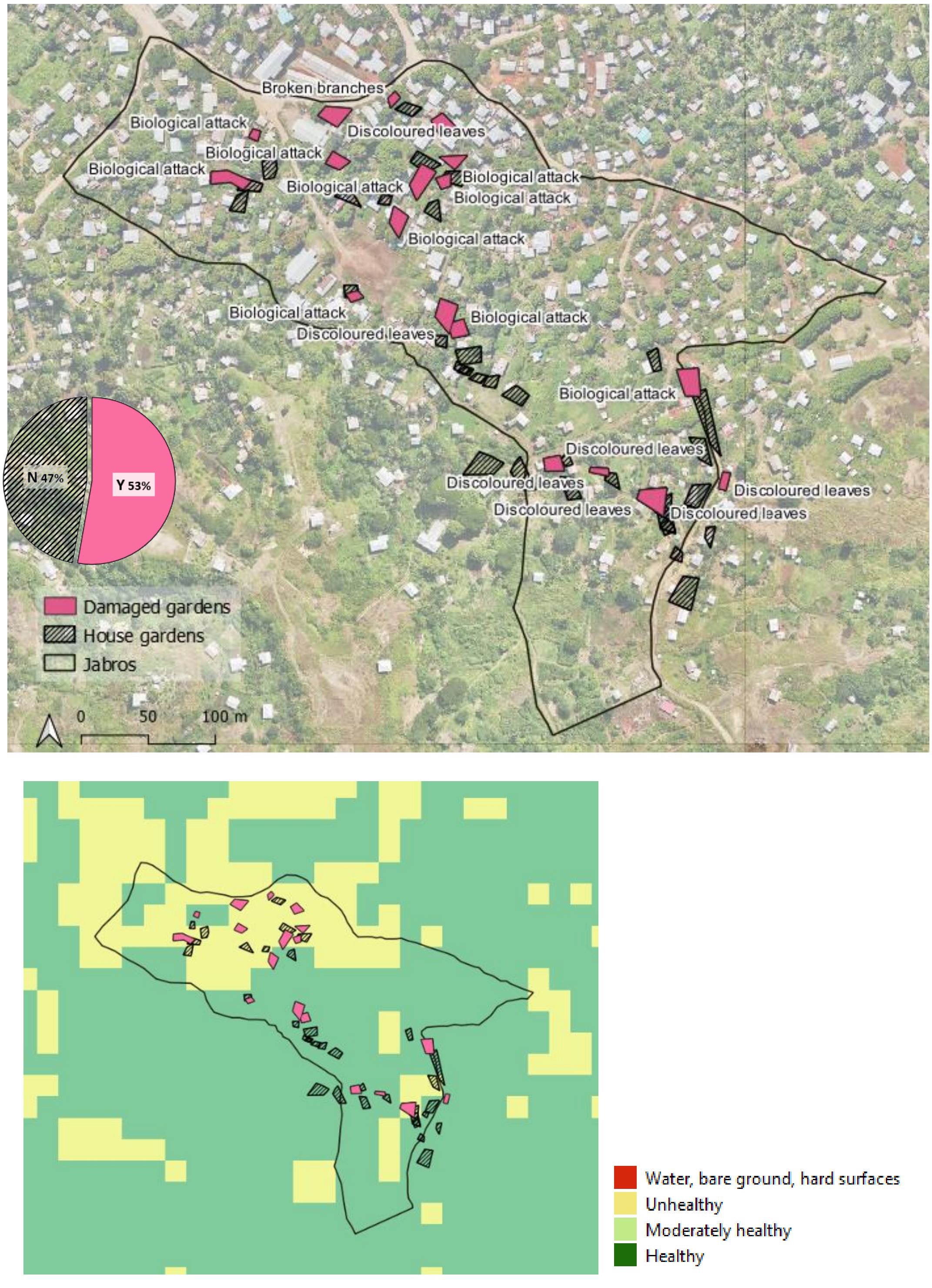


Figure 24. Distribution of house gardens with damaged crops (top) and location of damaged gardens correlated with NDVI analysis (bottom).

4. Conclusion

89 house gardens were surveyed across the peri-urban settlements of Wind Valley and Jabros. Gardens in Wind Valley are in general smaller in size, likely due to steep topography and dense housing. Women living in these peri-urban areas reported limited access to suitable land for gardens. Access to gardens is also worsening due to rapid urbanisation and the growing numbers of houses making up Honiara's burgeoning informal settlements. Some gardens can be as far as 90-minutes' walk away; often involving the navigation of steep terrain. With many of the gardens located on customary land outside the municipal boundaries, most women have negotiated access to gardens with the landowners.

Gardens in both peri-urban communities are likely to grow edible produce such as fruit and vegetables. 'Leafy greens' species are grown for family subsistence purposes, though this makes them vulnerable to pests, including the Giant African Snail. Ornamental crops are also common.

However, gardens in both communities were subject to high incidence of biological damage to crops (insects and fungus), with crops also commonly visibly stressed (e.g. discoloured leaves). Women not only highlighted the need for practical items such as seeds and tools, but also the knowledge and training needed to build raised gardens and then maintain them using best practice techniques e.g. composting, pest management, etc. Such training is needed if sup sup gardens are to remain productive in the face of overall vegetation degradation pressures. Kastom Gaden, a local civil society organisation, has been identified as being able to carry out training for women in the settlements.

The critical importance of sup sup and bush gardens for local subsistence and access to food was brought into sharp focus by the introduction of a State of Emergency in 2021; enacted to respond to the global pandemic. This sought to restrict people's movements and led to the closure of Honiara's informal 'satellite' markets (which disrupted the local cash economy and people's ability to spend). The consequences of these restrictions has resulted in renewed community interest in urban gardens as a local food security option

5. Acknowledgments

The field survey work was conducted by John Clemo and Lorraine Livia with support from local communities. Initial analysis of the data was provided by Mariana Dias Baptista.