Invasive Alien Species: A Threat to Sustainable Livelihoods in the Pacific? An Assessment of the Effects of *Wasmannia auropunctata* (little fire ant) and *Achatina fulica* (giant African snail) on Rural Livelihoods in the Solomon Islands

A dissertation presented in fulfilment of the requirements
for the degree of
Doctor of Philosophy
in
Development Studies

Massey University, Manawatū,
New Zealand.

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2016

Abstract

Invasive alien species (IAS) are a global phenomenon and are recognised as a driver of environmental change which can affect the well-being of people in a multitude of ways. Despite this, the role of IAS in local livelihoods has received relatively little attention. Influencing all three of the sustainable development pillars (social, economic, environmental), IAS should be recognised as a significant development issue. But they are not. As such, IAS issues are new to many sectors and governments and therefore largely go unseen and un-actioned.

Contemporary rural livelihoods in the Solomon Islands are heavily reliant on subsistence/semi-subsistence agriculture. Following a livelihoods' framework developed for the Solomon Islands, this thesis explores the influence IAS have on rural livelihoods in this country. Using two qualitative case studies, *Wasmannia auropunctata* (little fire ant) and *Achatina fulica* (giant African snail), this study investigates how vulnerable/resilient rural livelihoods are to the effects of IAS and the implications IAS have for sustainable development in the Solomon Islands.

The effects of IAS on rural livelihoods are complex and at times contradictory. *W. auropunctata* for the most part is not negatively affecting the dominant livelihood strategy (subsistence/semi-subsistence agriculture) practised in the Solomon Islands. While there are some social impacts associated with *W. auropunctata*, overall Solomon Island households can be considered resilient to this IAS. *Achatina fulica* is a different story. This species is negatively affecting the subsistence/semi-subsistence agricultural sector on which so many rural Solomon Island households depend. This has resulted in households implementing negative livelihood diversification measures as they fail to cope or adapt to the snails' presence. Unlike for *W. auropunctata*, Solomon Island households have not demonstrated any resilience to *A. fulica.*

Understanding how rural livelihoods are affected by various stressors and adverse events can help to design development policies and interventions geared towards building better lives for all people. This can only occur however, if the full range of

shocks are recognised. To date, this is not the case for IAS, and as such, they are still a significant missing component of development policy.

Key words: Invasive alien species, *Wasmannia auropunctata*, little fire ant, *Achatina fulica*, giant African snail, livelihoods, agriculture, impacts, sustainable development, Solomon Islands.

Acknowledgements

Thanks to my supervisors, Associate Professor Glenn Banks and Dr Rochelle Stewart-Withers, for all their help, advice and guidance throughout the PhD process.

Special thanks to my partner Amy for her support and patience during this time.

Thanks also to Dr Souad Boudjelas, John Fasi, and Bishop Terry Brown for providing advice and initial introductions to contacts in the Solomon Islands.

I am extremely thankful to all those people in the Solomon Islands who participated in this research or provided assistance while I was in the field. Your willingness to take time out of your day and share your experiences and provide help is greatly appreciated.

My gratitude also goes to my research assistants, Danny and Danny; not only for your help with my fieldwork, but also for your advice and insight into life in the Solomon Islands.

I am grateful to Eli Sarnat and Alex Wild (www.alexanderwild.com.) for permission to use their photographs of *Wasmannia auropunctata* (Photos 2.1 and 2.2 respectively). Likewise, to Max Oulton, Cartographer, Waikato University, for producing the maps used in this thesis. Thanks also to the Waikato University Geography Department for providing some desk space in their postgraduate rooms for me to work at.

Funding towards this research was provided by the New Zealand Biosecurity Institute (NZBI), the New Zealand Aid Programme (NZAID) Award for Postgraduate Field Research, and the Massey University People, Environment and Planning Graduate Research Fund.

This research was approved by the Massey University Human Ethics Committee.

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List of Acronyms

AECD	Allergenic Eczematous Contact Dermatitis
AUD	Australian Dollar
AUSAID	Australian Agency for International Development
BP	Before Present
CABI	Centre for Agriculture and Biosciences International
CBD	The Secretariat of the Convention on Biological Diversity
CBN	Cost of Basic Needs
CII	The Cooperative Islands Initiative
CLIP	Cocoa Livelihoods Improvement Project (AUSAID)
CTAHR	College of Tropical Agriculture and Human Resources
DFID	Department for International Development (UKAID)
GAS	Giant African Snail (*Achatina fulica*)
GEO	Global Environment Outlook
GISD	Global Invasive Species Database
GISP	Global Invasive Species Programme
GLF	Guadalcanal Liberation Front
GPPOL	Guadalcanal Plains Palm Oil Limited
GRA	Guadalcanal Revolutionary Army
HH	Household
IAS	Invasive Alien Species
IDS	Massey University Institute of Development Studies
IFM	Isatabu Freedom Movement
ILO	International Labour Organisation
ISSG	Invasive Species Specialist Group
IUCN	The International Union for Conservation of Nature
KGA	Kastom Gaden Association
LFA	Little Fire Ant (*Wasmannia auropunctata*)
MA	Millennium Ecosystem Assessment
MDG	Millennium Development Goals

MDPAC	Solomon Islands Ministry of Development, Planning and Aid Coordination
MECDM	Solomon Islands Ministry of Environment, Climate Change, Disaster Management and Meteorology
MEF	Malaitan Eagle Force
MEHRD	Solomon Islands Ministry of Education and Human Resource Development
MFAT	New Zealand Ministry of Foreign Affairs and Trade
MP	Member of Parliament
NDS	Solomon Islands National Development Strategy 2011-2020
NGO	Non-government Organisation
NZ	New Zealand
NZAID	New Zealand Agency for International Development
OCTA	Office of the Chief Trade Adviser
PACER	Pacific Agreement on Closer Economic Relations
PDCT	New Zealand Pacific Development and Conservation Trust
PIAG	Pacific Invasive Ant Group
PIFS	Pacific Islands Forum Secretariat
PII	Pacific Invasives Initiative
PRA	Participatory Rural Appraisal
RAMSI	Regional Assistance Mission to Solomon Islands
RRA	Rapid Rural Appraisal
RSIPF	Royal Solomon Islands Police Force
RTA	Regional Trade Agreement
SBD	Solomon Islands Dollar
SDG	Sustainable Development Goals
SI	Solomon Islands
SIAQS	Solomon Islands Agriculture Quarantine Service
SIBC	Solomon Islands Broadcasting Corporation
SIDS	Small Island Developing States
SIDT	Solomon Islands Development Trust
SIG	Solomon Islands Government
SINU	Solomon Islands National University

SITRC	Solomon Islands Truth and Reconciliation Commission
SPC	Secretariat of the Pacific Community
SPREP	Secretariat of the Pacific Regional Environment Programme
SPS	Sanitary and Phytosanitary
UK	United Kingdom
UKAID	United Kingdom Agency for International Development
UN	United Nations
UNEP	United Nations Environment Programme
UNOCHA	United Nations Office for the Coordination of Humanitarian Affairs
US	United States of America
USP	University of the South Pacific
VDR	Vidaka Damage Rate
WCED	World Commission on Environment and Development
WHO	World Health Organisation
WTO	World Trade Organisation
WWII	World War Two

Chapter 1: Invasive Alien Species – Flying Beneath the Development Radar

1.0 Mary's Story

> Before the snails came… we had an easy life here. We easily met the school fees of the children. We sold our crops in the market and got money and had income. Now it's very hard… it makes life very hard…. It's a really bad experience for us. I do not want it to happen to other people (HH female: interview # 32)[1].

Mary[2] lives with her husband and four school-aged children in a rural community on the island of Guadalcanal in the Solomon Islands. As her description above indicates, life for Mary and her family has become very difficult following the arrival of the invasive giant African snail (*Achatina fulica*) into their community. Like the vast majority of rural Solomon Island households, Mary and her family's livelihood was based predominately on semi-subsistence agriculture. They cultivated extensive areas of gardens, from which they fed the household and sold surplus crops at the market for income. The money they earned not only enabled Mary and her husband to cover expenses like the children's school fees, but it also provided for other household costs. While they were never cash rich, and life was far from idyllic, they were able to meet their basic food and non-food needs. This however all changed with the arrival of *A. fulica.*

On arriving in the area, *A. fulica* numbers increased rapidly and they soon began to have an impact on the family's gardens. Unable to keep on top of the numbers, garden crops were destroyed and the household's income decreased. Nowadays, despite spending up to one hour each day collecting snails from the area, the only food Mary is able to grow is a small patch of cassava; her once extensive gardens now lie abandoned because there are just too many snails in the area to make this a viable livelihood option. All the food and vegetables the household now needs, has to be

[1] The convention used throughout this thesis when citing interviews is as follows. The first half of the citation describes the type of interview conducted (e.g. household (HH), focus group, particular government department). The second half of the citation is the unique interview number assigned to that particular interview.
[2] Not her real name.

bought. To earn money Mary and her husband have turned to buying and on-selling betel nut at a roadside stall seven days a week, from morning to night. This is a much less profitable livelihood strategy for the household, but they have few other income-generating options available to them. The reduced income has made it a struggle to keep the children in school. The arrival of *A. fulica* has had a significant impact on the lives of Mary and her family. Not only are they now cash poor, they are asset poor. They can no longer rely on subsistence agriculture to meet their basic food needs. As Mary noted, it is now a hard life for her and her family.

1.1 Outline of the Research Problem

Mary's story is the human face of what the UNEP (2014a, p. 13) describes as "…one of the most serious but under-acknowledged threats to sustainable development in SIDS" (Small Island Developing States): the threat posed by invasive alien species (IAS). The problem of IAS is not confined to SIDS however. As will be explained in Chapter 2, IAS are a global phenomenon; a driver of environmental change which can affect the well-being of people in a multitude of ways. Posing a significant threat to both aquatic and terrestrial ecosystems (ibid.), IAS have had serious impacts on the goods and services those ecosystems provide (Reaser et al., 2007, pp. 5-6). IAS have also been implicated in the decline and extinction of species, particularly on islands (ibid., p. 1). In addition to their ecological impacts, IAS can also have socio-economic consequences (Reaser et al., 2007, p. 6; Thaman, 2013; UNEP, 2014a, p. 13). They can for example, "… pose a real threat to food security, human health, and export earnings from economic sectors including fisheries, agriculture, and tourism" (UNEP, 2014a, p. 13). In short, IAS cut across all three of the sustainable development pillars[3], and should therefore be recognised as a significant development issue. But they typically are not.

Invasive alien species are not a new phenomenon. People have been moving species around the world for millennia. Low (1999, p. 5) states that the oldest evidence for this is from New Ireland in eastern New Guinea where, sometime around 14,000 years

[3] The three pillars are economic, environmental and social.

ago[4], cuscuses (*Phalanger orientalis*) [5] were introduced to the island[6], probably as a food source. What is new, however, is the rate of spread. As the globalisation of trade has seen a marked increase in the movement of people and goods around the world, particularly over the last 50 years (Hulme, 2009, p. 11), so too has it seen an associated increase in the transport of IAS (GISP, 2006, p. 4). For good or for bad, the fate of Pacific Island countries is increasingly bound with the fate of contemporary global neoliberal practices and processes. One aspect of neoliberal sustainable development policies is the emphasis on economic growth, particularly through the reduction in the barriers to regional trade. For example, it is envisaged that the Pacific Agreement on Closer Economic Relations (PACER) Plus[7] trade and development agreement, "…will inject dynamism into the economies of Pacific Island Countries and enable them to derive significant benefits from international trade and achieve robust economic growth and sustainable development" (OCTA, 2015). While these 'significant benefits' are debateable[8], any "…rewards of free trade must be weighed against the huge costs of some of the problems it causes" (Low, 1999, p. 129). One of which is IAS. The increase in IAS that is accompanying increased trade across the Pacific region is raising concerns around the threat they pose to local livelihoods (SPREP, 2011, p. 20; Tye, 2009, p. 3).

As noted above, IAS have environmental and socio-economic consequences. Developing countries are considered to be particularly vulnerable to IAS,

> …because their economies typically rely heavily on agriculture, forestry and fishing. Moreover, within these countries it is generally the rural communities

[4] Leavesley (2005, p. 207) puts it at ca. 20,000 B.P, although he notes that the radiocarbon dates quoted in his paper are uncalibrated.
[5] *P. orientalis* is a Phalangerid possum (a marsupial). It has a wide distribution which is centred on the lowland forests of northern New Guinea and its satellite islands (Leavesley, 2005, p. 208).
[6] Low (1999, p. 6) notes that cuscuses were eventually taken west as far as Timor and east to the Solomon Islands, where they still affect the ecology to this day.
[7] PACER Plus is a regional trade and economic integration agreement currently under negotiation between the 14 member countries of the Pacific Islands Forum, Australia and New Zealand. Negotiations "…were launched by Pacific Islands Forum Leaders at their 40th Meeting in August 2009. Underpinning this initiative was recognition by Leaders of the importance of deepening regional trade and economic integration as a means to create jobs, enhance private sector growth, raise standards of living and advance the region's sustainable economic development" (MFAT, 2014).
[8] Morgan (2014, p. 333) argues that "…the high costs of island-based production suggests that even if smaller Pacific states have access to destination markets and rationalise their domestic economies through trade liberalisation, there are still only limited prospects for exports at internationally competitive prices". As a result, he notes that there is "…little consensus regarding the likelihood and extent of economic benefits arising from a regional trade agreement for the Pacific Islands Forum…." (ibid.).

> who are most at risk, as their livelihoods are almost solely based on these economic sectors… (GISP, 2006, p. 8).

Pacific Island countries (PICs) are no exception. Sustainable development in the Pacific is underpinned by island ecosystems, and the future of the Pacific and the livelihoods of its peoples rest in its productive sectors (namely agriculture, fisheries and tourism) (Barnett, 2011; PIFS, 2011). Globally, the role of IAS in local livelihoods has received relatively little focus[9] (C. Shackleton et al., 2007, p. 114). This is because IAS have primarily been deemed an ecological or environmental issue (GISP, 2006, p. i; C. Shackleton et al., 2007, p. 114). The result of this ecological focus means that IAS issues are new to many sectors and governments (Reaser et al., 2007, p. 9) and have therefore largely gone unseen. Again the Pacific is no exception. As one Pacific researcher has noted,

> IAS silently move beneath the radar screens of most of us, including our leaders, as they destroy the health and productivity of our islands and the health and hopes of our people (Thaman, 2013).

As such, there is a recognised need to regard IAS as a development issue (GISP, 2006, p. 11; UNEP, 2014a, p. 13) and give voice to those Pacific communities living with, and enduring the consequences of these invasions.

1.2 Thesis Contribution

Environmental change is a significant issue facing the planet today. It has serious consequences for both development and human well-being and as such it has been a growing focus of research. However, while there are a number of contributors to the environmental change process, much of the global environmental change focus is currently centred on climate change (Adams, 2009, p. 17). This focus is also evident in the Pacific, both in the development literature (for example see Barnett, 2011; Campbell, 2014; Gough, Bayliss-Smith, Connell, & Mertz, 2010 and the papers

[9] The exception being human health. The impacts of infectious diseases on novel human populations have been well documented (for example see Crosby, 1972, 1993; Mann, 2011, pp. 10-11). As Thaman (2013) notes, plagues and epidemics have led both directly and indirectly to the loss of millions of lives and livelihoods for centuries. This aspect of IAS is treated separately under international agreements (Perrings, Burgiel, Lonsdale, Mooney, & Williamson, 2010, p. 236). Invasive human diseases come under the mandate of the World Health Organisation (WHO), which administers the 2005 International Health Regulations. These regulations (which establish the rules countries must follow with respect to invasive human diseases) require countries to coordinate and cooperate to address human health risks (Perrings, Burgiel, et al., 2010, p. 236).

discussed therein) and in development and regional policy documents (SIG, 2011; SPREP, 2011; UNEP, 2014a). While the importance of this issue is not disputed, the focus on climate change is often at the expense of other equally important drivers of environmental change, which are in turn, equally as important to sustainable development in the Pacific (and globally). Scoones (2009, p. 189), in addition to climate change, lists a number of such drivers, including demography, urbanisation, migration, and land-use. To this I would add IAS. As another long-term, slow-wave driver of change IAS have many parallels with climate change[10], but unlike climate change, this issue, as Thaman (2013) has noted, largely flies beneath the radar.

Despite a significant body of research on the ecological impacts of IAS, and a growing body of literature which considers the economic costs[11], there has been "…limited research into and articulation of the social and human impacts of invasions…" (Rogers, 2015, p. 2), both globally and in the Pacific. Although it is acknowledged that IAS pose a threat to livelihoods in the Pacific, the paucity of research into the social and human impacts of IAS means that there is still a limited understanding of the impact they have on the livelihood strategies and well-being of households in the region.

Because the problem of IAS is still not well understood (or acknowledged) by many sectors and governments, there have been repeated calls for research on the various aspects of IAS to help raise the profile and awareness of the issue, and to ensure that IAS strategies and policies are based on the latest scientific knowledge (for example see – Browne, Pagad, & De Poorter, 2009, p. 13; Reaser et al., 2007, p. 10; Tye, 2009, p. 15; UNEP, 2014a, p. 14). This study therefore aims to respond to that research call by providing evidence on the challenges facing Solomon Island households living with IAS. The research does this by looking at two IAS case studies from the Solomon Islands, namely *Wasmannia auropunctata* (little fire ant) and *Achatina fulica* (giant African snail), and examines what influence these IAS have on rural livelihood strategies. Through this, the study aims to contribute new knowledge that will enhance

[10] For example, impacts on food security, forced migration, habitat loss.
[11] These have invariably been at the national and regional level (C. Shackleton et al., 2007, p. 114) and focus on the formal economy, not the informal economy (C. Shackleton et al., 2007, p. 114; S. Shackleton, Kirby, & Gambiza, 2011, pp. 177-178).

understanding of the influence IAS can have on Pacific people's livelihoods and add to policy discussions around the livelihood impacts of environmental change in the region.

1.3 Research Aims and Questions

This research aims to explore what influence IAS have on the livelihoods of rural Solomon Islanders. It seeks to investigate how vulnerable rural livelihoods are to the effects of IAS and whether, and to what extent, this has implications for sustainable development in the Solomon Islands.

The primary research question this study seeks to address is:

- What implications do IAS have for sustainable livelihoods in the Solomon Islands?

In order to answer this primary question the following secondary questions were developed and will be addressed by this research:

1) How are Solomon Island livelihoods influenced by *W. auropunctata* and *A. fulica*?

2) How do IAS affect the vulnerability and/or resilience of Solomon Island livelihoods?

3) To what extent do the livelihood impacts of IAS challenge current development policy in the Solomon Islands?

1.4 Conceptual and Methodology Overview of the Thesis

Central to this study is the livelihoods approach (DFID, 1999), which provides the overarching guiding conceptual framework. Because IAS issues are multi-dimensional, a holistic approach, which transcends sectoral boundaries, was chosen to explore the influence IAS have on rural Solomon Island livelihoods. A holistic approach is important because, as the UNEP (2014a, p. 51) explains,

> The social, economic and environmental pillars of sustainable development are inextricably entwined, and nowhere is this more apparent than in Small Island Developing States (SIDS), where a decision made in one sphere can have strong and immediate impact on the other two. …Many current environmental crises have their roots in human economic and social activity…. At the same time, many economic and social challenges are profoundly shaped by environmental realities….

IAS are one such reality. The livelihoods approach, with its holistic view and the need to understand the livelihoods of people in context (Arun, Heeks, & Morgan, 2004), provides a framework for exploring the realities people face in their quest to achieve their livelihood goals, and the dynamic approaches they take to do so (Carney, 1999; Scoones, 2009). As such, it was considered to be an effective approach for assessing the impacts IAS have on people's lives; albeit with some modifications, which are discussed more fully in Chapter 3.

This research takes an applied approach, in that it is concerned with understanding the nature of an issue of concern to society (Patton, 2015, p. 250). To develop this understanding the study primarily uses qualitative methods to explore the livelihoods of the participants and to gain some insight into their experiences of living with IAS. Semi-structured interviews form the main data collection method[12] and, as with the opening of this chapter, the responses of the participants are used throughout to help capture and communicate the actual experiences of what they face. "Qualitative data tell a story" (Patton, 2015, p. 54), and for audiences that are unaware, new, or even sceptical about an issue like IAS, narratives have at least as important a role in raising the profile and disseminating scientific information about the issue as do quantitative technical reports (Browne et al., 2009, p. 13).

1.5 Structure of the Thesis

This chapter (**Chapter 1**) has provided an introduction to the research. It has presented an overview of the research problem, identified that research gaps exist, and outlined how this research intends to contribute new knowledge. The aims and research

[12] See Chapter 4 for a description of the full range of methods used.

questions have been stated and the conceptual and methodological approaches driving this study have been broadly sketched.

From here, **Chapter 2** examines the problem of IAS through a review of the literature. Starting with a discussion of what IAS are, the chapter goes on to highlight the global phenomenon of IAS and why they should be considered a development issue. The chapter explores how globalisation acts as a driver for IAS. Chapter 2 continues with a review of the literature that explains why research into IAS is dominated by ecological concerns (and to a lesser degree macro-economic concerns) rather than the consequences they have for human livelihoods. The ecological, economic and social impacts of IAS are discussed and some of the shortfalls in knowledge are identified. Chapter 2 then moves on to look at IAS issues in the Pacific. Finally, the chapter introduces and explores the current knowledge from the Pacific for the two IAS species (*W. auropunctata* and *A. fulica*) on which the case studies are based.

Chapter 3 continues with an exploration of the literature, but here the focus is on the conceptual framework within which this study is situated; the livelihoods approach. The chapter begins by outlining the origins and development of the approach before describing the approach's main features. In discussing the main features, the relevance of the approach to IAS issues is illustrated using examples from the literature. The chapter then introduces and discusses the concept of livelihood diversification, again highlighting literature that shows how IAS may influence this process. A critique of the livelihoods approach follows. While the livelihoods approach is considered to be an effective framework for assessing the impacts of IAS on people's lives, it does have weaknesses that need to be considered. These weaknesses are discussed and ways of mitigating them are presented. Based on this discussion the chapter closes by presenting a revised general livelihoods framework which better accommodates the scope of this research.

The fieldwork process and the research methodology are described in **Chapter 4**. While these two processes intertwine and inform each other, I have split them in this chapter for ease of explanation. Starting with the fieldwork process, Chapter 4 begins by outlining the rationale behind why I chose the Solomon Islands for my fieldwork. The ethics of undertaking my research are discussed before the chapter proceeds with

a discussion around my time spent in the field. Patton (2015, p. 408) notes that fieldwork is dynamic, fluid, and essentially unique to the researcher. Because of this, I have endeavoured to outline in this chapter the processes, experiences and practicalities I faced while conducting my fieldwork in the Solomon Islands. Moving on from the fieldwork process, Chapter 4 continues by discussing the methodological paradigms behind this research and notes that it is pragmatism which has influenced the research design for this study. The research design, qualitative methods (including unstructured and semi-structured interviews, focus groups, and participatory approaches) used for this study, and data analysis are then discussed. The livelihoods approach and framework discussed in Chapter 3 was used not only to guide the research questions, but also informed what data was collected and how it was analysed. Chapter 4 concludes by outlining some of the limitations of the research.

Chapter 5 provides the Solomon Island context for the case studies. This context is important as it provides the backdrop which will be examined, through the lens of IAS, in the following chapters. Chapter 5 begins with a description of the Solomon Islands and then briefly explores the history of the country since European contact. Socio-political and socio-economic processes and events that have influenced life in the Solomon Islands are discussed. Running through these discussions is the premise that the majority of Solomon Island livelihoods are underpinned by subsistence/semi-subsistence agriculture, and that the informal economy is a significant factor in catering for these livelihoods. Drawing on the literature (Bourke et al., 2006) and fieldwork observations, contemporary rural livelihoods in the Solomon Islands are conceptualised as being supported by two pillars (subsistence agriculture and small-scale income-generating activities). The importance of natural capital (in the form of subsistence agricultural production) as a basis for Solomon Island livelihood diversification, along with the role that gender and culture play in contemporary rural livelihoods, is highlighted; thus linking the theoretical concepts discussed in Chapter 3 with the realities of life in the Solomon Islands. Based on the information presented in this chapter, the revised general livelihoods framework presented in Chapter 3 is refined to produce a rural livelihoods framework for the Solomon Islands. Chapter 5 concludes with a description of the study area.

Collectively, Chapters 6, 7 and 8 examine the influence IAS have on the rural livelihoods framework for the Solomon Islands, as outlined in Chapter 5. Together, these chapters address the research questions outlined in Chapter 1.

The case studies presented in **Chapter 6** (*W. auropunctata*) and **Chapter 7** (*A. fulica*) address the first of the secondary research questions, that is, how are Solomon Island livelihoods influenced by *W. auropunctata* and *A. fulica*? These two case study chapters, which draw heavily on the fieldwork component of my research, focus on the influence each species has on the two livelihood pillars described in Chapter 5. Both chapters follow a similar format. Beginning with a description of the arrival and distribution of each species, attention then moves to look at the influence each has on subsistence agriculture practices (pillar one). Discussions cover the impacts they have on subsistence agricultural activities, as well as the effects they have on subsistence agricultural productivity. Small-scale income-generating activities form the second pillar (pillar two) of rural livelihoods in the Solomon Islands. In the Solomon Islands this pillar is dominated by cash crops. How each species influences the activities and productivity of specific crops is discussed. In line with the livelihoods approach, which acknowledges that livelihoods are about more than just making an income, each of the case study chapters conclude by looking at the influence each species has on some of the other livelihood components which can affect the lives and well-being of Solomon Islanders. The two case studies presented highlight how complex and diverse the effects of IAS on rural livelihoods can be.

Chapter 8 addresses the second and third secondary research questions. These questions relate to the vulnerability/resilience context and the transforming structural processes component of the livelihoods framework described in Chapter 3 and refined in Chapter 5. Split into two parts, the first part of Chapter 8 uses the case studies to explore the vulnerability/resilience of Solomon Island livelihoods in relation to IAS. It highlights the varied, complex and often contradictory effect IAS can have on rural livelihood strategies. The second part of Chapter 8 uses the case studies from Chapters 6 and 7 to show how IAS pose a challenge to current development policy in the Solomon Islands. It illustrates a recurring theme of this thesis, that IAS cast a very wide net and have a much greater influence on rural livelihoods than is currently recognised by many governments worldwide.

Finally, **Chapter 9** reflects on the primary research question raised in Chapter 1; namely what implications do IAS have for sustainable livelihoods in the Solomon Islands? The chapter draws conclusions from the research and makes recommendations for future investigations.

Chapter 2: The Problem of Invasive Alien Species

2.0 Introduction

This chapter introduces the problem of invasive alien species (IAS) and explores why they should be considered a development issue. Starting with an explanation of what IAS are, the chapter goes on to highlight the global phenomenon of IAS. Although constituting one of the most serious drivers of global environmental change, the threat posed by IAS goes largely unseen, or unrecognised; none more so than in developing countries (UNEP, 2012a, p. 159; 2014a, p. 13). To date, IAS issues have largely been dominated by the ecological perspective (such as their impacts on biodiversity and ecosystems). This perspective, as discussed below, reflects the ecological roots of IAS research. While these ecological impacts can translate directly and indirectly into livelihood impacts, by and large, there has been little research conducted into the role IAS have in local livelihoods (C. Shackleton et al., 2007, p. 114). This lack of research, particularly in the Pacific where IAS have been identified as a major threat to livelihoods and sustainable development across the region (Thaman, 2013), is seen as a barrier to effectively addressing the issue.

2.1 What are Invasive Alien Species?

There are abundant definitions of IAS in the literature (Davis & Thompson, 2000, p. 227; Falk-Petersen, Bøhn, & Sandlund, 2006, p. 1415; Riley, 2008, p. 21; Valéry, Fritz, Lefeuvre, & Simberloff, 2008, p. 1345). As Falk-Petersen et al. (2006, p. 1409) point out, "…the scientific literature on invasion ecology seems to be particularly well endowed with synonyms", and the definition of IAS is no exception (see Table 2.1).

Table 2.1: Definitions of Invasive Alien Species (IAS)

Invasive Alien Species (IAS) Definition	**Reference**
"…are animals plants fungi and microorganisms entered and established in the environment from outside their natural habitat."	(CBD, n.d.-b)
"…an alien species whose introduction does or is likely to cause economic or environmental harm or harm to human health."	Presidential Executive Order 13112 as cited in Meyerson and Mooney (2007, p. 199)[13]
"Alien species that reach the final stage of the invasion process and have the capacity to spread (a subset of naturalized species). To become invasive, a species must overcome dispersal barriers (e.g. lack of spread seeds or restricted distribution of a crucial food plant)."	(Pyšek et al., 2008, p. 237)
"…are species that are introduced as a consequence of human activities to new geographic areas, where they become established and then proliferate and spread to the detriment of human interests and natural systems."	(GISP, 2006)
"…those non-native species that threaten ecosystems, habitats and species."	(Pejchar & Mooney, 2009, p. 497)
"…are introduced plants, animals and other organisms that can cause harm to the environment or human livelihoods."	(PII, 2010, p. 1)

[13] Fasi (2009, p. 6) and Pfeiffer and Voeks (2008, p. 281) also reference this definition although they use slightly different wording.

“…are plants, animals and other organisms taken beyond their natural range by people, deliberately or unintentionally, and which become destructive to the environment or human interests.”	(Tye, 2009, p. 2)
“Introduced species that become destructive to the environment or human interests.”	(Lovatt, 2011, p. vii)
“An alien species whose introduction and/or spread threaten biological diversity (For the purposes of the present guiding principles, the term ""invasive alien species"" shall be deemed the same as ""alien invasive species"" in decision V/8 of the Conference of the Parties to the Convention on Biological Diversity)."	(CBD, n.d.-a)
“An alien species whose establishment and spread threatens ecosystems habitats or species, with economic or environmental harm.”	(McNeely, Mooney, Neville, Schei, & Waage, 2001, p. 3)
“…means an alien species which becomes established in natural or semi-natural ecosystems or habitat, is an agent of change, and threatens native biological diversity.”	(ISSG, 2000)
“…animals, plants or other organisms introduced by man into places out of their natural range of distribution, where they become established and disperse, generating a negative impact on the local ecosystem and species.”	(ISSG, 2008)
“Alien species that sustain self-replicating populations over several life cycles, produce reproductive offspring, often in very large numbers at considerable distances from the parent and/or site of introduction and have potential to spread over long distances.”	(Richardson, Pyšek, & Carlton, 2011, p. 415)

"…species that have a net negative effect on human interests (which includes human concerns for native biodiversity)."	(Thomas & Ohlemuller, 2010, p. 21)
"A biological invasion consists of a species acquiring a competitive advantage following the disappearance of natural obstacles to its proliferation, which allows it to spread rapidly and to conquer novel areas within recipient ecosystems in which it becomes a dominant population".	(Valéry et al., 2008, p. 1349)
"Alien organisms that have established in a new area and are expanding their range."	(Falk-Petersen et al., 2006, p. 1411)

Although numerous attempts have been made to clarify terms and arrive at unifying definitions (Falk-Petersen et al., 2006; Richardson et al., 2011; Valéry et al., 2008)[14], there is still a lot of inconsistency, as Table 2.1 shows. While some of these differences can be attributed to the different sectors/contexts in which they are used (for example agriculture, marine, national legislation/policy – (Riley, 2008, pp. 22-25)), there is also an inconsistent approach by authors within a sector (for example, as shown in Table 2.1, both the Secretariat of the Convention on Biological Diversity (CBD) and Invasive Species Specialist Group (ISSG) use different definitions in different publications they have produced). Although not identical, most definitions presented in the literature are similar; sharing two or three main criteria: a human dimension, a spatial/temporal dimension and an impact dimension. These criteria are discussed more fully below.

2.1.1 The human dimension

Invasive alien species are an anthropogenic phenomenon (Pfeiffer & Voeks, 2008, p. 282) and most IAS definitions recognise, either directly or implied, that IAS are the result of human activity. People have been moving species around the world, both intentionally and unintentionally, since the beginning of human existence (Low, 2001, p. 36; Pfeiffer & Voeks, 2008, p. 282; Staples, 2001, p. 174). These species, "dubbed alien species because they are not native to the place where human activity put them"[15] (Staples, 2001, p. 171) may, or may not, become invasive. Whether an alien species is deemed to be invasive or not is largely dependent on how it reacts in its new environment; which brings into play the other two elements of most definitions.

2.1.2 The spatial/temporal dimension

Nearly all IAS definitions have a spatial element in that they define IAS as new or novel to an area. There is some debate in the literature over whether 'alien' only refers to non-native species (Richardson et al., 2011, p. 410; Richardson et al., 2000, p. 98) or if it can include native species that have moved into new environments as a result

[14] See these authors for summaries of previous attempts to propose a general definition of IAS.
[15] While this definition implies deliberate introduction of a species by humans into a new area, it can also be the result of changes to the environment by human activity which allows a species to colonise a new area (Davis & Thompson, 2000, p. 228; Valéry et al., 2008, p. 1348).

of human activity[16] (Valéry et al., 2008, p. 1348). These debates hang largely on the scale of the region under consideration (Davis & Thompson, 2000, p. 227). Given the similarity in mechanisms between native and non-natives when they move into a new area (Valéry et al., 2008, p. 1346), distinguishing between the two is largely a human construct "…rather than a distinction that has any fundamental biological meaning" (Thomas & Ohlemuller, 2010, p. 20).

The temporal element associated with IAS definitions is its rapidness. This element distinguishes IAS from "…the major (re)colonization's of biota in the course of evolution (e.g., after glaciations), which are very slow processes" (Valéry et al., 2008, p. 1349).

2.1.3 The impact dimension

A third dimension associated with many IAS definitions is the connotation of impact; where IAS are considered to cause ecological and/or economic damage. This criterion is also the subject of debate in the literature. While a number of definitions explicitly assume that invasive species cause negative impacts to the economy, environment or health (ISSG, 2008; McNeely, 2001b, p. 3; Meyerson & Mooney, 2007, p. 199), there are those that argue that the definition of IAS should be based exclusively on ecological criteria (Richardson et al., 2011, p. 415) and ontological criteria (Valéry et al., 2008, p. 1347) because impacts are "…circumstantial and variable" (ibid.).

Livelihoods research by C. Shackleton et al. (2007) and S. Shackleton et al. (2011) illustrates the circumstantial nature of the impact dimension of IAS. While prickly pear (*Opuntia ficus-indica*) is considered an invasive species in South Africa and subject to control (S. Shackleton et al., 2011, p. 179), it also forms a valuable contribution to the livelihood strategies of poor communities in the region (C. Shackleton et al., 2007, p. 120; S. Shackleton et al., 2011, p. 190), decreasing

[16] An example of this would be New Zealand's *Metrosideros excelsa*. *M. excelsa* "…is one of a number of *Metrosideros* species found in the Pacific. Its natural range in New Zealand is limited to the northern part of the North Island. Garden cultivation has now resulted in the tree becoming widespread outside its natural range. As well as invading natural ecosystems, it is hybridizing with the southern *Metrosideros* tree species. In the meantime, *Metrosideros kermadecensis*, introduced to northern mainland New Zealand from the offshore Kermadec Islands, is hybridizing with *M. excelsa*, threatening that species within its natural range" (CBD, 2001, p. 15).

household vulnerability (C. Shackleton et al., 2007, p. 120). As C. Shackleton et al. (2007, pp. 121-122) note "IAS are rarely uniformly problematic or uniformly beneficial to entire geographic communities. …Consequently, an IAS that has negative consequences for one group of rural stakeholders may have either a neutral or positive impact for others." Others (Low, 2001, p. 39; McNeely, 2001a, p. 10; Pfeiffer & Voeks, 2008, p. 283) also note that certain invasive species have been incorporated into local systems and are seen as positive attributes for some sectors of the community.

With this in mind it would seem that the exclusion of an impacts dimension from the definition of IAS is a valid argument. However, it is recognised that human and ecological systems are linked and cannot be treated independently (Berkes, Colding, & Folke, 2003, p. 3; Folke et al., 2002, p. 437; Millennium Ecosystem Assessment, 2005a, p. iii). Therefore, the concept of IAS cannot solely be dependent upon ecological criteria, but should also include human or social-economic criteria (McNeely, 2001a, p. 17). To paraphrase Cannon & Muller-Mahn's (2010, p. 632) discussion of another global environmental driver, climate change, the issue with a solely ecosystem approach is that it fails to account for the socio-economic system, shifting the focus away from the human dimension which is the root cause of the problem. With the ecosystem focus alone, there is a loss of the concept that it is the socio-economic systems themselves that expose people to different levels of risk.

Therefore, this thesis includes an impact dimension in its definition of IAS. However, as some authors have shown (Kaufmann, 2004; Kull et al., 2013; Pfeiffer & Voeks, 2008; C. Shackleton et al., 2007; S. Shackleton et al., 2011) impacts can also be positive, depending on the circumstances being considered.

2.1.4 Definition

Taking into account the above discussion, this thesis adopts a modified version of Valery et al.'s (2008, p. 1349) definition, defining IAS as;

> A species that acquires a competitive advantage following the disappearance of natural obstacles to its proliferation, which allows it to spread rapidly and to conquer novel areas within recipient ecosystems where it then becomes a

dominant population, resulting in impacts (either positive, negative, or both) on the environment and/or human livelihoods.

2.2 Invasive Alien Species: A Global Development Issue

Global environmental change is seen as one of the most pressing challenges facing the planet today (UNEP, 2012b, p. 2) as "humankind depends on the environment, which is critical for both development and human well-being" (UNEP, 2007, p. 4). This notion of global environment change has its foundations in the environmentalist movement of the 1960s and 1970s, in which environmental degradation was highlighted as a second global crisis, paralleling (but ultimately interconnected with) sustainable development and poverty (Adams, 2009, p. 15 & 19). Global environmental change is "…culturally, economically and sociologically shaped" (Dolman & Verhagen, 2003, p. 5) and the idea that environmental issues and sustainable development are closely (albeit complexly) linked had been recognised by the 1990s (Adams, 2009, p. 19).

Since that time a number of contributing factors to the environmental change process have been identified (for example climate change, land use/land change, over-exploitation of natural resources, pollution, to name a few) (Millennium Ecosystem Assessment, 2005b, p. 14; Vitousek, D'Antonio, Loope, Rejmanek, & Westbrooks, 1997, p. 2). While much of the global environmental change focus is currently centred on climate change (Adams, 2009, p. 17; Vitousek et al., 1997, p. 1) other global environmental change drivers are equally as important to sustainable development and warrant attention. IAS are one of these.

The Millennium Ecosystem Assessment (MA[17]) (carried out between 2001 and 2005) assessed the consequences of ecosystem change for human well-being (Millennium Ecosystem Assessment, 2005b, p. v). Focusing on the link between ecosystems and human well-being, it paid particular attention to ecosystem services, which it

[17] The use of 'MA' follows the nomenclature used by the Millennium Ecosystem Assessment reports. For example, see the MA Ecosystems and Human Well-being: Biodiversity Synthesis Report (Millennium Ecosystem Assessment, 2005a, p. 83).

considered to be the benefits people obtain from ecosystems (ibid.). These benefits include:

> "*provisioning services* such as food, water, timber, and fibre; *regulating services* that affect climate, floods, disease, wastes, and water quality; *cultural services* that provide recreational, aesthetic, and spiritual benefits; and *supporting services* such as soil formation, photosynthesis, and nutrient cycling" (Millennium Ecosystem Assessment, 2005b, p. v - emphasis in original).

Acknowledging that people are an integral part of ecosystems and are fundamentally dependent on the flow of ecosystem services, the MA examined how changes in ecosystem services (driven both directly and indirectly by human activity) influences human well-being (ibid.) or livelihoods[18]. One of the most important direct drivers of change identified in the MA are IAS (along with habitat change, over exploitation, pollution and climate change – (Millennium Ecosystem Assessment, 2005b, p. 14)).

Invasive alien species have been implicated in the alteration/degradation of a number of services and sectors, including: freshwater ecosystems, agriculture, terrestrial biodiversity, tourism, marine ecosystems, human health (Reaser et al., 2007) and forestry (GISP, 2006, p. 11). Taken across all sectors (such as human health, agriculture, forestry, marine) "…the problem of invasive species makes all other environmental problems pale into insignificance" (Perrings, Mooney, & Williamson, 2010, p. 2). Collectively, more resources are committed to "…protecting ourselves against invasive pests and pathogens, and we lose more in productivity, health, and security from the same sources, than from any other environmental stress" (ibid.). However, because losses from IAS are not always readily identifiable and are spread across many different sectors and stakeholders, there is a general lack of awareness of IAS within industries, communities and governments (Barnard & Waage, 2004, p. 4; Browne et al., 2009, p. 8; Pejchar & Mooney, 2009, p. 502); leading Achim Steiner (2010), Executive Director of the United Nations Environment Programme (UNEP), to state that "… far too many countries have failed to grasp the scale of the [IAS]

[18] The MA considers livelihoods to be one component of human well-being. Here I use the broader DFID (1999) concept of livelihoods (discussed in Chapter 3) which covers all the MD well-being constituents.

threat, or are far too casual in their response". This limited awareness is seen as a major constraint to effective action (IUCN, 2012a, p. 2).

The UNEP Global Environment Outlook (GEO) project, initiated in response to the reporting requirements of *Agenda 21*[19] (UNEP, 2002, p. 16) also identifies IAS as an important factor of environmental change and a threat to human well-being (UNEP, 1999, p. 4). The 2012 report, GEO-5, which provides the latest information[20] on the state and trends of the global environment, found that there had been little or no progress on the trends in IAS (UNEP, 2012b, p. 10), (which it identifies as continuing to spread) and that there were significant gaps in knowledge, particularly regarding their numbers and impacts in developing countries (UNEP, 2012a, p. 159).

Developing countries (especially islands) are seen to be particularly vulnerable to IAS (Barnard & Waage, 2004, p. 4; Reaser et al., 2007, p. 1; Tye, 2009, p. 3; UNEP, 2014a, p. 13) and consequently so too are the livelihoods of those that live in these nations. Invasive alien species are seen to contribute to social instability and economic hardship by placing constraints on economic growth, poverty alleviation and food security (GISP, 2006, p. 6; Reaser et al., 2007, p. 2). These constraints (such as reducing the yields of agriculture, forestry and fisheries for example) compromise international sustainable development objectives such as those of the Millennium Development Goals (MDGs) (Fish et al., 2010, p. 9; Steiner, 2010) and more recently the Sustainable Development Goals (SDGs). Despite this, IAS were not mentioned in the MDGs and, while included as a target (Target 15.8)[21] in the SDGs, they are limited to an environmental focus. This environmental focus is the dominant perspective on IAS. However, as will be emphasised throughout this thesis, IAS cast a much broader net than this.

Invasive alien species increase the vulnerability of nations to environmental, economic and health challenges (Thaman, 2013; UNEP, 2014a, p. 13), which in turn can affect

[19] *Agenda 21* is a non-mandatory action plan of the United Nations promoting sustainable development. It was the main output of the Earth Summit (UN Conference on Environment and Development) held in Rio de Janeiro, Brazil, in 1992 (Adams, 2009, Chapter 4).
[20] GEO-6 is due for release in 2017 (UNEP, 2014b).
[21] "By 2020, introduce measures to prevent the introduction and significantly reduce the impact of invasive alien species on land and water ecosystems and control or eradicate the priority species" (United Nations, n.d.).

the vulnerability of the world's poorest people and influence their ability to secure stable and meaningful livelihoods. Despite the seriousness of the issue, the threat IAS pose to sustainable development is still greatly under-acknowledged (UNEP, 2014a, p. 13). Consequently, there is a recognised need to regard IAS as a development issue (Barnard & Waage, 2004, p. 5; Fish et al., 2010, p. 52; GISP, 2006, p. 11; UNEP, 2014a, p. 13) and evaluate the impacts they have on the livelihoods of those most at risk.

2.3 Globalisation as a Driver of Invasive Alien Species

Globalisation is more than an economic phenomenon, it is also a biological one; and the two are closely linked. A number of authors point to the close link between trade and the spread of IAS (for example see Hulme, 2009, p. 10; Levine & D'Antonio, 2003, p. 323; McNeely, 2001a, p. 5; 2006, p. 6; Meyerson & Mooney, 2007, p. 199; Perrings, Fenichel, & Kinzig, 2010, p. 42; Perrings, Mooney, et al., 2010, p. 7; Reaser et al., 2007, p. 2; Westphal, Browne, MacKinnon, & Noble, 2008, p. 392). As McNeely (2006, p. 6) succinctly puts it "[t]rade, and more generally economic development, lead to more IAS". As stated earlier, people have been moving species around the world for millennia (Hulme, 2009, p. 10) so the spread of species today is nothing new (Low, 2001, p. 36). What is new however, is the rate of spread. Hulme (2009, p. 11) notes that while global trade has gradually increased over the last 200 years as economies have grown, there has been an unprecedented acceleration over the last 50 years. This has significance for the number and rate of new species introductions (Levine & D'Antonio, 2003, p. 324; Westphal et al., 2008, p. 395) as many IAS are not intentionally introduced but arrive as stowaways or contaminants of a commodity (Hulme, 2009, p. 14).

As global trade increases, invasion rates are also predicted to increase (Levine & D'Antonio, 2003, p. 325; Meyerson & Mooney, 2007, p. 200), as will the associated environmental, economic and social impacts (Meyerson & Mooney, 2007, p. 200; Westphal et al., 2008, p. 392). A significant factor influencing this issue is the trend toward regional trade agreements (RTAs) (Perrings, Mooney, et al., 2010, p. 8). These agreements aim to reduce the barriers to the movement of goods and people between the signatory countries, but "…the more open economies are, the more vulnerable they

are to species introductions" (Perrings, Fenichel, et al., 2010, p. 42). To date[22] 625 RTAs have been notified to the World Trade Organisation (WTO). One consequence of this has been a reduction in the effectiveness of import protection measures applying to the trade between member states (Perrings, Mooney, et al., 2010, p. 8), as the political power of governments to regulate such trade is reduced (Low, 2001, p. 39; McNeely, 2006, p. 10). This, coupled with having fewer resources to mitigate or address the risks posed by IAS place developing nations at a significant disadvantage (Barnard & Waage, 2004, p. 4; Perrings, Burgiel, et al., 2010, p. 245), increasing the vulnerability of their populations to the impacts of IAS. One example of this is the lopsided application of the precautions of the international Sanitary and Phytosanitary (SPS) Agreement[23]. Implementing the available protections against IAS under this agreement requires the production of supporting scientific evidence, effectively limiting this option to wealthier countries (Perrings, Burgiel, et al., 2010, p. 235), and leaving many developing nations little option but to live with the consequences of invasions.

Another issue is that because the costs of IAS are largely externalised when considering the costs of global trade (McNeely, 2006, p. 9; Perrings, Mooney, et al., 2010, p. 12), those who benefit from the trade and those who pay the costs associated with any subsequent IAS invasion are disproportionately different (McNeely, 2006, p. 9; Pejchar & Mooney, 2009, p. 498). While exporters and direct participants in global trade enjoy the benefits (Foote, 2004, p. 13) "… the general public and future generations end up paying most of the costs" (McNeely, 2006, p. 9). Nevertheless, current neoliberal development policies have an emphasis on economic growth, particularly through the reduction in barriers to regional trade (MFAT, 2015, p. 3)[24]. As noted above, this will see an associated increase in IAS, which developing

[22] 1 February 2016 - see http://www.wto.org/english/tratop_e/region_e/region_e.htm
[23] "Sanitary and phytosanitary (SPS) measures are typically applied to both domestically produced and imported goods to protect human or animal life or health from food-borne risks; humans from animal and plant-carried diseases; plants and animals from pests or diseases; and, the territory of a country from the spread of a pest or disease" (Zarrilli, 1999, p. 9). The SPS Agreement "…recognizes that countries have the right to maintain SPS measures for the protection of the population and the agricultural sector. However, it requires them to base their SPS measures on scientific principles and not to use them as disguised restrictions to trade" (ibid.).
[24] Also see Goal 8 and Target 17.10 of the SDGs (United Nations, n.d.).

countries are seen to be particularly vulnerable to. This further highlights the need to evaluate how IAS influence the livelihoods of those in developing nations.

2.3.1 Invasive alien species and climate change

Accompanying the unprecedented rates of global trade and its associated increase in the spread of IAS is the issue of climate change (Thomas & Ohlemuller, 2010, p. 25). While there are still many uncertainties around climate change which make predicting the consequences challenging, there is confidence within the scientific community generally with regard to the direction it is taking (Dukes, 2011, p. 347). Studies on how IAS will respond to climate change are still relatively new, but the issue is receiving increasing attention (ibid.). Potential responses include an expansion of the locations at which IAS may establish, the pathways through which they establish and even which species become invasive. Additionally, climate change could alter the impacts IAS have and the management options available to mitigate these impacts (Hellmann, Byers, Bierwagen, & Dukes, 2008, pp. 536-537; New & McSweeney, 2010, p. 31). On their own IAS and climate change are each significant drivers of global environmental change. Together, they are a "…potent force" (Thomas & Ohlemuller, 2010, p. 26) that in some cases will amplify each other's impacts and consequences (Dukes, 2011, p. 354; GISP, 2006, p. 4; IUCN, 2012b, p. 1; Thomas & Ohlemuller, 2010, p. 26). Climate change, through its interaction with IAS, will directly affect the living conditions of the most vulnerable through changes in the conditions from which people seek to achieve their livelihoods. However, while the effects climate change may bring are undeniably concerning, one should not lose sight of the fact that IAS issues are happening here and now. The influence IAS are having on contemporary livelihoods is the focus of this thesis.

2.4 The Impacts of Invasive Alien Species

Invasive alien species can have both direct and indirect impacts. Additionally, any single species can have several impacts which can interact with other factors to reduce or magnify its effects (Fish et al., 2010, p. 15). The invasive weed Parthenium (*Parthenium hysterophorus*), for example, can have a whole cascade of effects. Routine contact with the plant can cause allergenic eczematous contact dermatitis (AECD) and asthma (Fish et al., 2010, p. 16; Reaser et al., 2007, p. 7). Potentially this

can change the working practices or negatively affect the volume of work of those affected, with multiple follow on social and economic consequences (Fish et al., 2010, p. 15). Additionally, as a cropland weed, Parthenium can lower crop yields due to competition for resources. Reduced crop yields can affect food security or income in the case of cash crops; both of which also have a number of flow-on consequences (ibid.). Adding to the complexity, IAS can have consequences for more than one sector, and in some instances, impacts on one sector may be in opposition to impacts on another (Hulme, 2011, p. 306; Pejchar & Mooney, 2009, p. 502; 2010, p. 171). IAS therefore affect people in a multitude of ways.

While some sectors have had a long history of dealing with IAS (such as agriculture and human health[25]) (Fish et al., 2010, p. 8; Hulme, 2011, p. 302; McNeely, 2001a, p. 6; McNeely et al., 2001, p. 12), the global problem of IAS has only been the focus of attention in relatively recent times (Barnard & Waage, 2004, p. 4; McNeely, 2001a, p. 6). This global environmental issue grew out of concerns ecologists had with the impacts IAS were having over biodiversity and ecosystems (McNeely, 2001a, p. 6). Despite some earlier work (for example see Elton, 1958)[26] invasive species publications did not appear in the literature in any significant numbers until the 1980s and 1990s (MacIsaac, Tedla, & Ricciardi, 2011, p. 59; Pyšek, Richardson, & Jarošík, 2006, p. 438; Simberloff, 2011, p. 14). As such, much of the work on IAS to date has been dominated by ecological concerns (McNeely, 2001a, p. 6; Pejchar & Mooney, 2009, p. 502; Perrings, 2011, p. 316; Pfeiffer & Voeks, 2008, p. 281), in particular, as stated above, their impacts on biodiversity and ecosystems.

This dominant focus on the biodiversity consequences of IAS reflects the ecological roots of IAS research, which until relatively recently worked generally in the 'natural' system which excluded the influences of humans (Pyšek et al., 2006, p. 438). While many IAS papers note that IAS impacts on biodiversity and ecosystems can have flow on effects for human livelihoods, this has been a more recent development (Adams, 2009, p. 15), and in many cases this aspect is not expanded on. Accordingly, there is

[25] See note 8 Chapter 1.
[26] Charles Elton's book *The Ecology of Invasions by Animals and Plants* (Elton, 1958) is seen by many as the beginning of the field of invasion ecology (Richardson, 2011, p. vii). However, Simberloff (2011, p. 12) argues that Elton's book had limited influence on the development of the field (which he argues occurred much later) and regards Elton as more of a prophet than a founder.

still a strong focus solely on the ecological aspects of much invasion biology research (Pejchar & Mooney, 2010, p. 174) rather than the livelihood consequences they have for the people living with the invasion. This disconnection between environmental problems and development, despite their close links, is a long-standing issue (Adams, 2009, p. 19). In what he describes as "one problem, two cultures" Adams argues that "… in the three decades of sustainable development that followed publication of the Brundtland Report[27] in 1987, the fields of developmental and environmental studies have been far from unified" (ibid.). Although there is considerable overlap between the two cultures, they "… have often remained remote from each other both conceptually and practically" (ibid.).

2.4.1 The ecological impacts of invasive alien species

The biodiversity impacts of IAS have been assessed across multiple levels of organisation (such as genes, species, habitats and ecosystems) (Reaser et al., 2007, p. 4). At the population level, hybridisation of IAS and native species has resulted in detrimental impacts on endemic species (through reductions in the endemic populations). For example, hybridisation with the introduced North American mallard duck (*Anas platyrhynchos*) has had significant negative impacts on New Zealand grey duck (*Anas superciliosa superciliosa*) and Hawaiian duck (*Anas wyvillia*) numbers (Rhymer & Simberloff, 1996, p. 86).

Invasive alien species can affect species diversity through processes such as predation, competition and disease transmission (Reaser et al., 2007, p. 4). For example, the predatory rosy wolfsnail (*Euglandina rosea*), introduced from the United States of America, has been implicated in the extinction of endemic snail populations in French Polynesia (Lowe, Browne, Boudjelas, & De Poorter, 2000, p. 10). Likewise, the introduction of the southern house mosquito (*Culex quiquefasciatus*) into Hawaii facilitated the spread of avian malaria (*Plasmodium relictum*), another introduced species, into the native bird populations. At least ten native Hawaiian bird species have become extinct as a result, and the disease, through its mosquito vector, threatens many more (Lowe et al., 2000, p. 5).

[27] See WCED (1987).

Invasive alien species have also contributed to habitat fragmentation, alteration and degradation (Reaser et al., 2007, p. 5). The South American ornamental tree *Miconia calvescens* has had a major impact on the island of Tahiti. Introduced into a botanical garden in 1937, more than half of the island is heavily invaded by this plant today (Lowe et al., 2000, p. 9). With its large leaves shading out the forest understorey and its shallow roots promoting landslides and erosion, it has become the dominant canopy tree on the island (Lowe et al., 2000, p. 9; Reaser et al., 2007, p. 5), threatening several of the islands endemic species as a result of habitat loss due to this plant (Lowe et al., 2000, p. 9).

At the ecosystem level, IAS impacts include changes in the trophic structure, alteration of hydrological and nutrient cycles, and impacts on water quality (Pejchar & Mooney, 2010, p. 163; Reaser et al., 2007, p. 5). On Christmas Island in the Indian Ocean, yellow crazy ants (*Anoplolepis gracilipes*) have impacted on the island's forest ecosystem. Their most notable impact has been their decimation of the island's red land crab (*Gecarcoidea natalis*) which plays an important role in litter breakdown (Lowe et al., 2000, p. 4). The loss of the crabs (three million in an 18 month period (ibid.)) resulted in an accumulation of leaf litter which had flow on effects for the island's food-web (Reaser et al., 2007, p. 6). The ants farming of honey-dew producing Homoptera[28] has resulted in population booms of these insects, which damage the forest canopy (Lowe et al., 2000, p. 4; Reaser et al., 2007, p. 6). Although the ecological impacts of IAS can translate directly and indirectly into livelihood impacts[29], the consequences of this is not the focus for much of the IAS literature on these issues.

2.4.2 The economic impacts of invasive alien species

While the IAS literature has been largely dominated by ecological concerns, there has been a rapid increase in recent years in economic studies on invasive alien species (Lodge, Lewis, Shogren, & Keller, 2009, p. 18; Touza, Derechsler, Johst, & Dehnen-Schmutz, 2010, p. 145). Decision makers, particularly governments, are widely

[28] Homoptera are plant sucking insects. (Encyclopaedia Britannica, 2012).
[29] For example, habitat degradation and changes in hydrological and nutrient cycles can impact on food security.

influenced by arguments couched in economic, rather than emotive or ethical terms (McNeely, 2001a, p. 14). As such economic arguments around the costs and benefits of IAS have also been used to highlight the IAS issue (ibid.).

There is no debate that IAS can impose a considerable cost on society (Evans, 2003, p. 6; McIntosh, Finnoff, Settle, & Shogren, 2009, p. 151; Polasky, 2010, p. 100). How big a cost though is unknown; widely reported estimates such as those by Pimentel (2011) and Pimentel et al. (2000; 2001; 2005), which in one estimate, puts the global cost at over US$1.4 trillion per year[30] (Pimentel et al., 2001, p. 14), are noted as being far from complete (Lodge et al., 2009, p. 18; Perrings, 2011, p. 320).

In addition to these estimates there are many case studies (largely from developed countries) of the damage costs of particular IAS (Perrings, 2011, p. 320). For example, the initial stages of the response programme for the yellow crazy ant (*A. gracilipe*) on Christmas Island, as described above, cost around AUD$1.5 million (Reaser et al., 2007, p. 8). The coqui frog (*Eleutherodactylus coqui*), introduced into Hawaii in the mid to late 1990s is depressing real estate values[31] due to its very loud, piercing calls, which it makes from around dusk till dawn (Beard & Pitt, 2005, p. 1; Kaiser & Burnett, 2006, p. 1 & 5). It also threatens the multimillion dollar floriculture and nursery industries due to decreased sales from customers reluctant to purchase potentially infested material (Beard et al., 2009, p. 300) and from stringent quarantine regulations (Beard & Pitt, 2005, p. 1; Beard et al., 2009, p. 300) aimed at stopping their spread.

Furthermore, most estimates of the economic costs of IAS focus on the formal economy, not the informal economy (S. Shackleton et al., 2011, pp. 177-178). The informal economy is a significant component of the economic and social make up of developing countries (Chant, 2002, p. 213; de Soto, 1989, p. 12; Jütting & de Laiglesia, 2009a, p. 18; Portes, Castells, & Benton, 1989, p. 1). On average around 60 per cent of workers in developing countries operate in the informal economy (Bacchetta, Ernst, & Bustamante, 2009, p. 9), although there are large regional variations to this figure[32]

[30] Close to 5% of global GDP (Pimentel et al., 2001, p. 14).
[31] Its presence is now a disclosure requirement for property sales (Beard, Price, & Pitt, 2009, p. 300).
[32] For example, in sub-Saharan Africa the rate reaches at least 80 percent (Jütting & de Laiglesia, 2009b, p. 11).

(Bacchetta et al., 2009, p. 38; Jütting & de Laiglesia, 2009a, p. 20). Regardless of the exact figure, the informal economy, particularly in developing countries, is a central aspect of people's livelihoods and is more the norm than the exception (Jütting & de Laiglesia, 2009b, p. 11). Consideration therefore needs to be given to how IAS influence livelihoods operating within the informal economy. Another issue associated with this is that some groups are more susceptible to informal employment than others. Women for example are over-represented among the informal sector (Jütting & de Laiglesia, 2009b, p. 13; Kucera & Xenogiani, 2009, p. 90; Peake & Trotz, 2002, p. 336) which may potentially make them more vulnerable to the economic impacts of IAS. As there are few studies on IAS that take a gender perspective (Fish et al., 2010, p. 5), this aspect is one that also warrants closer attention.

As the above discussion implies, assessing the true costs of IAS is difficult and imprecise. This is because the economic cost of IAS goes beyond the direct market impacts (such as those a pest may have on agricultural yields) to include indirect non-market impacts (such as impacts on ecosystem functions) (Evans, 2003, p. 7). Valuing the non-market impacts of IAS is a challenge (Evans, 2003, p. 8; Hulme, 2011, p. 306; Lodge et al., 2009, p. 20), as they are for many global environmental issues (Adams, 2009, p. 143; Lodge et al., 2009, p. 20); a problem economists have been debating for some time[33] (Adams, 2009, p. 143).

2.4.3 The social impacts of invasive alien species

There are few studies on the social impacts of IAS, and this is particularly so for developing countries (Fish et al., 2010, p. 23). Pfeiffer and Voeks (2008, p. 282) argue that critical questions around how IAS have impacted social systems and cultural landscapes remain unaddressed. This is a view supported to some extent by C. Shackleton et al. (2007, p. 114) who argue that there is relatively little research on the role IAS have in local livelihoods. Focusing on the impacts on ecosystem services, Pejcher and Mooney (2009, 2010) note that interactions between IAS and cultural

[33] See Chapter 6 of Adams (2009) for a detailed review of the development and debates of environmental economics.

services[34] are the most complex, are the least understood, and are not well documented (Pejchar & Mooney, 2009, p. 502).

Human pathogens aside, the view that IAS are more than just an ecological or economic problem is starting to receive more consideration. In a livelihoods study on the impacts of prosopis (*Prosopis juliflora*) in Kenya, Maundu et al. (2009) discuss the positive and negative impacts of this invasive plant on local communities. These included social aspects, such as its beneficial use as a shade tree in hot dry areas[35] and, due to its thorns, its use as a fence to deter thieves and snakes (ibid., p. 44 & 46). Health issues associated with the thorns, however, were the most common negative issue raised by communities, who reported suffering both physical and psychological harm (ibid., p. 46). Siges et al. (2005, pp. 886-887) also highlight social issues resulting from the spread of the invasive shrub *Piper aduncum* in Papua New Guinea, including for example the loss of indigenous knowledge regarding traditional food sources and non-timber products.

Despite these and other examples (for example see Fish et al., 2010; Geesing, Al-Khawlani, & Abba, 2004; Kaufmann, 2004; Rogers, 2015; Thaman, 2013), the social impacts of IAS are still the least explored of what is already an under represented livelihoods issue. This is particularly so for developing nations, who in a lot of ways are the most vulnerable to the effects of IAS and the least equipped to mitigate them (Barnard & Waage, 2004).

2.5 Invasive Alien Species in the Pacific

As stated previously, humans have been moving species around the world for millennia and the Pacific is no exception to this phenomenon. Kirch (1982, p. 3) notes that there is direct archaeological evidence of invasive plants being introduced into pre-European Hawaii by the colonising Polynesians. This process would not have been unique to Hawaii but repeated throughout Polynesia and Melanesia as humans

[34] Defined as the non-consumptive attributes of an ecosystem - for example those attributes that "…hold value for recreation, tourism, culture, history, education, science, heritage, inspiration, spirituality and aesthetics" (Pejchar & Mooney, 2009, p. 501; 2010, p. 171).
[35] Although this effect was also seen as a negative aspect with regard its impact on biodiversity (Maundu et al., 2009, p. 46).

colonised new lands (intentionally and unintentionally bringing with them new species, some of which would have become invasive) and subsequently traded between them.

Like all humans, the people of the Pacific transformed their island habitats, manipulating the environment and adapting their practices[36] (Rapaport, 2006), which over many generations have developed into the rich diversity of cultures and livelihoods seen today (SPREP, 2011, p. 7). While resource extraction and use, and ecosystem modification, have been ongoing since people first stepped onto the land, modern development pressures are accelerating this tread, "…undermin[ing] the very basis of the Pacific way of life, which requires healthy ecosystems and continued access to natural resources for livelihoods and cultural enrichment" (SPREP, 2011, p. 1). Invasive alien species are seen as a significant factor contributing to this. Their rapid increase via transport and trade has been identified as a major threat to livelihoods across the region (SPREP, 2011, p. 20; Thaman, 2013; Tye, 2009, p. 3). However, despite the recognised dependence many Pacific Islanders have on their natural resources for subsistence and semi-subsistence lifestyles (Barnard & Waage, 2004, p. 36), and the threat IAS pose to their livelihoods, IAS research in the Pacific has (like elsewhere - see section 2.4) been dominated by ecological rather than livelihood concerns. While this reflects the global trend with regards the issue, it is also partially an artefact of the disproportionately low level of IAS research conducted on islands (Pyšek et al., 2008, pp. 239-241).

This paucity of scientific research on the impacts of IAS, particularly those impacts they have on people's livelihoods, is a barrier to implementing effective policies addressing the issue. As Barnett (2001, pp. 981-982) notes, governments (and decision makers generally) are reluctant to invest scarce resources into solutions to meet problems whose impacts are uncertain or unknown, due to the social and political risks that may be incurred. This is a view backed up by Lodge et al. (2009, p. 18), who note that most national policies have paid little attention to the threat of invasive species. It is also reflected in the few local policy documents that do attempt to address IAS

[36] Also see Kirch (2000, pp. 59-62) for a description of early environmental impacts in the Pacific following human colonisation.

issues. For example, the 'Guidelines for Invasive Species Management in the Pacific'[37] (Tye, 2009) notes that decision makers have a limited understanding of the threats IAS pose and that this is a key constraint in addressing IAS issues in the Pacific (ibid. , p. 6). One of the key themes of this policy document is to generate support for the issue by raising awareness of the impacts IAS have on, among other things[38], livelihoods in the region. To achieve this, the 'Guidelines' recognise the need for species-focused research on the impacts of high priority species so that managers have the necessary information to take effective action (Tye, 2009, pp. 14-15). Two such species are *Wasmannia auropunctata* (little fire ant) and *Achatina fulica* (giant African snail).

2.5.1 Wasmannia auropunctata in the Pacific

Ants are considered to be the most harmful group of invasive insects on islands (CBD, 2003, p. 16; Reaser et al., 2007, p. 8). Highly successful as invaders (Causton, Sevilla, & Porter, 2005, p. 159; PIAG, 2004, p. 5) they are "…among the most widespread and damaging of introduced species" (Tsutsui & Suarez, 2003, p. 48). Of particular concern are the 'tramp'[39] ant species that are spread around the world by trade and other human-assisted pathways (PIAG, 2004, p. 5; Wetterer, 1997, p. 3), causing significant economic, environmental and/or social impacts (CTAHR, 2010; Jetter, Hamilton, & Klotz, 2002; PIAG, 2004, p. 5; Tsutsui & Suarez, 2003, p. 49; Wetterer & Porter, 2003, p. 2). To date at least thirty-five ant species have invaded the Pacific region. One of these is *W. auropunctata* (Photos 2.1 and 2.2).

Native to the neotropics (Wetterer & Porter, 2003, p. 2), *W. auropunctata* is easily transported, and growing trade between countries has seen it spread to many parts of the world (Causton et al., 2005, p. 160), SIDS in the Pacific included. *Wasmannia auropunctata* is considered to be a major threat to the Pacific region (Fasi, Brodie, & Vanderwoude, 2013, p. 7), through which it is rapidly expanding.

[37] This regional policy document aims to provide a comprehensive framework for IAS management in the Pacific (Tye, 2009, p. 3). A similar theme occurs in another regional policy document, 'The Pacific Regional Environmental Programme Strategic Plan 2011-2015' which has lifting IAS up the political agenda as one of its targets (SPREP, 2011, p. 23).
[38] Biodiversity, economics and health are the other aspects identified.
[39] Ants that are human commensal (McGlynn, 1999, p. 536).

Photo 2.1: Wasmannia auropunctata (little fire ant). The ant is considered to be a significant threat to biodiversity and livelihoods within the Pacific region (Photo credit: Eli Sarnat).

Photo 2.2: Wasmannia auropunctata (little fire ant). This small (1.5mm) ant originating from tropical America can reach high densities in areas it invades. (Photo credit: Alex Wild, www.alexanderwild.com.).

The ant has been present in the Pacific region since its arrival in the Galapagos archipelago sometime between 1924 and 1934 (Jourdan, 1997, p. 61). Since then it has been recorded from a number of countries throughout the region (see Table 2.2).

Table 2.2: Known Location of Wasmannia auropunctata in the Pacific

Location	Arrival Date	Source
Galapagos archipelago	between 1924 and 1934	(Jourdan, 1997, p. 61)
Solomon Islands	1968[40]	(Bigger, 1984, p. 30)
New Caledonia	1972	(Fabres & Brown, 1978, p. 139; Jourdan, 1997, p. 62; Le Breton, Chazeau, & Jourdan, 2003, p. 204)
Wallis and Futuna	before 1981[41]	(Wetterer & Porter, 2003, p. 15)
Tahiti	1990s[42]	(GISD, 2006)
Tuvalu	before 1995	(GISD, 2006)
Vanuatu	1998	(Foucaud et al., 2010, p. 3; SPC, 1999)
Hawaii	1999	(Foucaud et al., 2010, p. 3; Wetterer & Porter, 2003, p. 15)
Papua New Guinea	2005	(GISD, 2006)
Australia	2006	(GISD, 2006)
Guam	2011	(Raymundo & Miller, 2012, p. 85)

[40] The literature incorrectly puts its arrival into the Solomon Islands in 1974. Investigations undertaken during this research found this timeline to be incorrect. See Chapter 6, Section 6.1 for additional details.
[41] Wetterer and Porter (2003, p. 15) note that an extensive ant survey of Wallis and Futuna in 1965 did not record *W. auropunctata* so it probably arrived between this date and 1981, when it was found to be on all three main islands.
[42] Although its official discovery was in 2004, *W. auropunctata* had been present on Tahiti for at least 10 years prior to this date (GISD, 2006).

Studies of *W. auropunctata* to date have largely focused on their ecological impacts (Walker, 2006; Wetterer & Porter, 2003), which have shown significant effects on biodiversity (Causton et al., 2005, p. 160; Fasi, 2009, p. 53; Jourdan, 1997, p. 62; Le Breton et al., 2003; Lubin, 1984; SPC, 2010). Causton et al. (2005, p. 160) report that *W. auropunctata* have had wide ranging impacts in the Galapagos Islands, negatively affecting invertebrates and the nesting activities and young of reptiles and birds. The ants have also been reported attacking Galapagos giant tortoises, damaging their eyes and cloacae (Hayashi, 1999, p. 14; Wetterer, 1997, p. 4). Research conducted in New Caledonia found that *W. auropunctata* reduced the abundance of the native ant fauna (Jourdan, 1997, p. 62; Le Breton et al., 2003, p. 204) as well as other insect and reptile species (Jourdan, 1997, p. 62). Wetterer and Porter (2003, pp. 23-24) describe reports of *W. auropunctata* attacking the eyes of emerging Melanesian Scrubfowl (*Megapodius eremita*) chicks on Savo Island in the Solomon Islands (a species from which local people harvest the eggs) (ibid.). *Wasmannia auropunctata* have also been implicated as a possible cause for the disappearance of the flight-impaired San Cristobal Moorhen from areas of Makira Island in the Solomon Islands (Danielsen et al., 2010, p. 105).

Other aspects, such as the economic or social impacts of *W. auropunctata*, have received much less attention. Studies that have been done show that *W. auropunctata* can be a significant agricultural pest, stinging workers as they tend to crops (Causton et al., 2005, p. 160; Fabres & Brown, 1978, pp. 139-140; Spencer, 1941, p. 6). *Wasmannia auropunctata* have a painful sting that hurts and burns strongly, and this can cause welts to form, which is followed by intense itching that can last for two weeks or more (CTAHR, 2010, p. 1). They have also been implicated in reducing crop yields due to their habit of protecting populations of plant pests, such as Homoptera[43] (Harris & Berry, n.d., p. 3; SPC, 1999). Fasi (2009, p. 62) found that due to the ants' mutualistic relationships with crop pests their presence reduced crop productivity in subsistence gardens in the Solomon Islands (although he did not quantify or qualify if this had any impact on the people relying on those gardens for their livelihoods). Conversely (due to their very success at controlling other insects), *W. auropunctata* have been deliberately spread in some areas of the world as a pest control technique

[43] See footnote 28.

to increase crop productivity in some sectors (for example, maize and cacao in West Central Africa) (Fabres & Brown, 1978, p. 140; Wetterer & Porter, 2003, pp. 22-23).

Concern over the impacts of *W. auropunctata* has seen Hawaiian authorities encourage people to report infestations of the ant to a state pest hotline (CTAHR, 2010, p. 1). First recorded in Hawaii in 1999, heavy infestations are reported to "…negatively impact commercial, recreational or residential uses of property, and the presence of the pest is a 'disclosure issue' in property sales" (ibid.). Protective clothing is required in some areas severely infected "…where contact with foliage, including sitting on lawns can invite stings" (ibid.).

Less is known from other Pacific Islands. Wetterer and Porter (2003, p. 24) noted that locals on Savo Island (Solomon Islands) all knew the ant "…from its painful sting" and that in Vanuatu *W. auropunctata* "…infested houses, gardens and taro fields" (ibid.). Others have noted that due to sting aversion Pacific gardening practices had been altered (Fasi, 2009, p. 69; PIAG, 2004, p. 19). Saunders (in Lovatt, 2011, p. 19) described how due to the ant's bite, the Kanak people in the Mount Panie region of New Caledonia, now only garden at night when the ants are less active, and that they garden naked because if the ants get into their clothes they can continue to bite for hours afterwards. He also noted that the women no longer take their children to the family gardens due to the ants' painful stings. As a consequence, there is a concern that Kanak gardening knowledge and culture may not be passed on to the next generation.

Locals in the Solomon Islands reported their dogs were blinded by the ants' venom and rarely lived more than five years (Wetterer, 1997, p. 4) and similar impacts on livestock (SPC, 2010) and domesticated cats and birds (Fasi, 2009, p. 58) have also been noted. Because *W. auropunctata* also infest houses (Fernald, 1947, p. 428; Spencer, 1941, p. 10), residents are sometimes stung while sleeping (Loeve, 2008; MAF-Biosecurity, 2008; Spencer, 1941, p. 10). What implications all this has on the day to day lives of those living with *W. auropunctata* are largely unknown.

2.5.2 Achatina fulica in the Pacific

A native of East Africa (Raut & Barker, 2002, p. 61), the introduction of *A. fulica* (Photo 2.3) into the Pacific "…was aided by the Second World War and postwar commerce and by deliberate introductions for a variety of reasons"[44] (Raut & Barker, 2002, p. 62). Widespread throughout the Pacific region[45], *A. fulica* continues to spread. Mead (1979, p. 18) argues that it is "virtually predestined that, eventually, *Achatina fulica* will successfully invade new territories… until it is found in all major areas in the tropics and subtropics and, to a limited extent, in the warmer temperate regions too". As one of the most damaging land snails in the world (Sankaran, 2012, p. 1), *A. fulica* poses a significant threat to Pacific livelihoods.

Photo 2.3: Achatina fulica (giant African snail) is widespread in the Pacific region.

[44] One reason was as a food source. Lange Jr (1950, p. 324) notes that during WWII the Japanese carried the snail from one island to another during their Pacific campaign to supplement their diet (although there is no record that they brought them to the Solomon Islands during their occupation). Mead (1961, p. 17), in his seminal work *The giant African snail: a problem in economic malacology*, states that there are many references in the literature to wilful introductions of *A. fulica* into un-infested areas as a food source for people and animals (ducks); or just because they looked beautiful (ibid.).

[45] The Global Invasive Species Database lists *A. fulica* as being present in American Samoa, Cook Islands, Federated States of Micronesia, French Polynesia, Guam, Hawaii, Kiribati, Marshall Islands, New Caledonia, Northern Mariana Islands, Palau, Papua New Guinea, Samoa, Solomon Islands, Vanuatu, Wallis and Futuna (GISD, 2010). While the date of introduction is known for some countries (for dates see Mead, 1961, pp. 6-16; 1979, pp. 7-17; Raut & Barker, 2002, pp. 62-63), for many of the others it is unknown when *A. fulica* arrived (GISD, 2010).

Achatina fulica are hermaphrodites, meaning that each individual produces both sperm and ova (Sankaran, 2012, p. 1). While individuals generally need to cross fertilise with another individual to produce viable eggs, *A. fulica* have the ability to store allosperm from matings which allows them to produce fertilised eggs at any time of the year if conditions are favourable (Raut & Barker, 2002, pp. 69-70). This ability means that "a single allosperm-bearing specimen is sufficient for the establishment of a colony in a previously non-infested area" (ibid., p. 70). Reaching sexual maturity in five to eight months, *A. fulica* can produce up to 1800 eggs annually (ibid., p. 68 & 72). Individuals normally live for three to five years and can reach up to 20cm in length and 12cm in diameter (Sankaran, 2012, p. 1) (Photo 2.4 and 2.5). *Achatina fulica* can tolerate a wide range of environmental conditions, remaining active at a temperature range of 9-29^{o}c. At temperatures lower than 2^{o}c they survive by hibernation. Above 30^{o}c *A. fulica* survive by aestivation. Killed by direct sunlight, *A. fulica* are active mostly at night (ibid.), but can remain active during cloudy or rainy days (Lambert, 1974, p. 37).

Photo 2.4: Achatina fulica (giant African snail) shell from the Solomon Islands. This shell was approximately 18cm in length and was collected from the Guadalcanal plains by a villager from West Guadalcanal and shown to me during a focus group interview.

Photo 2.5: Achatina fulica (giant African snail) shell from a garden site on the Guadalcanal plains, Solomon Islands. Collection and destruction of the snails was a daily chore for the garden's owner (see Chapter 7 and Photos 7.2-7.4 and 7.6 for the impacts A. fulica were having on this woman's garden).

In areas where it has been introduced, *A. fulica* has shown "…a predilection for modified environments, such as plantations and gardens" (Raut & Barker, 2002, p. 65). Recognised as a significant crop pest (Lambert, 1974, p. 317; Lange Jr, 1950, p. 323; Raut & Barker, 2002, p. 65; Venette & Larson, 2004) *A. fulica* can cause extensive damage to many different fruit and vegetable crops[46] through their feeding. (Lange Jr, 1950, p. 323; Mead, 1961, pp. 39-49). Lambert (1974, p. 37) observed that in some islands of Micronesia *A. fulica* caused tremendous damage to vegetable and flower gardens and that if effective control was not taken then farmers' crops could be totally ruined. Likewise, Lange Jr. (1950, p. 350) noted that the economic damage to

[46] The list of host plants reported for *A. fulica* is long. Venette and Larson (2004) for instance list 237 species as being reported in the literature. This includes many of those commonly grown in the Solomon Islands as food crops. Sankaran (2012, p. 1) notes that *A. fulica* consumes at least 500 different types of plants.

vegetable crops on Saipan varied from slight damage through to complete losses. What impact this had on the people reliant on these crops was not discussed by either author.

Following establishment in a new location, *A. fulica* populations around the world have been recorded to increase rapidly, reaching high densities[47]. Studies show that these populations then remain at these high levels for an indefinite period before suddenly declining (Civeyrel & Simberloff, 1996, p. 1235; GISD, n.d., p. 1; Raut & Barker, 2002, p. 91; Simberloff & Gibbons, 2004, p. 165). Mead (1979, p. 83) noted that "…the phenomenon of decline in populations of *Achatina fulica* appears to be inevitable". While the reasons for this decline are still not fully understood, Mead (1979, p. 83) argues that a "…spectrum of environmental conditions, both extrinsic and intrinsic are involved". This characteristic collapse of *A. fulica* populations has led Civeyrel and Simberloff (1996, p. 1236) to question the long-term threat *A. fulica* poses to agricultural production. Similarly, Simberloff and Gibbons (2004, p. 169) have argued that a do-nothing approach to the management of *A. fulica* is something that should be considered because of this phenomenon.

However, while this characteristic decline in populations may reduce the impacts *A. fulica* have, it can take anywhere from 20 to 60 years[48] to occur (see GISD, n.d., p. 1 for cited cases). While this is short in ecological terms, for those households reliant on agriculture to sustain their livelihoods over this period, this eventual population decline is of little comfort. While the impacts of *A. fulica* on crop production are well noted (for example see Mead, 1961; Raut & Barker, 2002), there is little in the literature which describes how these impacts carry through and influence Pacific livelihoods. But it is clearly of particular concern given the importance agriculture plays in many of the livelihoods in the region.

2.6 Conclusion: A Holistic Approach to Invasive Alien Species

Despite the increased awareness of IAS as a major driver of global environmental change over the last two decades (Fish et al., 2010, p. 51), IAS issues, as discussed

[47] Raut and Barker (2002, p. 76) cite a number of studies where the densities range from 2.8/m^2 up to 73/m^2.
[48] Raut and Barker (2002, p. 65) note that *A. fulica* has been thriving for 100-150 years in some areas of India with no signs of abating as a pest.

above, have largely been deemed an ecological issue (C. Shackleton et al., 2007, p. 114), resulting in the biological perspective being the dominating view of the issue. As a result, their impacts on people have largely been overlooked or at most received only secondary attention in the majority of the IAS literature. However, as McNeely (2001a, p. 6) notes "…the problem of IAS is above all a human one…" and as such they cut across all spheres of human life. As outlined in the sections above, IAS affect issues relating to global environmental change, sustainable development, ecosystem services, human health and well-being, agriculture, forestry, fisheries, biodiversity, trade, economics, food security, poverty alleviation, power relations, ethics, equality and much more. They go "…to the very heart of problems policy makers are spending much time debating, ironically usually without reference to IAS" (McNeely, 2006, p. 6). Because of the complex interactions IAS have with these issues and the inter-relativeness of the issues themselves, IAS should not be looked at as though they were only an ecological problem, or just an economic or social concern. They need to be examined more holistically, under a broader framework, one that places people at the centre of the analysis. With such broad ramifications it is likely that there will be a wide range of responses to the presence of IAS, and the effects they have (positive or negative) on people's ability to pursue meaningful livelihood strategies (McGarry et al., 2005, p. 3). Such a holistic approach, which enables an exploration of the link between IAS and livelihood strategies, is picked up in the following chapter.

3.0 Theoretical Context and Study Approach

3.0 Introduction

As outlined in Chapter 2 concern has been raised over the threat IAS pose to livelihoods in the Pacific. However, there are few studies that relate the impact of IAS on livelihood strategies and the well-being of households in the region and those that do exist focus mainly on plants (for example Day et al., 2012; McWilliam, 2000; Siges et al., 2005). In particular, little focus has been given to the role IAS have in the context of livelihood diversification (Ellis, 2000a) and the influence they have on a household's overall vulnerability or resilience. Taking this into account, this chapter outlines the guiding conceptual framework which is central to this study; the livelihoods approach. The chapter begins therefore by looking at the livelihoods approach and the concepts underlying it. This is followed by an introduction to, and discussion of, the concept of livelihood diversification. The chapter then moves on to examine the shortcomings of the livelihoods approach. Ways of mitigating these weaknesses are then examined before the chapter closes with the presentation of a general livelihoods framework which encompasses the scope of this research.

3.1 The Livelihoods Concept and Approach

In its simplest sense, a livelihood is a means of making a living (Chambers & Conway, 1991, p. 5; Ellis, 2000a, p. 7). As Ellis (2000a, p. 7) notes, this is more than "…just the net result in terms of income received or consumption attained", but also includes non-material or intangible aspects as well (Chambers & Conway, 1991, p. 7; de Haan & Zoomers, 2005, p. 32; King, 2011, p. 299; Scoones, 1998, p. 7; Zoomers, 2008, p. 147). These intangible aspects, or "non-economic attributes of survival" (Ellis 200b pg 290) include the claims people may make for support from, for example, social and kinship networks, and the access they have to use a particular resource or service (Chambers & Conway, 1991, p. 8).

While there are many definitions of livelihoods, one of the most common is that given by DFID[49] (1999: section 1.1) which states:

> "A livelihood comprises the capabilities, assets (including both material and social resources) and activities required for a means of living. A livelihood is sustainable when it can cope with and recover from stresses and shocks and maintain or enhance its capabilities and assets both now and in the future, while not undermining the natural resource base."

The livelihoods concept has been around for a number of decades (King, 2011, p. 207; Scoones, 2009, p. 173; Solesbury, 2003, p. 1). It has developed through "… a composite of many ideas and interests [and] the coming together of a number of different strands in the development debate"[50] (Scoones, 1998, p. 7). As a result it has evolved into an approach that can "…be used as a basis for analysing, understanding and managing the complexity of livelihoods, enabling complementarities and trade-offs between alternative supporting activities to be assessed and [provides] a basis for identifying policy objectives and interventions" (Rakodi, 2002, p. 4).

The livelihoods approach arose in response to the disappointing results of early neo-liberal approaches to development (Bebbington, 1999, p. 2021; de Haan & Zoomers, 2005, p. 29; Scoones, 2009, p. 175; Zoomers, 2008, p. 147) which, despite their long history of policy interventions, resulted in little improvement in the lives of the rural poor (Carney, 1999, p. 1; Zoomers, 2008, p. 147). These approaches, with their emphasis on economic liberalisation and privatisation (Carney, 1999, p. 2) took a largely single-sector approach to development problems (de Satgé, 2002, p. 3; Scoones, 2009, p. 172). They had a narrow economic perception of poverty[51] which failed to capture the complexity and diversity of people's lives (Carney, 1999, p. 2; Chambers & Conway, 1991, p. 3).

[49] This definition by DFID is an adaption of the definition given by Chambers and Conway (1991, p. 6).

[50] For example, de Satge (2002, p. 3) notes that the approach built on earlier development theory including aspects of integrated rural development planning approaches, food security initiatives, rapid rural appraisal (RRA), participatory rural appraisal (PRA), gender analysis and risk and vulnerability assessments. Ellis (2000a), Solesbury (2003), de Haan and Zoomers (2005) and Scoones (2009) also provide a history of livelihoods thinking and the different strands that have contributed to the concept and debate.

[51] With poverty being assessed against income and consumption criteria (Arun et al., 2004, p. 2; Brocklesby & Fisher, 2003, p. 187; Farrington, Carney, Ashley, & Turton, 1999, p. 2).

Changing perspectives and improved understandings of poverty, influenced by such things as the recognition of the active role poor individuals and households played in shaping their own lives (Arun et al., 2004, p. 2; Bagchi et al., 1998, p. 456; Brocklesby & Fisher, 2003, p. 187; de Haan & Zoomers, 2005, p. 28); by a growing awareness of the importance of sustainability (Arun et al., 2004, p. 2; Cahn, 2006, p. 55); by a shift towards local participation (Arun et al., 2004, p. 2; Bagchi et al., 1998, p. 456; Cahn, 2006, p. 55); and a focus on the realities of the poor (Cahn, 2006, p. 55), led to a greater understanding of the diversity of livelihoods and a consolidation of the livelihoods approach. Nevertheless, as Scoones (2009, p. 173) notes, the approach took some time to find a purchase within mainstream development practice and has only really had a central role in development thinking since the late 1990s (Crawford & Bell, 2012, p. 1047; Scoones, 2009, p. 171).

The livelihoods approach is about putting people at the centre of analysis[52]. Understanding people and the realities of their livelihoods is the priority (Allison & Horemans, 2006, p. 758; DFID, 1999: section 1.3; Ellis & Freeman, 2005, p. 5; Farrington et al., 1999, p. 4); and this forms one of the core principles of the approach. Another core principle is that the approach is holistic (DFID, 1999: section 1.3; Ellis & Freeman, 2005, p. 5; Farrington et al., 1999, p. 4). In other words it seeks to transcend sectorial boundaries (Allison & Horemans, 2006, p. 758); recognising that people adopt multiple livelihood strategies and that there are multiple influences on people and multiple livelihood outcomes that they can achieve (DFID, 1999: section 1.3). Thirdly, the livelihoods approach is dynamic in that it "…seeks to understand and learn from change so that it can support positive patterns of change and help mitigate negative patterns" (DFID, 1999: section 1.3). A fourth principle of the approach is one of building on strengths (DFID, 1999: section 1.3). The emphasis being on what people have (strengths) and not on what they lack (needs) (Moser, 1998, p. 1; Zoomers, 2008, p. 148). The focus is therefore on their existing capabilities (Allison & Horemans, 2006, p. 758). A fifth principle is that the livelihoods approach should bridge the gap between micro, meso and macro levels (Allison & Horemans, 2006, p. 758; DFID, 1999: section 1.3; Farrington et al., 1999, p. 5). This

[52] As outlined in Chapter 2, people have not been the central concern with most IAS research, despite the recognition that IAS are a major driver of environmental change with significant consequences for human well-being (UNEP, 1999, p. 4). This represents a gap in IAS and development research.

acknowledges the importance of macro and meso level policies to local livelihoods and how the lessons and insights gained at the local level are important in informing higher level policy development and planning (DFID, 1999: section 1.3). The sixth principle of the livelihoods approach is its commitment to the key dimensions of sustainability (environmental, economic, and social) (Allison & Horemans, 2006, p. 758; DFID, 1999: section 1.4). Sustainability relates to how elements of the livelihood system "…are utilised, maintained and enhanced so as to preserve livelihoods" (Chambers & Conway, 1991, p. 9).

The livelihoods approach is underpinned by the concepts of capitals and capabilities (Bebbington, 1999, p. 2022; Chambers & Conway, 1991, p. 7) which draws on work such as that by Amartya Sen (Allison & Horemans, 2006, p. 763; Scoones, 2009, p. 176). In particular Sens' seminal 1981 work on entitlements and 1985 work on capabilities (de Haan & Zoomers, 2005, p. 31) in which entitlements are the "…set of all the alternative bundles of commodities that [a person] can acquire in exchange for what he [or she] owns…" (Sen, 1981, p. 3). Hunger and poverty are seen to result not from availability of resources but from a person's ability to command or access these resources (ibid. 1981, p. 45). Capabilities are seen as a person's ability to function; what they can do or can be (Sen, 1985, p. vi). However, as Ellis (2000a, p. 17) notes, while there are some similarities, not all elements of Sen's capability concept and entitlement approach overlap in either meaning or intent with the terms used to describe the livelihoods approach. As such, he argues that the livelihoods approach should be distinguished from the ideas of capability and entitlement (ibid. 2000a, p. 27).

The livelihoods approach, which can be represented as a framework[53] (Figure 3.1) is "…grounded in the idea that people's livelihood largely depends on the opportunity to access capitals which form the basis of their livelihood strategies" (Zoomers, 2008, p. 148).

[53] There are a number of diagrammatic variations of this framework (for example see de Satgé, 2002: Chapter 1; Ellis, 2000a, p. 30; Ellis & Freeman, 2005, p. 4; Rakodi, 2002, p. 9).

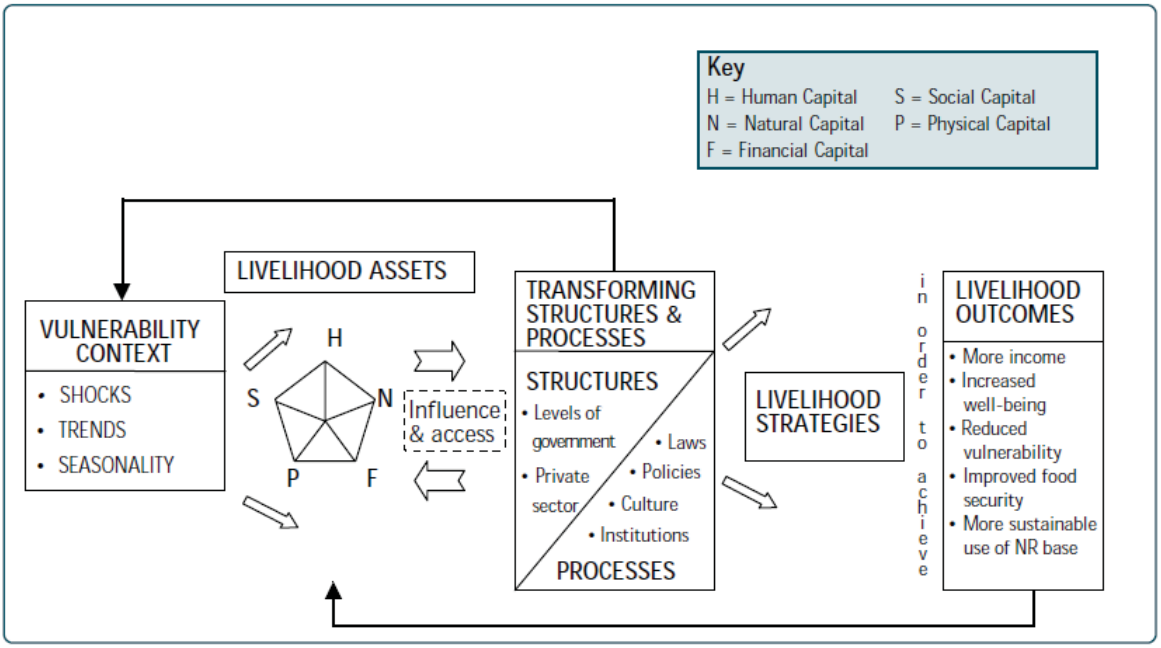

Figure 3.1: The sustainable livelihoods framework (Source: DFID, 1999: section 2.1).

These capital assets are usually grouped into five categories; human capital, natural capital, financial capital, physical capital and social capital[54] (Allison & Horemans, 2006, p. 758; DFID, 1999: section 2.3; Ellis, 2000a, p. 8; Farrington et al., 1999, p. 3; Zoomers, 2008, p. 148). In brief, human capital represents things such as the skills, education level and health status of people. Natural capital refers to the natural resource base from which resources and ecosystem services are derived. Financial capital is the financial resources (money, credit) that are available to purchase consumption and production goods. Physical capital comprises basic infrastructure and producer goods (for example houses, livestock, and machinery). Social capital is the social networks, organisations and associations that people draw support from (DFID, 1999: sections 2.3.1 to 2.3.5; Ellis, 2000a, p. 8; Zoomers, 2008, p. 148). Not all people will have access to all (or for the most destitute, potentially any) of the above capital assets. Which ones they access and how they put them to use determines, in large part, the livelihood strategies they adopt.

[54] While there is a broad agreement in the literature on the key assets, this list is not exhaustive and there are other variations on the capitals concept. For example, some authors have also added cultural capital (Bebbington, 1999, p. 2029), while others have identified political capital as another potential category (Scoones, 1998, p. 17). Bebbington (1999, p. 2029) also has a produced capital instead of physical and financial capital. Moser (1998, p. 4) uses labour, human capital, productive assets, household relations and social capital in her framework on urban livelihoods.

This approach highlights that livelihoods and people's well-being are dependent on a range of capitals, other than just financial. It also recognises the inter-connectivity of the capitals; such that gains from one capital (for example financial) can be reinvested into another (for example human capital in the form of funding education for children) (S. Shackleton, 2005, p. 11). An important point to recognise here, however, is that the converse also applies. A reduction in one capital can have flow on effects to another (for instance when children are removed from school (human capital) due to a reduction in financial capital). Because of their diverse effects, IAS have the potential to have an influence on any or all of the asset categories with a variety of tangible and intangible consequences. For example, as illustrated in Chapter 2 (section 2.5.1), *Wasmannia auropunctata* have been implicated in affecting human capital (for example, their effects on human health from their stings (CTAHR, 2010)); natural capital (for example, attacking Melanesian Scrubfowl (*M. eremita*) chicks, a species from which local people harvest eggs (Wetterer & Porter, 2003, pp. 23-24)); financial capital (for example, affecting house prices (CTAHR, 2010)); physical capital (for example, their impacts on domestic livestock and poultry (Fasi, 2009; SPC, 2010)); and social capital (for example, via their infestation of public places such as recreational grounds, making them unusable (CTAHR, 2010)). Understanding how *W. auropunctata* and *Achatina. fulica* affect the different capitals available to households in the Solomon Islands and the ramifications these effects may have on people's livelihood strategies and well-being is an important aspect of this study.

While the livelihoods approach acknowledges that people require and draw on a range of assets in pursuing their livelihood strategies (DFID, 1999: section 2.3; Farrington et al., 1999, p. 3), it also recognises that access to these assets and their use in pursuing a livelihood is influenced by a number of social, economic and policy considerations (Ellis, 2000a, p. 37; Rakodi, 2002, p. 15). These are shown as 'transforming structures and processes' in Figure 3.1. These structures and processes can include such things as social and cultural relations (including power and gender relations), institutional and government policies (such as national development policies), or even international economic trends and market conditions (Allison & Ellis, 2001, p. 379; Allison & Horemans, 2006, p. 758; Ellis, 2000a, p. 37; Farrington et al., 1999, p. 3; Rakodi, 2002, pp. 15-16).

This aspect of the livelihoods framework draws on ideas and approaches from fields such as political ecology (Scoones, 2009, p. 6). Political ecology emerged as an approach in the 1970s and 1980s and has diverse origins (Adams, 2009, p. 197; Bryant, 1997, p. 8; 1998, p. 80; Gray & Moseley, 2005, p. 14; Neumann, 2005 Chapter 2; Peet, Robbins, & Watts, 2011, p. 24; Peet & Watts, 2004, pp. 6-9; Robbins, 2012, p. 5). The approach can be broadly considered as a way of understanding "…the political sources, conditions and ramifications of environmental change" (Bryant, 1992, p. 13); or, as it is often defined, as combining "… the concerns of ecology with a broadly defined political economy" (Blaikie & Brookfield, 1987, p. 17).

The transforming structures and processes shape what livelihood strategies are available from the capital assets people access. For example, in South Africa, government policies aimed at removing the invasive prickly pear (*Opuntia ficus-indica*) from the landscape has an impact on local traders who rely on this species for their livelihood (S. Shackleton et al., 2011, p. 117). The influence these structures and processes have on local livelihoods should not be underestimated. Failure to account for these is one of the most common criticisms of the livelihoods approach, a point discussed in more detail in Section 3.3.3 below.

Livelihoods are also affected by the external environment in which people live and this can also have an influence on the capital assets people access, how they are used, and the livelihood strategies people adopt. This aspect is shown as the 'vulnerability context' in Figure 3.1. Factors that make up the vulnerability context include shocks, trends and seasonality (DFID, 1999: section 2.2; Farrington et al., 1999, p. 3). Shocks are generally considered to be immediate, unpredictable disturbances (Scoones, 1998, p. 7) and can include things such as natural disasters, health issues and conflicts or wars. Trends are generally more predicable disturbances which have an accumulative effect (ibid. 1998, p. 6); and seasonality relates to such things as the uneven, cyclic nature of income flows due to differing seasonal patterns of crop production (Ellis & Freeman, 2005, p. 6) or employment opportunities (DFID, 1999: section 2.2). IAS can fall into any of these categories. For example, the initial impacts *A. fulica* had on Mary's household (described in Chapter 1, section 1.1) would be categorised as a 'shock'. A woody tree species that slowly encroaches onto pastureland, reducing grazing opportunities over time, would constitute a 'trend'; whereas a crop pest that

repeatedly reduces the yield of a crop during a particular period each year would be a seasonality factor.

The capital assets a person or household has access and control over, mediated by the structures, processes and vulnerability factors operating within their lives, therefore influences the "…range and combination of choices that people make/undertake in order to achieve their livelihood [strategies]" (DFID, 1999: section 2.5). In short, livelihood strategies compose a portfolio of activities (Allison & Ellis, 2001, p. 380) which "…generate the means of household survival" (Ellis, 2000a, p. 40). How people combine and use their capital assets while pursuing their livelihood strategies dictates what outputs or livelihood outcomes they may achieve. Positive outcomes should improve incomes or standards of living, increase well-being, reduce vulnerability, improve food security and decrease inequalities of power (Allison & Horemans, 2006, p. 759; DFID, 1999: section 2.6; Rakodi, 2002, p. 16).

3.2 Livelihood Diversification

The livelihoods approach, as described above, essentially follows an assets-access-activities format (Ellis, 2000a, p. 231) which results in the adoption of livelihood strategies. These strategies comprise a portfolio of activities which are diverse and dynamic, changing and responding to different pressures and opportunities (ibid.). In order to survive, households add and shed activities as circumstances dictate; a process defined as livelihood diversification (Ellis, 2000a, p. 232; S. Shackleton, 2005, p. 12). Livelihood diversification is "pervasive and enduring [in] character" (Ellis, 2000b, p. 290). It is pervasive in that it is widespread and found in all locations; in both rural and urban (ibid.) and rich and poor households (Ellis, 2000b, p. 290; Goulden, Adger, Allison, & Conway, 2013, p. 915; Martin & Lorenzen, 2016, p. 231; Niehof, 2004, p. 326). It is enduring in that it is not a transient phenomenon, disappearing as economic conditions improve (Ellis, 2000b, p. 290; Martin & Lorenzen, 2016, p. 231), but is rather the norm (Niehof, 2004, p. 321).

Although agriculture predominates, rural households in developing countries often rely on a diverse set of income-generating activities as part of their livelihood strategies (Martin & Lorenzen, 2016, p. 231; Robaa & Tolossa, 2016, p. 96). This

means that '…most rural households depend on some combination of agricultural [farm and off-farm] and non-agricultural [non-farm] activities to make a living" (Martin & Lorenzen, 2016, p. 232). Ellis (1998, p. 5) notes that "farm income includes livestock as well as crop income and comprises both consumption-in-kind of own farm output and cash income from output sold". Off-farm activities include wage or exchange labour on other people's farms (Ellis, 1998, p. 5; Robaa & Tolossa, 2016, p. 103), whereas non-farm activities refers to non-agricultural activities which generate income (Ellis, 1998, p. 5; Robaa & Tolossa, 2016, p. 104).

The role that livelihood diversification plays in the lives of rural households has received a lot of debate in the literature. A number of commentators (such as Allison & Ellis, 2001, p. 383; Ellis & Freeman, 2005, p. 62; Steward, 2007, p. 76; Turner II et al., 2003, p. 8075) view diversification as a proactive strategy which "…contributes to the security of a rural livelihood because it improves long-run resilience in the face of adverse trends or sudden shocks" (Ellis, 2000a, p. 235). Others however, point out that livelihood diversification may, in some instances, be a consequence of having no other choice. Some, they argue, may diversify solely out of necessity; as a reactive coping strategy which may in fact constrain their livelihood options and increase their vulnerability (Nygren & Myatt-Hirvonen, 2009, p. 838; S. Shackleton, 2005, p. 12). Martin and Lorenzen (2016, p. 231) argue that these two views can be broadly thought of as progressive diversification (or pull diversification - Robaa & Tolossa, 2016, p. 97) and distress diversification (or push diversification - Robaa & Tolossa, 2016, p. 97)[55]. Progressive-pull diversification is when households are proactive and take advantage of new opportunities which offer the potential to increase the household's income (Martin & Lorenzen, 2016, p. 232; Robaa & Tolossa, 2016, pp. 96-97). Distress-push diversification is where rural households are forced into low-return activities due to a lack of opportunities on-farm because, for example, incomes have been depressed following successive droughts (Robaa & Tolossa, 2016, p. 97). In reality, the reasons for livelihood diversification vary (Ellis, 1998, p. 7; Martin & Lorenzen, 2016, p. 232):

[55] Robaa and Tolossa (2016, p. 96) note that there are many dichotomies used in the literature to refer to these two typologies. Shackleton (2005, p. 12), for example, refers to the former as 'choice' or positive diversification, whereas the latter is referred to as 'no-choice' or negative diversification. Liao et al. (2015, p. 1303) use voluntary and involuntary.

> ranging from an attractive choice for accumulation purposes, enabled by asset wealth and the diversity of those assets, to a distress-induced insurance strategy brought on by crisis (Martin & Lorenzen, 2016, p. 232).

Ellis (1998, p. 7) notes that this continuum of causes and motivations will vary across households at a particular point in time, and for the same household at different points in time. Liao et al. (2015, p. 1303) argue that

> although there is considerable evidence that diversification can facilitate improved standards of living, the connection from livelihood diversification to increased incomes or other manifestations of higher quality of life is certainly not automatic.

Why households diversify, and the form this diversification takes, is important in either diminishing or accentuating a household's quality of life.

Risk is considered to be the fundamental motive for livelihood diversification (Ellis, 2000b, p. 294). Households diversify to spread their risk. They aim to avoid 'putting all their eggs in one basket' (ibid.). Ellis (2000b, p. 294) contends that

> one of the critical motives of livelihood diversification for risk reasons is the achievement of an income portfolio with low covariate risk between its components. This means that the factors that create risk for one income source (e.g. climate) are not the same as the factors that create risk for another income source (e.g. urban job insecurity).

Critically, Ellis (2000b, p. 294) also notes that while agricultural households can diversify to "take advantage of differences in the risk-proneness of crops or crop mixes to adverse natural events, the protection this affords is only partial…" because of the high degree of covariance between these activities. Having an income portfolio with a high covariance between its components means that there is potentially a high correlation between the risks associated with the different income streams, making them all simultaneously prone or vulnerable to any one particular adverse event or shock (Ellis, 1998, p. 13; Goulden et al., 2013, p. 915). Ellis (1998, p. 13) notes that this vulnerability is "…characteristic of rural livelihoods in developing countries…", especially for poor households who have limited income opportunities outside their own production (ibid.).

This covariance of livelihood activities is important in relation to livelihood diversification in the Solomon Islands. Liao et al. (2015, p. 1303) argue that "in certain settings, the socio-ecological context strongly favours a particular income-generating activity". As will be discussed in more detail in Chapter 5, many Solomon Island households favour subsistence/semi-subsistence agriculture for their day to day survival. This sector not only provides the basis on which many rural households in the Solomon Islands have built their livelihoods, but it is also the sector within which these households have diversified their livelihoods. Therefore, for many rural Solomon Island households, all or at least the majority of their eggs are in the one basket. How IAS affect this livelihood approach is the focus of the later chapters.

3.3 Critique of the Livelihoods Approach

As the above discussions show, the livelihoods approach offers an important lens for understanding the realities people face in their quest to achieve their livelihood goals and the dynamic approaches they take to do so (Carney, 1999, p. 1; Scoones, 2009, p. 191; Zoomers, 2008, p. 148). It provides a basis for identifying the constraints (Carney, 1999, p. 1) and opportunities that influence their livelihood strategies. As such, it can be an effective lens for assessing the impacts IAS have on people's lives. But the approach also has its weaknesses, and these need to be considered if the approach is to have relevance for investigating challenges such as IAS.

3.3.1 The role of gender and culture

One concern with the livelihoods approach is that in its simplest form the approach is gender neutral (Arun et al., 2004, p. 1; Cahn, 2002, p. 5), whereas livelihoods are highly gendered (Masika & Joekes, 1996, p. 12). While the approach has the potential to incorporate gender aspects, Krishna (2012, p. 15) argues that "gender analyses are largely missing from the livelihoods literature"; a view supported by Okali (2006, p. 14) who claims that the livelihoods literature does not substantially address this issue. Taking a gender perspective to the impacts of IAS is important because gender affects the experiences, concerns and capabilities of people differently and influences how environments are used and managed over time (Masika & Joekes, 1997, p. 5). Fish et al. (2010, p. 6) note that there are very few publications which take a gendered approach to IAS. Because IAS can have significant impacts (both negative and

positive), how they influence men and women's livelihood strategies is a matter of some consequence; particularly as "experiences of poverty and environmental change are gender differentiated" (Masika & Joekes, 1997, p. 6).

In her revision of the livelihoods framework for the Pacific (Figure 3.2), Cahn (2006, p. 144) notes that gender interacts with all aspects of the livelihoods assets, strategies and outcomes. Consequently she highlights gender as being part of the transforming processes to emphasise that it is an 'environment' in which the livelihoods exist (ibid., pp. 145-146) or are embedded. She argues likewise for culture[56]. As Hooper (2005, p. 3) notes, "[c]ulture plays a much more significant role in national economies and national life of Pacific countries than it does in most other regions of the world". Culture, gender and livelihoods are therefore intertwined in complex ways and are important aspects in understanding the impacts IAS have on shaping livelihoods in the Pacific.

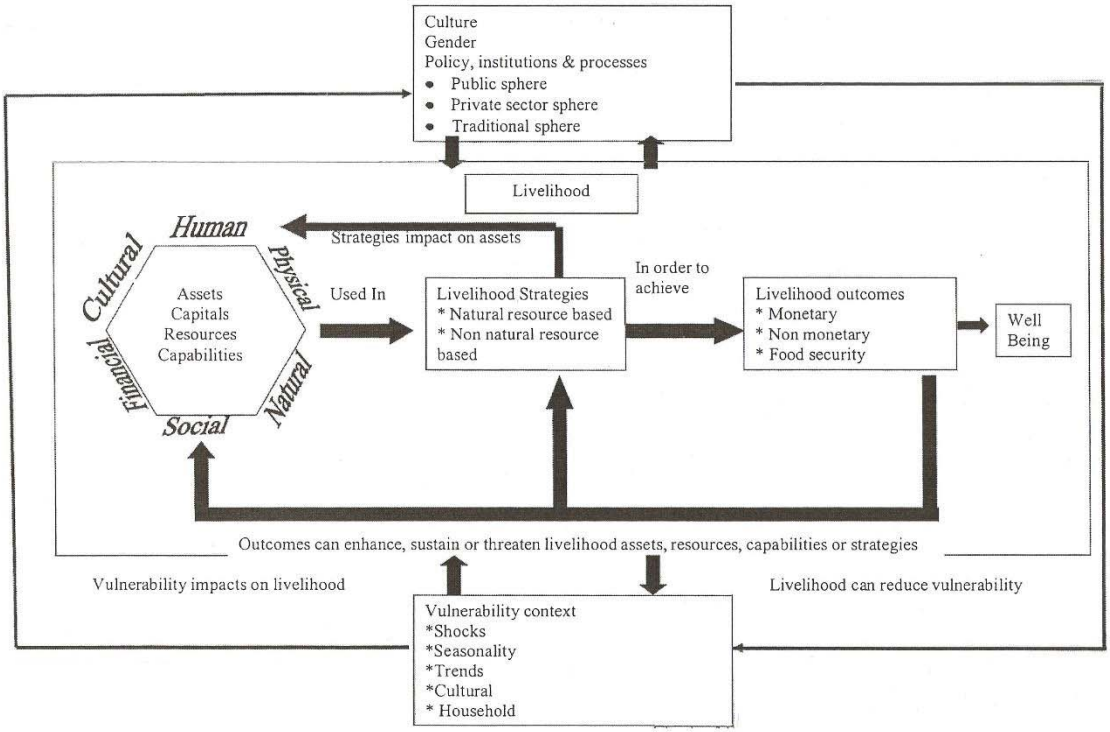

Figure 3.2: Sustainable livelihoods framework for the Pacific (Source: Cahn, 2006, p. 146).

[56] The integration of culture into the sustainable livelihoods framework is in fact the main focus of her work.

3.3.2 Vulnerability and resilience

A further issue with the livelihoods framework is that the 'vulnerability context' does not explicitly take into account the inherent capabilities people have to withstand the pressures placed upon their lives. Therefore, the concept of resilience also needs to be considered as part of this component of the framework. There has been a lot of debate in the literature around the concepts of vulnerability and resilience, and these are briefly examined in order to understand why both concepts need to be considered when assessing what influence IAS may have on local livelihood strategies.

There are no universally accepted definitions of vulnerability and resilience in the literature. As Jansen and Ostrom (2006, p. 237) point out, the initial experience on delving into the large expanse of literature on these subjects is like encountering a Tower of Babel. At first glance no two authors appear to be speaking the same language. Definitions vary (Barnett, 2001, p. 979; Cutter et al., 2008, p. 599; Eakin & Luers, 2006, p. 388; Hinkel, 2011, p. 199; Hufschmidt, 2011, p. 621); associated terms vary (for example: adaption, adaptive capacity, adaptability, capacity of response, coping capacity); and even the conceptual linkages vary. Some, for example, see resilience as a component of vulnerability (Pelling, 2003, p. 48; Turner II et al., 2003, p. 8077); others see resilience as the flip side of vulnerability (Berkes, 2007, p. 292; Folke et al., 2002, p. 13); while still others see resilience and vulnerability as two separate but linked concepts (Cutter et al., 2008, p. 602).

These differences are largely due to the different epistemologies in vulnerability and resilience research (Adger, 2006, p. 277; Cutter, 1996, p. 529; Gallopín, 2006, p. 293; Hufschmidt, 2011, p. 621; Janssen & Ostrom, 2006, p. 237; Manyena, 2006, p. 433; Miller et al., 2010) and the particular focus each has taken on the subject. Despite this lack of universal agreement there is a growing consensus in the literature highlighting the importance of the concepts of vulnerability and resilience (and their associated concepts of adaption and coping) in understanding socio-ecological systems (Adger, 2006, p. 268; Cutter et al., 2008, p. 599; Eakin & Luers, 2006, p. 366; Eriksen, Brown, & Kelly, 2005, p. 288; Schwarz et al., 2011, p. 1128). This convergence around the importance of the concepts has been driven largely by the debates within the global change and disaster risk-reduction communities (Vogel, Moser, Kasperson, &

Dabelko, 2007, p. 350). Many of the debates on these concepts are also applicable to the livelihoods impacts of IAS.

The contemporary concepts of vulnerability and resilience have largely evolved from three broad theoretical approaches[57] (Eakin & Luers, 2006, p. 367; Füssel, 2007, p. 160; Hufschmidt, 2011; Miller et al., 2010; Turner II, 2010). These are;

1) the risk-hazards approach, in which vulnerability is seen as a factor of where people live, the probability and impact of the hazard, and the resources people have to respond (Adger, 2006, p. 271);

2) the political ecology approach, which focuses on the underlying political and structural causes of vulnerability and adaptive responses in society. This approach seeks to address the differential impacts of hazards and the role class structure, governance and economic dependency have on this (Adger, 2006, p. 271; Blaikie, Cannon, Davis, & Wisner, 1994, p. 9; Wisner, Blakie, Cannon, & Davis, 2004, p. 6); and,

3) the adaption of the concept of ecological resilience[58] to socio-ecological systems, in which resilience is seen as a system's capacity to absorb disturbance, learn from and modify itself to changes (Barnett, 2001, p. 984; Berkes, 2007, p. 286; Cutter et al., 2008, p. 599; Folke, 2006, p. 253). Adaption and adaptive capacity are therefore seen as core components of this concept (Folke, 2006, p. 259; Hufschmidt, 2011, p. 626; Nelson, Adger, & Brown, 2007, p. 399).

Over time these three approaches have become more integrated in their use of terms (Janssen & Ostrom, 2006, p. 238) and to some degree their perspectives (Füssel, 2007, p. 161). The political ecology approach has been particularly influential, being incorporated into the risk-hazard approach (for example see Cutter et al. (2008) and into resilience research (for example see Miller et al. (2010)).

[57] See Eakin and Luers (2006) for a detailed discussion on the historical lineage of these approaches.

[58] The origins of the resilience concept have been attributed to the fields of psychology and psychiatry (Manyena, 2006, p. 433). However, it is the ecological perspective that has primarily contributed to resilience theory in relation to socio-ecological systems (Miller et al., 2010). The concept of ecological resilience was first defined by Holling (1973) as a "measure of the persistence of systems and their ability to absorb change and disturbance and still maintain the same relationships between populations or state variables" (ibid. , p. 14). This ecological approach has been developed (and broadened) over time with its application to socio-ecological systems (Berkes, 2007, p. 286; Gallopín, 2006, p. 247; Miller et al., 2010).

Although the concepts of vulnerability and resilience have received a high degree of recognition across the various approaches, as noted above, there is still debate over the definitions, and the concepts are still often used with differing connotations (Birkmann, 2006, p. 16). Despite these differences, a number of generic features of vulnerability and resilience can be found across the literature. These include: the importance of considering them from a socio-ecological perspective, the central role adaption plays, that they are an equity issue, the importance of place based studies, and the importance of assessments for effective development of policies and decision making (Adger, 2006, p. 277; Cutter et al., 2008, p. 599; Eakin & Luers, 2006, p. 388; Eriksen et al., 2005, p. 289; Smit & Wandel, 2006, p. 286; Turner II et al., 2003, p. 8078).

Because there is no universal agreement on the relationship between vulnerability and resilience and because the literature contains numerous semantic differences in their definitions of the terms, the following conceptual framework (Figure 3.3) and definitions with regards vulnerability and resilience in relation to IAS and the role they play in influencing livelihood strategies have been developed for this thesis.

Like Cutter et al. (2008, p. 602), I see vulnerability and resilience as being neither mutually exclusive nor mutually inclusive, but rather two separate but linked concepts. People have inherent capabilities, not just vulnerabilities. They have positive qualities (resilience) that can counter their vulnerabilities (Cannon, 2008, pp. 1-2). Being vulnerable does not necessarily make one a victim. Although shown as such in Figure 3.3, the link between vulnerability and resilience should not necessarily be considered symmetrical (for example, an increase in resilience equating to a similar decrease in vulnerability), as has been suggested by some authors (Oviatt & Brett, 2010, p. 63). As Cannon and Muller-Mahn (2010, p. 623) rightly point out, some coping strategies involve people having to dispose of assets which can erode their ability to survive, therefore increasing their vulnerability. Being vulnerable in itself however is not necessarily an issue as far as a household's livelihood and well-being are concerned. Vulnerability is not about current well-being, it is, as Adelman et al. (2015, p. 11) contend, "…about expectations of reductions in future-well-being" or the pre-event potential for loss or harm (Cutter et al., 2008, p. 599). As shown in Figure 3.3, vulnerability is a function of sensitivity (or the probability of the shock occurring) and

exposure (or the magnitude of the impact when it does occur). So, being vulnerable does not necessarily equate to a poor livelihood if there is a low probability of the shock occurring, or when it does occur the impact is small or manageable.

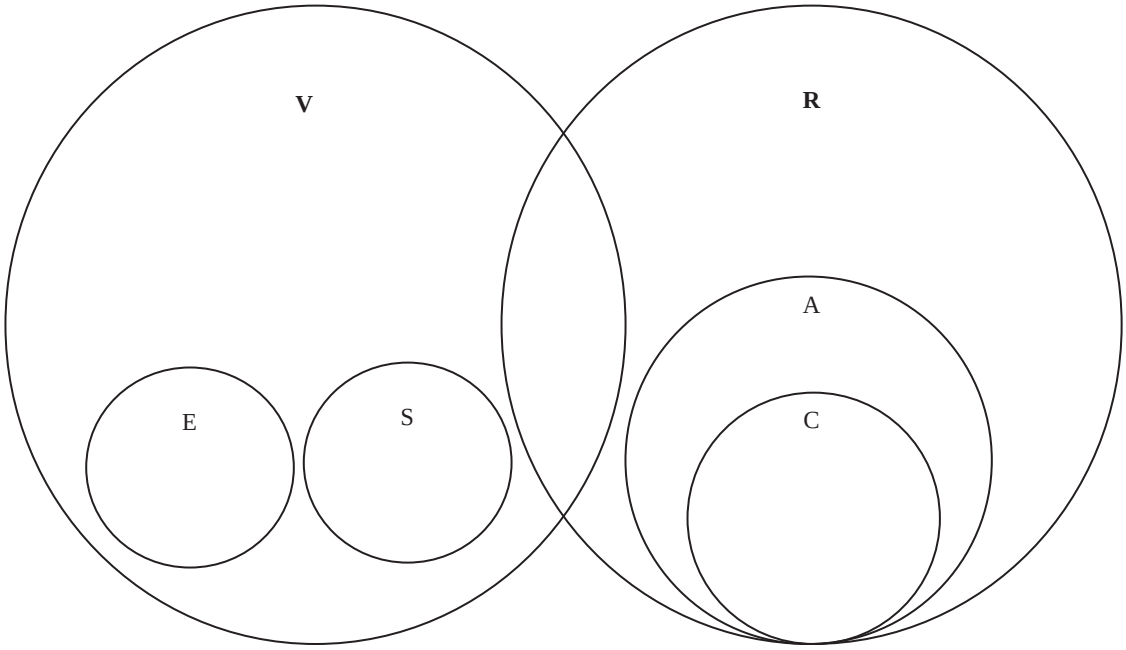

Figure 3.3: Conceptual framework for vulnerability (V) and resilience (R), and the associated concepts of exposure (E), sensitivity (S), adaption (A) and coping (C).

Coupled with its vulnerability is a household's resilience (Figure 3.3), or its inherent capability to respond (cope and/or adapt) to an adverse event, either proactively or reactively. Resilience can be thought of as a household's ability to absorb or endure shocks or stresses and bounce back or adapt without undermining their livelihoods (Pasteur, 2011, p. 13). Resilience is, in part, determined by the range of capitals a household is able to access, as these can influence the range of options and opportunities available for responding to change (ibid., pp. 14-15). Coping forms one aspect of resilience. Ellis (2000b, p. 297) emphasises that coping is an *ex post* event activity and comprises "…the methods used by households to survive when confronted with unanticipated livelihood failure" (ibid.). Coping in the face of an

adverse event can include a wide range of tactics by a household[59]. These tactics broadly follow two phases (Ellis, 1998, p. 14; Niehof, 2004, pp. 328-329). The first involves strategies that seek to maintain the existing income generating capability of the household (positive coping). Positive coping strategies are an important aspect of resilience as they help households to manage and recover from adverse conditions in the short term (Ellis, 1998, p. 14). However, depending on the magnitude of the adverse event, these tactics may fail, leading to greater and greater austerity measures being put in place (negative or erosive coping strategies). It is at this point that households move into the second phase. Here assets critical for future survival are sold, abandoned or disposed of (ibid.). This second phase can affect the household's ability to generate sufficient income, making the household vulnerable to future shocks (Cannon & Muller-Mahn, 2010, p. 623). Resilience, as Folke (2006, p. 259) notes, is not always a good thing.

As shown in Figure 3.3, the other aspect of resilience is adaptation. Proactive adaptive responses are the long-term strategies households put in place to take advantage of opportunities or learnings in response to a potential adverse event or shock, in order to limit the risk to the livelihood portfolio. This can include diversification of the household's livelihood portfolio. Although, as Ellis (2000b, p. 298) notes, the two are not synonymous.

> Diversification explicitly draws attention to a variety of dissimilar income sources (farm, non-farm, remittances etc.) as its chief characteristic. This is one potential outcome of adaption but not the only one; new ways of trying to sustain the existing income portfolio are also forms of adaption. Adaption may be positive or negative: positive if it is by choice, reversible, and increases security; negative if it is of necessity, irreversible, and fails to increase security. Negative adaption results in the adoption of successively more vulnerable livelihood systems over time (ibid.).

[59] Such as selling assets, using up food stocks and savings, relying on social networks (for instance relatives or neighbours) for assistance, purchasing food with credit, finding casual work, reducing the variety, quality and/or quantity of food consumed, and so on (Ellis, 1998, pp. 13-14; Niehof, 2004, p. 328; Pasteur, 2011, p. 14).

In recent times the literature on these concepts has shifted focus more towards resilience (Cannon & Muller-Mahn, 2010, p. 632). This has been driven by the premise that resilience is forward looking and positive (empowering even) whereas vulnerability is negative and has connotations of victimhood (Berkes, 2007, p. 284; Cannon, 2008, p. 1; Gaillard, 2007, p. 523; 2010, p. 220; Manyena, 2006, p. 435; Miller et al., 2010). Resilient societies are considered better able to cope and adapt with environmental, socio-economic and/or political stresses and shocks. This focus on resilience relates closely with the actor-orientated approaches to livelihoods, which emphasise the active role people play in earning their livelihoods and their capability to construct meaningful livelihood strategies (Nygren & Myatt-Hirvonen, 2009, p. 827). However, as discussed below, this approach can over-emphasise the degree of choice people have in constructing their livelihoods. An exclusive focus on resilience to the exclusion of vulnerability may therefore obscure the structural conditions and political power relations giving rise to the conditions that underlie their situation in the first place (Nygren & Myatt-Hirvonen, 2009, p. 828; O'Laughlin, 2004, p. 387). Just as vulnerability has been shown to be created by social, economic and political conditions; resilience must also be treated as being socially constructed (Cannon & Muller-Mahn, 2010, p. 622): a concept at risk of being missed with this shift in focus towards resilience (ibid., p. 632). Therefore, for the livelihoods framework to have relevance, particularly in investigating the effects IAS may have on livelihood strategies, both the inherent vulnerability and the inherent capability of people's livelihood strategies need to be considered.

3.3.3 Transforming structures and processes

In her livelihoods framework (Figure 3.2), Cahn (2006, pp. 145-146) places the 'Policy, institutions and processes' outside of the livelihood box, thus highlighting the overarching influence and importance these factor have on livelihoods. As de Haan and Zoomers (2005, p. 33) argue, there is a tendency of livelihoods research to focus on capitals and activities to the detriment of the role structural features have in shaping livelihoods. This is a view echoed by Allison and Horemans (2006, p. 764) who argue that there is a good reason why the transforming structures and processes box is at the centre of most livelihoods diagrams. Insufficient attention to this aspect of the livelihoods framework has been a common criticism of the approach (for example see

King, 2011, p. 299; Murray, 2000, p. 117; 2002, p. 493; O'Laughlin, 2004, p. 387; Zoomers, 2008, p. 148).

Associated with this is the way recent research on livelihoods has overemphasised the active role played by the poor in earning their livelihoods (Nygren & Myatt-Hirvonen, 2009, p. 857). Introduced earlier as the actor-orientated approach to livelihoods, this view, rather than seeing people "…impelled by forces beyond their control" (ibid.), focuses instead on their capabilities to construct their livelihoods. The criticism is that this can exaggerate the "…degree of volition and choice exercised by the poor…" (ibid.), while obscuring the conditions giving rise to their situation. As Scoones and Wolmer (2002, p. 183 – cited in de Haan & Zoomers, 2005, p. 43) argue[60],

> Livelihoods emerge out of past actions and decisions are made within specific historical and agro-ecological conditions, and are constantly shaped by institutions and social arrangements.

This means that while individual households can and do make their own livelihood decisions, these decisions are influenced by historical and social conditions, which can pre-structure the livelihood portfolio (de Haan & Zoomers, 2005, p. 43; Liao et al., 2015, p. 1303; Robaa & Tolossa, 2016, p. 109). This pre-structuring is evident in the majority of contemporary Solomon Island livelihoods. As will be outlined in Chapter 5, subsistence agriculture has always been the underlying mainstay of Solomon Island livelihoods. This, coupled with the development of a plantation economy and the subsequent uneven development by both colonial and post-colonial governments, has left a limited palate from which the majority of Solomon Island households can create a livelihood portfolio.

For the livelihoods approach to remain relevant and applicable there is a need to better incorporate the processes underlying people's livelihood diversification and the structural mechanisms involved (Nygren & Myatt-Hirvonen, 2009, p. 187; Scoones, 2009). This is of particular relevance to an anthropogenic environmental issue such as IAS, where social and political factors lie at the heart of the problem. While these concepts are already a part of the livelihood approach (i.e. captured in the transforming structures and processes in Figure 3.1 – (DFID, 1999: section 2.4)), they are often not

[60] Using studies based on rural African livelihoods.

explored (Scoones, 2009, p. 187). Therefore, in order to understand the processes shaping people's livelihoods at the local level it is also necessary to identify and trace the wider structural processes and the role they play. Bryant (1998, p. 86) argues that due to social and economic inequalities, participation in the global economy can disadvantage certain groups "…as their way of life is subverted by the spread of a development process outside their control." Development, as Adams (2009, p. 199) notes creates winners as well as losers. How IAS contribute to this process is explored further in Chapters 6 to 8.

3.4 The Study Approach

The preceding discussion has outlined the underlying concept central to this study: the livelihoods approach. In discussing the approach, this chapter has sought to address some of the weaknesses raised in the literature. Taking these issues into account, a revised general livelihoods framework, which better accommodates the scope of this research, is presented below in Figure 3.4.

Drawing on Cahn (2006), livelihoods are envisioned as being embedded within or an integral part of cultural and gender processes. Recognising both the shift in the literature away from vulnerability towards resilience, and the risk that a focus on one over the other may obscure part of the story, a vulnerability/resilience context has been included in the revised framework. The importance that the transforming structures and processes have on livelihoods is acknowledged; as is the criticism that this aspect of the livelihoods framework is often overlooked.

As shown in Figure 3.4, this study takes the approach of examining the livelihoods framework through the lens of IAS. To this end, Chapters 5 through 8 explore what influence IAS have on contemporary rural livelihoods in the Solomon Islands. With this study concept in mind, the following chapter outlines the methods used in conducting this research.

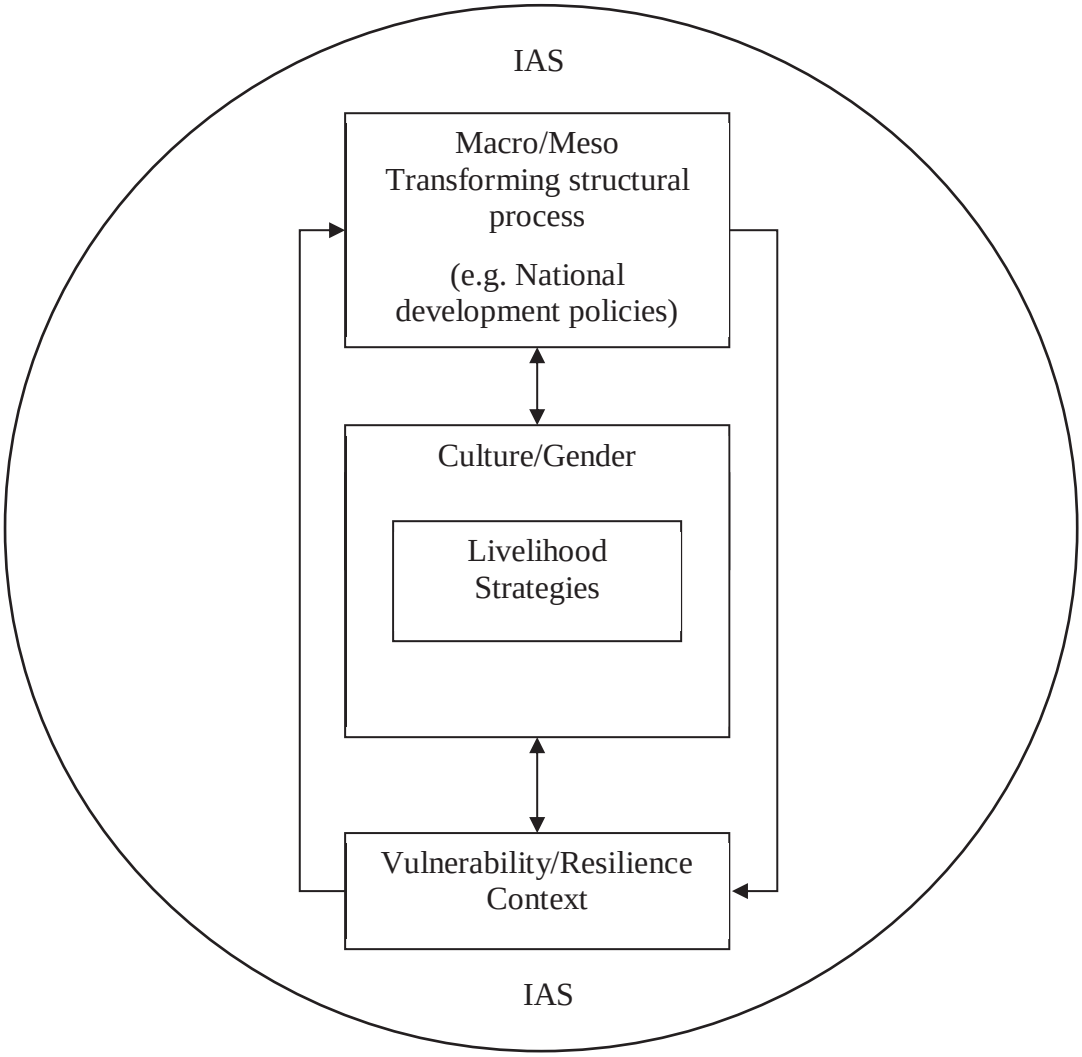

Figure 3.4: General livelihoods framework, seen through the lens of IAS

Chapter 4: Fieldwork Process and Research Methodology

4.0 Introduction

This chapter, in short, describes what I did and why I did it that way. While I have largely separated out the fieldwork and the methodological process for ease of explanation, it should be understood that the two are not separate processes but are in fact intertwined and inform each other.

Given the enormous number of IAS and the widespread threat they pose to the Pacific region, part one of this chapter begins by exploring the rationale behind why I chose to focus my research on *Wasmannia auropunctata* (little fire ant) and *Achatina fulica* (giant African snail) in the Solomon Islands. The chapter then discusses the steps and processes undertaken to ensure the research was conducted in an ethical manner before moving on to discuss my time in the field. Fieldwork, as Patton (2015, p. 408) emphasises, is dynamic, fluid, and essentially unique to the researcher. With this in mind, this chapter describes my experiences and the practicalities of preparing and conducting my fieldwork in the Solomon Islands.

Part two of this chapter then describes the methodologies behind this research and the methods employed while in the field. Strategies used to ensure credibility and trustworthiness (Stewart-Withers, Banks, McGregor, & Meo-Sewabu, 2014, pp. 77-78) of the data are outlined[61]. How the data emanating from the fieldwork was analysed is discussed and the chapter concludes by identifying some of the research limitations.

[61] Qualitative studies have their own criteria and standards to ensure rigour (O'Leary, 2010, p. 114; Stewart-Withers et al., 2014, p. 77). Stewart-Withers et al (2014, p. 79) argue that "approaches to questions of rigour in qualitative research focuses on credibility and trustworthiness of data". Saturation, triangulation of data methods and sources, peer review, positionality and reflexivity of the researcher, using multiple methods of data collection, and provision of sufficient methodological detail so that studies are auditable and/or reproducible, are all strategies that can be used to show appropriate standards of credibility and trustworthiness in qualitative research (O'Leary, 2010, pp. 114-115; Stewart-Withers et al., 2014, pp. 77-78).

PART 1: FIELDWORK PROCESS

4.1 Choice of Research Focus and Location

This research grew out of a career working on IAS issues in New Zealand[62], coupled with an interest in development studies; particularly in regards to how people interacted with environmental and conservation issues in developing countries. Holidays in the Pacific always had an environmental bent to them, with IAS being of particular interest. There are hundreds of IAS in the Pacific. The Global Invasive Species Database[63], a global resource that is focused on documenting invasive alien species that threaten native biodiversity and which covers all taxonomic groups from micro-organisms to animals and plants, lists 867 species; 569 of which can be found in the Oceania region. While this research could potentially have focused on any one of these species, an interest in the livelihood impacts of *W. auropunctata*[64] led to this species being the initial focus of my research. As discussed below, a second case study using *A. fulica* was added to the study following a pilot trip to the Solomon Islands.

The initial focus on *W. auropunctata* played a significant role in dictating the location of the study. As outlined in section 2.5.1, *W. auropunctata* is widespread throughout the Pacific region. This study could therefore have been conducted in any number of countries with an invasion history for this species. Prior to selecting a location to undertake this research I consulted with invasive species experts at the Pacific Invasives Initiative (PII) regarding the issue of *W. auropunctata* in the Pacific. This organisation "… was established as the first regional programme of the Cooperative Islands Initiative (CII)[65] in 2004" (ISSG, 2011). Its establishment was a result of

[62] I spent seventeen years working for the New Zealand Department of Conservation as a technical advisor on wild animal management issues. This work focused on the negative aspects of IAS and as such this has influenced to some degree the way I view IAS. To help avoid any personal subjectiveness I have used the responses of the participants throughout this thesis to capture and communicate the actual experiences of what they face. Additionally, I also kept a field notebook and personal journal while in the field. These were used to reflect on my experiences and observations, and to help develop ideas and question my views around IAS.

[63] See http://www.issg.org/database

[64] This interest was sparked initially from conversations with an ex-colleague working on ant biosecurity issues in the Pacific.

[65] "The Cooperative Initiative on Invasive Alien Species on Islands (The Cooperative Islands Initiative or CII) is a global initiative that was launched in 2002 following calls from island countries and countries with islands for more efforts to manage invasive species. CII aims to facilitate cooperation and enhance capacity to prevent and manage invasive species on islands. The CII is hosted by the Invasive Species Specialist Group (ISSG) of the Species Survival Commission of IUCN - International Union for Conservation of Nature, under the umbrella of the Global Invasive Species Programme. The

requests from the Pacific region for help with capacity development in the management of IAS, and "…was the first formal invasive species partnership in the Pacific" (ibid.). With a multi-disciplinary team of invasive species specialists, PII provides advice, planning assistance, training, specialist assistance and information to Government agencies, NGOs, and community-based organisation working on invasive species management projects in the Pacific (ibid.). The discussions with this organisation identified some potential study locations and reinforced the concerns raised in the literature regarding the threat *W. auropunctata* posed to livelihoods in the Pacific.

Following these, and subsequent discussions with the Secretariat of the Pacific Regional Environment Programme (SPREP) verifying the current hotspots for *W. auropunctata* in the region[66], the Solomon Islands were purposively selected as a potential location to undertake this research. The two deciding factors in favour of the Solomon Islands were language and the presence of a local researcher[67] who was willing to provide initial assistance, such as facilitating contacts with officials and communities within the country. Although I do not speak Solomon Island pijin[68] and was aware that I would need an interpreter to conduct the majority of my interviews, English is the official language of the country. This meant that accessing official documents, dealing with officials, and even conducting day to day activities such as shopping could be done in a language I knew. Borovnik et al. (2014, p. 117) note that in considering where to conduct your research "there is much to be said for starting from a position of some strength...". Taking advantage of practical issues, such as a familiar language for example, can make a considerable difference when faced with the many challenges that fieldwork in a developing country throws up.

New Zealand Agency for International Development (NZAID) and the New Zealand Pacific Development and Conservation Trust (PDCT) provided funding to establish the programme based at the ISSG's headquarters, then at the University of Auckland. In 2002, CII was proposed by the NZ government as a Type II Partnership at the World Summit on Sustainable Development" (ISSG, 2011).

[66] Solomon Islands, Guam, Hawaii and French Polynesia (P. Skelton, SPREP, pers. com. 2012)

[67] An outcome of my initial consultation with staff from PII was an introduction to a researcher who at the time was a lecturer at Solomon Islands College of Higher Education (now Solomon Islands National University – SINU), and who had undertaken research on *W. auropunctata* in the Solomon Islands (see Fasi, 2009; Fasi et al., 2013).

[68] While there are numerous dialects spoken in the Solomon Islands (see footnote 129 Chapter 5), Solomon Islands pijin is the lingua franca.

The Solomon Islands have a relatively long history of *W. auropunctata*. Although thought to be widely distributed throughout the country (Wetterer & Porter, 2003, p. 14), the actual distribution of *W. auropunctata* is largely unknown (ibid.). Because of this, a decision was made to focus the research on Guadalcanal as this was one island within the Solomon Islands that was known for certain to contain *W. auropunctata*, at least partly along the northern coast[69] (J.K. Wetterer pers. com. 2012). Guadalcanal is also the location of the country's largest urban centre, Honiara. Focusing on Guadalcanal as a research location and basing myself in Honiara would not only allow access to rural communities along the northern coast, but also allow access to other stakeholders such as government departments and NGOs which were based in the capital. In the end this proved to be a good decision, particularly with regards the latter, as I was able to undertake repeat visits to government departments and NGOs over the entire course of my fieldwork to discuss follow-up issues. More importantly, it gave me the flexibility to reschedule interview appointments with these stakeholders when they got cancelled or were not kept by the stakeholders[70]; or to pursue additional opportunities that arose as a result of the interviews[71].

Prior to finalising the location of my research I made repeated email contact with John Fasi in the Solomon Islands with whom I discussed my research proposal and sought feedback and advice. Advice was also provided by a second contact, Bishop Terry Brown[72]. It was Bishop Brown who first raised the issue with me of *A. fulica* being of concern to households in the Solomon Islands.

4.2 Ethics

Ethics is central to the research process and great care was taken to ensure that ethical issues were considered and addressed throughout the course of this research. This meant keeping a range of concepts or principles to the forefront of the research process. These principles included obtaining informed consent, ensuring privacy and

[69] The other location known with any certainty was Makira where John Fasi undertook his research on *W. auropunctata* (Fasi, 2009; Fasi et al., 2013)
[70] This was a fairly regular occurrence. It was only by being based in Honiara that I was able to persist and get the interviews I did.
[71] For example, as a direct result of my interviews I was taken on three fieldtrips by staff from different government departments in order to show me in person some of the issues we had been discussing.
[72] Former Bishop of the Diocese of Malaita, Church of Melanesia, Solomon Islands. Bishop Brown had recently retired back to Canada but provided advice and introductions to others in the Solomon Islands.

confidentiality, and ensuring no harm came to participants (O'Leary, 2010, p. 41). These principles are discussed in more detail below in terms of my specific research.

Prior to my going to the Solomon Islands, I met with my supervisors and another departmental academic to discuss what was ethically expected during the conduct of research from an Institute of Development Studies (IDS) and Massey University perspective. Additionally, following Massey University's 'Code of Ethical Conduct for Research, Teaching and Evaluations Involving Human Participants' (Massey University, 2013), approval was sought from Massey University's Ethics Committee to undertake this research. Approval was granted on 1 May 2013, with the research deemed to be low risk (Appendix 1).

At all times during the fieldwork process emphasis was placed on ensuring participants gave informed consent. Informed consent requires participants to have a full understanding of the research and their involvement in it. This includes the understanding that their participation is entirely voluntary and that they have the right to discontinue their participation at any stage without fear of prejudice (Banks & Scheyvens, 2014, p. 165; O'Leary, 2010, p. 41). All participants in this research were provided with an information sheet and consent form (Appendix 2) describing the research, its purpose, and their rights if they chose to participate[73]. Banks and Scheyvens (2014, p. 166) note that in cultures with strong oral traditions and/or communities with variable levels of literacy, the use of written material for informing participants about the research may not necessarily be the best way to ensure that they understand the research and their part in it. There is a strong oral tradition in the Solomon Islands (Seller, 1996, p. 6) and, as noted by a local NGO, the range of cultures and variable literacy levels can make the dissemination of information and the raising of awareness with communities very difficult[74] (SIDT, n.d.-b). Therefore, in order to be confident that potential participants had a full understanding of what the research involved, the contents of the forms were discussed with the participants, prior to every interview, either in English, pijin or a local dialect, depending on the

[73] This information sheet was in English. While pijin is the lingua franca in the Solomon Islands it is largely a spoken rather than written language (Moore, 2013; Terrill, 2002, p. 212).
[74] This local NGO is noted for its use of oral awareness techniques, in particular a theatre group, when undertaking awareness programmes with rural communities.

interviewee. Every opportunity was given to potential participants to discuss the information provided and ask questions if they desired. Often participants would ask more questions at the end of the interview.

The university's code of ethics required a signed consent form from participants. While this was not a problem in most instances it was soon evident that not all participants were comfortable signing one, even though they were eager to talk about their experiences. In this situation I accepted verbal consent, recording their permission on my digital voice recorder. While it has been noted that in some circumstances participants may find the recording of their consent equally as intimidating as signing a form (Banks & Scheyvens, 2014, p. 167), I did not encounter this. I recorded all my interviews during my fieldwork, with no one objecting to this practice.[75]

During the ethics meeting held with IDS departmental staff prior to going to the Solomon Islands, consideration was given to ensuring my proposed research did not cause potential participants any harm. Central to this was ensuring that all information provided was treated confidentially and was only used in a way that did not place the informant at risk or cause embarrassment. This extended to how I kept my data secure while in the field[76] and back in New Zealand[77]. Another aspect of this, discussed during the ethics meeting and later with all participants, was not revealing the identity of the participant unless they specifically wished to be identified. To this end, where I have needed to use a name in this thesis when discussing the response I received, a pseudonym has been used. In all other cases I have used an interview number to cite participants.

Maintaining the privacy and confidentiality of Government and some NGO employees was not always possible, particularly when they were speaking in their official capacity. This was discussed with the participants prior to the interview and in only

[75] All my interviews were digitally recorded and copied onto my laptop at the end of each day. Interview files were renamed to reflect the location and participant interviewed.
[76] When not with me my field note books, voice recorder and laptop were kept locked in my suitcase; which in turn was locked in my room.
[77] Time in the field excluded, I worked mostly from home during the course of this study because I did not reside in the same city as the university. When not with me on my periodic visits to the university, all my data was secured in my office at home.

one instance did the participant ask that they remain anonymous. Government and NGO interviewees are cited in this thesis using an interview number; although in the case of Government officials the organisation is also identified.

4.3 Fieldwork

My fieldwork comprised three trips to the Solomon Islands during 2013, totalling just over three months in duration (see Table 4.1). The first trip was a two-week pilot trip, the aims of which are discussed more fully below. My second and third trips to the Solomon Islands were when the bulk of my data collection occurred. I chose to split my fieldwork to accommodate family and personal commitments. Borovnik et al. (2014, p. 117) note that there are many practical issues that dictate when you undertake fieldwork, and these need to be just as carefully considered in your planning as you would methodological and academic matters.

Table 4.1: Solomon Islands Fieldwork Dates

Trip 1 (pilot trip)	6 May 2013 – 17 May 2013
Trip 2	4 August 2013 – 20 September 2013
Trip 3	27 October 2013 – 26 November 2013

Although I originally planned to spend longer in the field, my fieldwork was suddenly and unexpectedly cut short when I developed malaria (*Plasmodium falciparum*) about three weeks into my third trip to the Solomon Islands.[78] Although treated for this in the Solomon Islands, I was seriously ill and struggled to look after myself. As soon as I was fit enough to travel I returned home. Ongoing health issues stemming from this incident meant that I was unable to work to my full capacity for at least six months after returning home.[79]

[78] This was despite taking anti-malarial medication, using a treated mosquito net when sleeping, wearing long-sleeved shirts and long trousers when out and about, and covering myself in Deet (N,N-Diethyl-meta-toluamide) insect repellant.
[79] I suspended my thesis with the university for six months because of this.

4.3.1 Pilot trip

In May 2013 I undertook a two-week pilot trip to the Solomon Islands. This trip had three main aims. The first was to establish contact with local communities and obtain their permission to conduct my research within their communities. The second was to ascertain the process for obtaining a research permit and the third aim of the trip was to familiarise myself with the Solomon Islands. This familiarisation aspect of the trip included general orientation and logistical objectives which underlie effective fieldwork[80]. While none of these aims was mutually exclusive of the other two, the individual aims are discussed in more detail below.

4.3.1.1 Establishing Initial Community Contacts

Leslie and Story (2003, p. 122) note that the ability to be flexible is of paramount importance for conducting fieldwork in developing countries. This was certainly true in my experience. My pre-laid plans and arrangements made leading up to my trip to the Solomon Islands quickly dissolved upon arrival in the country. Time constraints and other commitments meant that my primary contact was unable to help directly with introductions to communities as planned; necessitating me to make alternative arrangements. Although unable to help directly, this contact was however able to suggest other people I should approach; one of whom was the Director of Quarantine (SIAQS) at the Ministry of Agriculture and Livestock. This suggestion led not only to an appointment with the Director to discuss my research proposal, but also to a field visit a few days later with the Director to some rural areas for a first-hand look at the issues. While the focus of my discussions with the Director of Quarantine was around *W. auropunctata*, we also talked about other IAS issues facing the Solomon Islands, in particular *A. fulica*, which was a main focus for the quarantine department. The field visit with the Director provided me with the opportunity to approach the leaders of two communities to talk about my proposed research and obtain their permission to come back and conduct interviews within their communities later in the year[81]. At this

[80] For example, finding affordable, comfortable and safe accommodation from which to base myself. Familiarisation with public transport, banking, telecommunications, internet services and location of government departments, were some of the other tasks carried out during this trip.

[81] Despite a number of tries I was unable to re-establish contact with one of these communities on my return to the Solomon Islands as my contact for this community had left. Because I was, by the time of my return, now also looking at *A. fulica* (which was absent from this particular community) I chose to redirect my efforts into establishing contact with communities affected by *A. fulica* rather than begin

stage I was still focusing on the livelihood impacts of *W. auropunctata* but the discussions and field visit with the Director of Quarantine had left me considering the possibility of looking at other IAS as well.

In order to gain as wide a perspective of IAS issues as possible during this trip I also followed up on the introductions provided to me by Bishop Brown[82]. In typical snowball fashion these introductions led to introductions, which in turn led to introductions. While not all of them panned out, by the end of my two weeks in the Solomon Islands I had preliminary permission from a further two communities and an NGO to undertake my research with them. Of greater consequence to my research was that this chain of introductions led me to a local NGO who was assisting the SIAQS with their awareness programme for *A. fulica*. This repeated highlighting, through different sources, of the impacts *A. fulica* were having in the Solomon Islands led to the decision to include this IAS as a case study in my research.

4.3.1.2 Research Approvals

Prior to undertaking the pilot trip to the Solomon Islands I had made little progress towards obtaining a research permit. There was very little information regarding the process on the Solomon Island Government websites and my email enquiries to various departments had gone unanswered. Once in the country enquiries in person proved to be much more fruitful. Unfortunately, in my quest to get advice I did get caught up in some departmental politics/rivalries, which delayed the issuing of one of my permits.

One of the first appointments I got on arriving in the Solomon Islands was with the Ministry of Environment, Climate Change, Disaster Management and Meteorology (MECDM). During this meeting I was told that following recent legislative changes (which I was shown), this Ministry was now responsible for issuing research permits for the type of research I wanted to undertake, and not the Ministry of Education and Human Resource Development (MEHRD) as was once the case. As per this advice I sought a permit through this ministry; submitting my application at the end of my pilot

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the access process again from scratch with this particular community (where I had planned to discuss issues relating to *W. auropunctata*).

[82] See footnote 72.

trip. The MECDM permit process also involved obtaining approval from the Guadalcanal Provincial Government. Following face-to-face discussions with the administration officer responsible for processing my approval, an application for this permit was also submitted at the end of my pilot trip[83].

Following my return to New Zealand I was subsequently informed by the Guadalcanal Provincial Government that I also needed approval from the MEHRD. My email enquiries as to the need for approval from the MEHRD, as per the advice received from the MECDM, were meet with the insistence from the MEHRD that they, and no other Ministry, were to issue research permits on behalf of the Solomon Island Government. My queries to the MECDM clarifying the issue meet with a similar response from them. Given the impasse and rather than antagonize anyone, I ended up obtaining permits from both ministries (paying considerable application fees to both). Because I was now back in New Zealand I attempted to obtain my permit from the MEHRD remotely. This however proved unsuccessful. Enquires as to the progress of my application went un-replied and in the end I had to resubmit my application in person after arriving in the country for my second visit. Repeated visits to the MEHRD to politely enquire as to progress saw this permit granted during the second week of this trip.

While arduous, there was a positive aspect to the process of obtaining official approval to conduct my research. Both the MECDM and the Guadalcanal Provincial Government provided me with additional research contacts; the provincial government, unbeknownst to me, going as far as contacting representatives from two communities on my behalf and seeking their approval for me to conduct my research with them.[84] Unfortunately this had some negative consequences in that they over promised what I was there to do. This became apparent during my initial meeting with one of the community contacts when I had to severely dash his expectations around any financial assistance his community was going to receive from me. Fortunately, he

[83] Both the MECDM and the Guadalcanal Provincial Government permits were approved in principle prior to my return to the Solomon Islands. The actual permits were not issued until I had paid the application fees on my return to the Solomon Islands. This involved paying the fee to the Ministry of Finance and taking the receipt back to the permitting authority as evidence of payment.

[84] One of these communities was in a remote location on the Weather Coast. Logistically it was not realistic for me to visit them without dedicating more time in the field than I could afford so I therefore had to let them know that I would not be coming.

realised that this misunderstanding was not of my making and through this contact I was able to directly set up two focus groups.

Borovnik et al. (2014, p. 109) note that official approval is only the first step of many when seeking research permission. In my case, once granted, official approval largely became redundant as none of the participants was interested in the fact that I had official permission from the Government to undertake my research. This is not to say that the process was not important. Ethically it was important to demonstrate to the authorities that I was not there to cause harm or make trouble. However, in practice the most important permissions were the informal permissions; granted firstly by community/organisation leaders for me to undertake my research in their community or organisation, and secondly by the individual households/staff within those communities/organisations. Banks and Scheyvens (2014, p. 172) note that

> often it is *local* gatekeepers who will need to be satisfied before an adequate level of fieldwork can be undertaken. In some cases this will be informal 'permission' – people's consent will be indicated by their degree of participation and enthusiasm for you and your work. This is perhaps the most important and relevant permission you will be granted and will continue to strive for and negotiate even on a daily basis.

Because permission by leaders did not automatically guarantee participation by individual households or staff this needed to be constantly negotiated prior to every interview. This helped ensure that participants were not coerced into taking part in the research, thus ensuring that the ethics of the research was maintained.

4.3.1.3 Familiarisation and Logistics

The big advantage of undertaking a pilot trip to the Solomon Islands was that it enabled some familiarisation with the country. Transportation, communication, where to get money, where to eat, where to shop and where best to stay for example, were all issues addressed during this pilot trip. Having this prior knowledge made the transition into fieldwork that much easier on my subsequent trips as I was able to hit the ground running more quickly. One issue, however, that I was unable to make any progress on during the pilot trip was that of hiring a research assistant.

4.3.2 Trips two and three

My second and third trips to the Solomon Islands (see Table 4.1 for dates) were largely spent interviewing participants and collecting data. As noted above, and in the section to follow, the second trip also involved the completion of some outstanding activities from my pilot trip (e.g. the finalisation of research approvals and the hiring of a research assistant). Interviews for this study were conducted almost every day, however, the number of interviews conducted per day did vary depending on the availability of participants.

4.4 Research Assistant

Having a research assistant was a necessary and invaluable component of my research. In addition to needing an interpreter, it was also important to have someone who could advise me on the appropriate social and cultural protocols and expectations. Having someone with local knowledge also saved many hours, if not days, when it came to logistics. While my pilot trip to the Solomon Islands provided me with a broad familiarisation of the local infrastructure and layout of the area, it was no match for someone who had spent most of their life there. Another invaluable aspect was being able to get first hand advice on the local dangers and annoyances.

While having a research assistant was invaluable, finding one was not so straightforward. During my pilot trip I was given a contact at the Solomon Islands National University (SINU) who agreed to help me find a suitable candidate on my return to the Solomon Islands. Unfortunately, when I arrived back in the country for my second trip this contact was away and would not be back for some weeks. Instead I had to draw on the contacts I made during my pilot trip and through these I was introduced to another SINU staff member who made enquiries on my behalf amongst his students. In addition, I also mentioned that I was looking for a research assistant to all the NGOs and organisations I visited in the first week of my stay[85]. I also approached a local training centre that I had read about in the local newspaper which had just graduated a number of students in different fields.

[85] While waiting to find a research assistant I started arranging and conducting interviews with stakeholders in Honiara as these could all be done without the need of an interpreter.

My efforts yielded four candidates and after talking to them all I selected one who was a recent environmental science graduate from the University of the South Pacific. In addition to being from Guadalcanal and having good language skills (English, pijin, local dialects), this candidate also showed a strong interest in what I was doing. This person ended up acting as my research assistant for the bulk of my fieldwork. The only time he was unavailable was during the first two and a half weeks of my third trip to the Solomon Islands. He did, however, organise his own replacement for this period so that my fieldwork would not be interrupted. Prior to commencing interviews with my research assistant we spent some time discussing the research and going over the interview schedules I had prepared (see section 4.5.3.1 below). Discussions were also held around how literal I wanted the translations to be[86]. At this stage I also field-tested the interview process with two participants at a local market[87] in order to practise working together with my research assistant and to sort out any issues with the process, content and comprehension of the interview questions.

My research assistants proved to be an enormous asset during my fieldwork. Not only did they help with my data collection and fieldwork logistics, but they also provided advice and insight into life in the Solomon Islands. Banks and Scheyvens (2014, p. 174) argue that it is important to consider what you can give back to those who assist you with your research. While I was paying my research assistants to do a job[88], it was important to me that they also had the opportunity to get more from the experience than just financial remuneration. To this end my main research assistant and I often talked over the research and methodologies as a way of assisting with his own professional development and interests. Additionally, even when I had interviews that

[86] While it did not have to be exactly word for word I was after as literal a translation as was possible. In particular, I emphasised the need not to omit or filter responses, instead to repeat what was said regardless of whether it seemed relevant or not. I also repeated this exercise with my second research assistant. Initially I had some issues with this second research assistant paraphrasing and even answering for the participants. By this stage of my fieldwork I understood enough pijin to broadly follow the conversation and could detect this happening. This research assistant had previously worked on other research projects in the Solomon Islands and had a preconceived view of what was required (see McLennan et al. (2014, pp. 152-155) for further discussions on the pros and cons of using a research assistant). However, after further discussions with this research assistant around what I wanted and why I wanted it done that way, things improved markedly.

[87] These two women were from rural communities east of Honiara and had come into town for the day to sell their produce at the market.

[88] I sought advice from Bishop Brown and an international NGO working in the country as to an acceptable rate of pay. It was important to my own personal ethics that I paid a living wage as opposed to the minimum wage.

did not require the services of my research assistant, such as with some government officials, I still took him along with me as a way of helping him expand his own professional networks.

PART 2: RESEARCH METHODOLOGY

4.5 Methodological Approach

Fieldwork both informs, and is informed by, research methodologies. The research methodologies behind this study are covered in the remaining part of this chapter. While this research primarily uses qualitative techniques, it is strongly influenced by the mixed-methods philosophy and its underlying pragmatic approach; which rather than associating research methods with epistemological assumptions, instead emphasises the "appropriateness of those methods for answering research questions" (Bryman, 2008, p. 19). This approach sits well with my own worldview, which reflects my ecological training tempered with seventeen years work experience dealing with a wide variety of communities, issues and perspectives. [89]

The debate around the relative merits of different research methodologies is long-standing (Patton, 2015, p. 88). The paradigm wars[90], which was essentially a head-to-head debate between those championing the positivist (with its associated quantitative) stance and those promoting the constructivist (with its associated qualitative) approach, has in many respects (although not entirely so – Bryman, 2008, p. 17; Patton, 2015, p. 88) moderated with the resurgence of the mixed methods approach[91] (Bryman, 2008, p. 15). While traditionalists believe "…that qualitative and quantitative research methods cannot be mixed in a single study as they have different ontological and epistemological origins"[92] (Doyle et al., 2009, p. 183), mixed

[89] You do not have to attend many public meetings on, for example, the use of the poison sodium monofluoacetate (1080) for pest control in New Zealand, to realise that there are many perceptions of the world (multiple truths), and that no single approach can do justification to the complexity of social issues and the variety of meanings people ascribe to their experiences.

[90] Arising in the 1970s, the paradigm wars resulted from the domination of social science by quantitative research post World War II, and the attachment of philosophical issues to research methods (Bryman, 2008, p. 17).

[91] Mixed methods is not a new approach. For example, Bryman (2008, p. 15), Alastalo (2008, p. 38) and O'Leary (2010, p. 130) provide early examples of mixed methods research from the 1930s.

[92] Known as the incompatibility thesis (Doyle, Brady, & Byrne, 2009, p. 183; Johnson & Onwuegbuzie, 2004, p. 14) in which it is argued that a combination of the positivist (with its objective approach to research) and constructivist (with its subjective approach to research) paradigms is not possible due to

methodology researchers have rejected this thesis, adopting an alternative view (the compatibility thesis – Howe, 1988, p. 10; Teddlie & Tashakkori, 2010, p. 9). This view argues that combining qualitative and quantitative methods is appropriate and is not "…epistemologically incoherent" (Howe, 1988, p. 10) because the terms qualitative and quantitative describe types of data and methods not philosophical paradigms (Biesta, 2010, p. 98; Greene & Hall, 2010, p. 124).

The different views expressed above arise because these arguments are primarily operating at different levels; the epistemological (ontological) level and the technical level (Bryman, 2008, p. 15):

> At the epistemological and ontological levels there is an incompatibility of fundamental assumptions in terms of what should be regarded as acceptable knowledge and how society and its institutions should be characterised…. At the technical level, the differences are more to do with the character of the data generated by the research methods associated with quantitative and qualitative approaches and their relevance to different kinds of research questions or roles in the overall research process (ibid.).

It is this technical approach which characterises much of the mixed methods literature (ibid., p. 19).

Patton (2015, p. 92) takes this technical approach to research further, arguing that adhering to a single research paradigm, be it qualitative, quantitative, or even mixed methods, can limit research inquiry by locking

> …researchers into unconscious patterns of perception and behaviour that disguise the biased, predetermined nature of their methods "decisions". Methods decisions tend to stem from disciplinary prescriptions, concerns about scientific status, old methodological habits, and comfort with what the researcher knows best. Training and academic socialisation tend to make researchers biased in favour of and against certain approaches. (ibid., p. 89).

This he argues, limits methodological choices, flexibility and creativity (ibid.). Instead, Patton champions methodological appropriateness (ibid., p. 92); in which the

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the fundamental differences between them (D. L. Morgan, 2007, p. 58; Teddlie & Tashakkori, 2010, p. 8).

study design is appropriate for the research situation or interest being studied. In his experience, he argues, "methods can be separated from the epistemology out of which they have emerged" (ibid., p. 154). He further notes that while "intellectual, philosophical, and theoretical traditions have greatly influenced the focus, value and legitimacy of particular types of … inquiry, it is not necessary to swear vows of allegiance to any single epistemological perspective…" in order to use a particular method (ibid.).

This bottom-up approach, in which research questions and methods drive the process (Teddlie & Tashakkori, 2010, pp. 14-15) has its groundings in the pragmatic theory of truth[93], in which "truth is verified and confirmed by testing ideas and theories in practice" (Patton, 2015, p. 152). While Patton (2015, p. 153) describes pragmatism as an unique philosophical worldview, Greene and Hall (2010, p. 132) describe pragmatism as more of an anti-philosophy. Biesta (2010, p. 97) on the other hand suggests that

> …pragmatism should not be understood as a philosophical position among others, but rather as a set of philosophical tools that can be used to address problems – not in the least problems created by other philosophical approaches and positions. One of the central ideas in pragmatism is that engagement in philosophical activity should be done to address problems, not build systems.

As a framework, "pragmatism directs us to seek practical and useful answers that can solve, or at least provide direction in addressing, concrete problems" (Patton, 2015, p. 153). It also directs us to make "pragmatic decisions while conducting the inquiry based on real-world constraints of limited time and resources. This means making method decisions based on the situation and opportunities that emerge rather than adherence to a pure paradigm, theoretical inquiry tradition, or fixed design" (ibid.). It is this bricoleur[94] approach which "…sees methods as emergent and dependent upon

[93]As developed from the writings of classical pragmatists such as John Dewey, Charles Sanders Peirce and William James (Greene & Hall, 2010, p. 131; Johnson & Onwuegbuzie, 2004, p. 16).

[94] This term comes from the anthropologist Levi-Strauss (1966, p. 16). A rough translation from French would be a person who is considered to be a "Jack of all trades or a kind of professional do-it-yourself person" (ibid., p. 17). Patton (2015, p. 153) uses the term as a metaphor for researchers who use "diverse techniques to fit the complexities of a particular fieldwork situation", whereas O'Leary (2010, p. 96) regards it as someone who is "comfortable with a variety of methodological/methods options". This does not mean that the pragmatist 'makes it up as they go along' or 'if it works use it'. A key point from Levi-Strauss's (1966, pp. 18-19) writings regarding this metaphor is that methods are pre-constrained

both question and context" (O'Leary, 2010, p. 96) which has influenced the research design for this study.

4.5.1 Research design and methods

As raised earlier in Chapter 2, the majority of the research on IAS has focused on ecological rather than livelihood concerns. This has meant that the impacts on people and their ability to pursue meaningful livelihood strategies have been largely overlooked in the literature. Although IAS are considered to be one of the most serious threats to sustainable development in SIDS (UNEP, 2014a, p. 13), the livelihood impacts of IAS are still poorly understood and lack adequate attention and recognition (ibid.). To ensure my research addressed this situation, I drew on the livelihoods approach to inform my research design. The livelihoods approach provides both a framework and a theoretical concept on which inquiry and analysis can be based (Cahn, 2006, pp. 77-78). This approach not only guided my research questions, but, as outlined below, also informed what data was collected and how it was analysed.

Raising the profile of IAS is a common imperative across both the academic and policy literature (for example see Browne et al., 2009; SPREP, 2011; Tye, 2009; UNEP, 2014a). For this reason, and acknowledging the call for research that can address the knowledge gap and highlight the effects IAS have on livelihood strategies, I chose to use a case study approach for this research. Mabry (2008, p. 214) defines a case as an "…investigation of a specified or *bounded* phenomenon" (emphasis in original); the purpose of which is to provide an understanding of complex social issues (Mabry, 2008, p. 217; Yin, 2009, p. 4). This understanding is achieved by purposefully selecting information-rich cases "…from which one can learn a great deal about issues of central importance to the purpose of the inquiry…" (Patton, 2015, p. 264). Rather than producing empirical generalisations, the purpose of studying information-rich cases is to yield insights and in-depth understanding (ibid.).

Drawing on the literature, expert advice and my pilot trip, I selected two typical case studies (Mabry, 2008, p. 217; Patton, 2015, p. 284) which describe and illustrate how

and this limits what they can be used for or the situations they can be used in. Pragmatists, in choosing a particular method, must take these limitations into account.

rural Solomon Island households are affected by IAS, and use these to address the research questions posed in Chapter 1. Patton (2015, p. 284) notes that typical case studies are used to "understand, illustrate and highlight what is typical and normal" in situations that may otherwise be unfamiliar. For IAS, this unfamiliarity is characterised by the ease in which IAS issues fly beneath the radar of many, including governments (Thaman, 2013; UNEP, 2014a), despite being a widespread phenomenon. Both the *W. auropunctata* and the *A. fulica* case study are considered to be typical in that the species in question meet the IAS definition outlined in Chapter 2; both are considered by the ISSG as classic examples of IAS (Lowe et al., 2000, p. 3) and; both are recognised as agricultural pests in the literature (see Chapter 2).

All research designs involve trade-offs (Patton, 2015, p. 256). Limits in time, resources and "…the human ability to grasp the complex nature of social reality necessitate trade-offs" (ibid.). The dilemma of breadth versus depth with regards the sampling strategy within the case studies is an example of this. Whether to focus on a small number of households/communities in detail, spending many days with each (depth); or to sample a greater range of households/communities in less depth, spending a shorter time with each (breadth), was an important decision in my research design. I chose the latter. As the next chapter outlines in detail, around 80% of the population in the Solomon Islands live rurally, with the majority of rural households dependent on subsistence/semi-subsistence agriculture for their livelihoods. With this in mind it became evident to me that, for this study, the location of the household was less important than the livelihood strategies the household pursued. This meant that I did not need to confine myself to one or two communities but could interview households over a larger geographical area and still remain within the boundaries of my cases. While potentially providing less detail, this approach provided access to households with a greater range of experiences. In addition, another outcome of my pilot trip was a better awareness of how busy people's lives were. While many people freely took time out of their busy schedules to talk with me, I was conscious of the fact that I was imposing on their daily routine. Taking a broader approach meant less intrusion and disruption on individuals. Patton (2015, p. 258) notes that the choice between breadth and depth is not one between good or bad design, but rather, is just a choice between alternative approaches.

Because the distribution of *W. auropunctata* and *A. fulica* within the Solomon Islands is largely unknown[95] (and therefore so too is the distribution of households affected by them) I used a combination of non-random or purposive techniques to select participants for each case. The aim of this was to select information-rich participants who have detailed knowledge or experience of the issue under investigation (Curry, Nembhard, & Bradley, 2009, p. 1445). There are a number of different sampling strategies available for purposively selecting participants (Collins, 2010, p. 357; O'Leary, 2010, pp. 165-171; Patton, 2015, p. 264)[96]. These strategies are not mutually exclusive and any one or a combination of approaches may be used as necessary (Patton, 2002, p. 242; 2015, p. 305). At the broadest level I used criterion sampling, where all the participants meet some specific criteria (Patton, 2015, p. 281); in this instance the criteria were rural households whose livelihood activities were affected by either *W. auropunctata* or *A. fulica.* Snowball sampling, where participants identify other potential participants (ibid., p. 298), was utilised in conjunction with this approach; firstly to expand the number of key contacts[97] who could provide me with specific information regarding the location of households/communities matching the above criteria, and secondly to build the sample of households at an identified location. In addition to these techniques I also used opportunity sampling. Patton (2015, p. 300) describes opportunity sampling as taking advantage of unanticipated opportunities "…to interview someone or observe an activity…", that arises during fieldwork, and which could not have been predicted or planned for in advance. An example of this are the field trips I was taken on by government officials[98].

4.5.2 Sample size

Patton (2002, p. 244) states that "…there are no rules for sample size…" in regards using qualitative methods. The number of participants depends on the purpose of the research and on what it is you want to know (Collins, 2010, p. 356; Dawson, 2002, p. 49; Kvale, 2007, p. 43; Patton, 2002, p. 244). With purposive sampling, the aim is "…to add to or generate new theories by obtaining new insights or fresh perspectives…" (Collins, 2010, p. 357), with saturation being the ultimate end goal

[95] See the sections on arrival and distribution in each case study below.
[96] Collins (2010, p. 357) identifies nineteen different strategies, Patton (2015, p. 264) describes forty.
[97] As noted in section 4.3.1.1 I started with one firm research contact and a couple more potential contacts from which I built up my research sample.
[98] See footnote 71.

(Guest, Bunce, & Johnson, 2006, p. 60). Saturation occurs when collecting additional data does not provide any new information or concepts (Collins, 2010, p. 360; Patton, 2002, p. 246). While I reached saturation with regards many aspects of my enquiries, I was unable to fully follow up on some emerging topics[99] due to having to cut my fieldwork short after catching malaria.

4.5.3 Data collection

A number of methods were used to collect data during fieldwork and these are discussed in detail below. Using multiple methods or triangulation provides greater strength or validity in a study by seeking corroboration between data (Curry et al., 2009, p. 1449; Doyle et al., 2009, p. 178; Patton, 2002, p. 247). Triangulation is "…based on the premise that no single method ever adequately solves the problem of rival explanations" (Patton, 2002, p. 555). Using multiple methods of data collection and analysis allows for cross-data corroboration and strengthens confidence in the resulting conclusions (ibid., p. 556).

4.5.3.1 Interviews: One-on-One and Focus Groups

Interviews are an important method for gathering data during qualitative research. I used this method extensively during my fieldwork, interviewing households and key informants (such as NGOs, Government officials, and commercial businesses). Table 4.2 provides a summary of the number of interviews conducted during this research for each case study.

Table 4.2: Summary of Interviews. The LFA + GAS column represents interviewees who discussed both Wasmannia auropunctata (little fire ants) and Achatina fulica (giant African snail) during their interview

Interview Setting	Little Fire Ant (LFA)	LFA + GAS	Giant African Snail (GAS)	**TOTAL**
Household	14	10	20	**44**
NGO		5		**5**
Government		8	2	**10**
Focus group		5	2	**7**
Walk-through		2	4	**6**
Commercial		3		**3**
TOTAL	**14**	**33**	**28**	**75**

[99] For example, see the discussion on betel nut in Chapter 7, section 7.3.3.

Interviews are conversations carried out between a researcher and a participant, generally on a one to one basis (Curry et al., 2009, p. 1445), which seek to explore how people experience and perceive their world (Curry et al., 2009, p. 1445; Kvale, 2007, p. 9; Patton, 2002, p. 341). While the structure and purpose of the conversation is determined by the interviewer (Kvale, 2007, p. 7) the approach aims to allow the respondent to identify and describe the experience under investigation in detail, and in their own words (Curry et al., 2009, p. 1445; Patton, 2002, p. 348). Patton (2002, p. 242; 2015, p. 437) outlines three basic approaches to collecting interview data. These are conversational or unstructured interviews, in which the questions are not predetermined and flow from the immediate context; the interview guide or semi-structured interview, which employs "…open ended questions within a predetermined set of topics" (Curry et al., 2009, p. 1445); and standardised or structured interviews, in which the questions are predetermined and are not deviated from between participants (Patton, 2002, p. 346). Both unstructured and semi-structured interviews were used during this study. Most interviews used the semi-structured approach, but unstructured interviews were also utilised where appropriate, particularly in conjunction with the observational walk-throughs described below.

Prior to the fieldwork commencing separate interview schedules for the household and key informant semi-structured interviews were developed (Appendix 3). Using the livelihoods framework (Chapter 3) as a guide, these schedules comprised a list of topics and questions that were explored during the semi-structured interviews (Creswell, 2009, p. 183; Dawson, 2002, p. 68; Kvale, 2007, pp. 56-57; Patton, 2002, p. 343). As noted above, these schedules were trialled once I was in the field and refined. Minor refinements took place throughout the fieldwork period as part of my post-interview process. This process involved recording my reflections on the information gathered from the days interviews and on the emerging themes (Dawson, 2002, p. 111; Patton, 2002, p. 384). These thoughts and reflections took the form of notes in my field notebook[100] and journal, as is illustrated by the following example.

[100] On a practical note I ran two field notebooks. My main field notebook was a hardbound 2B5 exercise book. However, I found that in some circumstances, such as on crowded buses, it was difficult to make notes in. For this reason, I also carried a small pocket notebook which I could use in these situations. I also kept a personal journal while in the field. This also contained reflections on my experience.

> Joseph mentioned that women have the additional task of doing snail patrol morning and night to manage the infestations on their gardens. This is on top of their normal tasks. Find out how much time this takes each day. Also attitudes. (Field notebook 16 August 2013).

This post-interview process helped to identify improvements/changes for subsequent interviews. The above example for instance, resulted in a refinement to my interview schedule to ensure this new line of inquiry was followed up during future interviews.

Another interview technique utilised during my fieldwork was focus group interviews (Table 4.2). Focus groups are small facilitated group meetings in which participants are encouraged to discuss a central topic of interest and share insights and opinions on the topic at hand (Curry et al., 2009, p. 1445; D. L. Morgan, 1996, p. 130; Patton, 2002, p. 385; Thomas-Slayter, Esser, & Shields, 1993). As Patton (2015, p. 475) outlines, a focus group interview is first and foremost an interview.

> It is not primarily a discussion, though direct interactions among participants often occur. It is an *interview*. The twist is that, unlike a series of one-on-one interviews, in a focus group, participants get to hear each other's responses and to make additional comments beyond their own original responses as they hear what other people have to say (emphasis in original).

Group composition is subject to a variety of determinants (such as the nature of the data required, logistics, and availability of participants). Appendix 4 describes the composition of the seven focus groups convened for this study. As Curry et al. (2009, p. 1446) highlight, the guiding criterion for focus groups "…is to ensure that the group composition does not inhibit members from speaking, so that the discussion generates comprehensive information that reflects the full spectrum of opinions and experiences". In almost all cases I was able to accomplish this[101]. The major exception was a focus group with men from one community where the group was comprised of both village leaders and young men from the community. Despite prompting, the young men remained quiet with the conversation dominated by the community

[101] All my focus groups were organised through a key contact within the community/organisation in question. While I specified what I wanted in regard group composition, the actual final composition was beyond my control. While I worked hard to ensure engagement from all participants, I was not always successful.

leaders. This focus group still generated good data, but it could only be considered to represent the views of the community leaders.

4.5.3.2 Participatory Approaches

In conjunction with the interview approach described above I also utilised participatory techniques to gather data for this research. Originating in the 1970s, participatory approaches have evolved considerably and consist of a wide range of techniques[102] which can be used to find out about local context and life (Chambers, 2008, p. 297). Working largely at the community scale through public meetings and group activities, participatory techniques place an emphasis on local knowledge production (Stewart-Withers et al., 2014, p. 69).

For three of the focus groups, where participants were reserved and cautious about talking to me about their experiences, I began the focus group by asking the participants to produce a community map (see photo 6.1, Chapter 6, for an example) as a means of stimulating discussion. These maps, which provided information on the communities, their lives and environment (Chambers, 2008, p. 298; World Bank, 2011), helped to generate discussion and to cross-check responses from the focus group and household interviews. A second method used to stimulate discussions during two of the focus group interviews was pair-wised ranking (Thomas-Slayter et al., 1993; World Bank, 2011). This technique involved participants producing a list of IAS which they deemed to be of significance to the community. These were then displayed as a matrix with the identified IAS listed along the top and down the left hand side of the grid (see Appendix 5). Participants ranked the IAS two at a time against each other, with their overall importance being determined by the number of times each IAS is chosen in the match ups (Thomas-Slayter et al., 1993).

A third participatory technique utilised during my fieldwork was transect walks (Chambers, 1994, p. 960) or walk-throughs[103]. This technique involves walking "…with local people through an area, observing, asking, listening [and] discussing…" (ibid.) the issues at hand. Participants for the walk-throughs were opportunistically

[102] For example, see Chambers (1994, pp. 959-961) for a menu of participatory methods.
[103] I have used the term walk-through as transect implies a systematic route, whereas the routes taken in this study were at the discretion of the local participants and often meandered.

selected from the household and focus group interviews[104] and the routes taken for all the walk-throughs were chosen by them. Unstructured interviews were used during the walk-throughs as the discussions were wholly dependent on the setting and context encountered. Interviews were recorded[105] and photographs were also taken. These walk-throughs helped to enrich and cross-check information obtained from the semi-structured interviews, focus groups, and other participatory exercises.

4.5.3.3 Secondary Documents

The use of secondary data is considered standard practice when undertaking fieldwork in developing countries (Overton & van Diermen, 2014, p. 14). I collected secondary data throughout the research process, drawing on both published and unpublished government and NGO reports, newspaper articles, website databases and academic publications, for example. As with the other data sources described above, this secondary data not only provided information in its own right, but was also used to triangulate or cross-check my primary research data (ibid.).

4.5.3.4 Ant Samples

The Solomon Islands support at least 237 unique ant taxa (Sarnat, Blanchard, Guénard, Fasi, & Economo, 2013, p. 55). Although, as Wetterer and Porter (2003, p. 24) attest, Solomon Islanders are all familiar with *W. auropunctata* due to its painful sting, I considered it important to confirm that the ant being discussed by interviewees was in fact *W. auropunctata*[106]. To this end, I had interview participants from different locations show me the ant we were discussing[107], which I then collected for later verification. All the samples were collected in labelled snap-lock plastic bags and double bagged to prevent escape. Samples were frozen to kill the ants. The ant samples

[104] Walk-through participants varied from a single participant to a group.
[105] With the permission of the participants, I had my research assistant 'miked up' with my digital voice recorder which enabled our conversation to be recorded as we walked along. This not only enabled the capture of important snippets but also allowed for a more free-flowing conversation, as I did not have to try and take notes at the same time. I decided to use this approach following my first walk-through. On that occasion I did not use my voice recorder. During this walk-through I found that my taking notes interrupted the flow of the conversation. It also required a session after the walk-through with my research assistant to talk over and record what we had heard. While this captured the themes and issues, it lost the voice of the participants as it was impossible to remember exactly what they said at the time.
[106] There was no need to collect *A. fulica* for identification purposes. Both live snails and empty shells were often plainly evident and gestured at as I conducted interviews with people.
[107] People used different names (red ant, red stinging ant, fire ant) for *W. auropunctata*, as is evident in the quotes used throughout this thesis.

were identified following the identification guidelines set out in the Pacific Invasive Ant Key (Sarnat, 2008) using an Olympus CX31 biological microscope[108] (see Appendix 6 for results). As an additional check, one of my identified samples was independently reconfirmed by a SIAQS officer using their own identification manual.

4.5.4 Data analysis

The analysis of qualitative data follows an iterative process of moving back and forth between data collection, data management, data analysis and drawing of conclusions (O'Leary, 2010, p. 262). It requires the researcher to become intimate with their data through reading and re-reading their transcripts and repeated sorting and resorting of their data (O'Leary, 2010, p. 262; Stewart-Withers et al., 2014, p. 76).

As noted in section 4.5.3.1, this cyclic process started while still in the field with my post-interview process; in which field notes on emerging potential themes were recorded. Transcription of the interviews also began while still in the field, but was largely completed after fieldwork was finished. While mainly a data management activity, the process of transcribing (repeatedly replaying recorded interviews and writing them out) also resulted in the recognition and recording of potential themes. Broad, overarching impression of the data and the story it was telling (O'Leary, 2010, pp. 263-264; Stewart-Withers et al., 2014, p. 76) were identified and recorded at this time. A key part of this process was the production of a policy brief for the New Zealand Ministry of Foreign Affairs and Trade (MFAT) outlining my initial findings and impressions following the completion of my fieldwork [109].

The next stage of analysis involved coding and labelling the primary and secondary data into broad themes. Coding involves deconstructing the data (Stewart-Withers et al., 2014, p. 76) into categories of understanding (O'Leary, 2010, p. 264). This involved reading the interview transcripts and secondary data documents line-by-line to isolate the different concepts that were discussed. Common concepts were then

[108] All samples were identified at facilities in the Solomon Islands. The two facilities used were a teaching laboratory at the University of the South Pacific (USP), Solomon Islands Campus, and the SIAQS laboratory near Henderson Airport.

[109] The production of this policy brief was a requirement of the New Zealand Aid Programme Award for Postgraduate Field Research, of which I was a recipient in 2013. A requirement of the award was that a policy brief had to be completed within three months of completion of the fieldwork.

grouped together into themes. I used the qualitative software programme NVIVO to help manage this process. This software made the process of storing, labelling and amalgamating the data into the different themes quicker and easier than if I had done it manually. However, as Patton (2015, p. 529) notes, software programmes only facilitate the work of analysis, they do not do the analysis for you, so the decisions on how the data was interpreted were still mine to make. Coding can be an inductive process (where the themes are not predetermined and emerge from the data), a deductive process (where predetermined (a priori) themes are used to examine the data), or a combined process (which involves an interactive process or cycle of inductive and deductive reasoning) (O'Leary, 2010, pp. 261-262; Onwuegbuzie & Combs, 2010, p. 409; Patton, 2002, pp. 453-454). This study took a combined approach to coding. Using the sustainable livelihoods approach as the guiding conceptual framework for this research meant that there were some predetermined categories[110] that were looked for while exploring the data. However, because these categories are broad, the specific themes which emerged from within them followed an inductive process. Taking an inductive approach here also allowed for alternative explanations to be considered (O'Leary, 2010, p. 262).

Once the broad themes were established the data within each theme was then reordered multiple times as it was examined in relation to the literature, research and theories relevant to this research (O'Leary, 2010, pp. 266-267; Stewart-Withers et al., 2014, p. 76). O'Leary (2010, p. 263) describes this as part of the 'abstracting out' process. This is where meaningful understanding is obtained from the data through the exploration of the relationships within and between themes, and through the building of theories and the drawing of conclusions; all the while engaging "…in a dialogue and juxtaposing the themes…with relevant research and theoretically orientated literature" (ibid., p. 267).

4.6 Limitations of the Research

This research is written from the perspective of an outsider; someone who is not a Solomon Islander. My time in the Solomon Islands was short and therefore as a

[110] For example, those categories represented in the assets pentagon and the concepts of vulnerability and resilience.

consequence my understanding of the dynamics and intricacies of life in the Solomon Islands can only be considered to be partial. With this is mind I have endeavoured to use, when discussing IAS issues in the country, the responses provided by participants in an effort to balance any of my potential outsider bias. Scheyvens and McLennan (2014, pp. 4-12) provide a brief account of the insider/outsider debate with regards the legitimacy of doing development studies research. While being an outsider will have an influence on the insights gained during this research, it does not make the research any less valid. Rather, this research just presents one particular perspective on the issue.

Another potential limitation to this research is that it is contextual. The study is specific to the Solomon Islands, the livelihoods framework outlined in Chapter 5, and the IAS investigated. While extrapolating the results to other SIDS is not possible, it is intended that the findings can be used to inform the meta-discussions (Woodley, 2002, p. 24) around the livelihood impacts of IAS in SIDS and around the wider environmental change issues affecting the Pacific.

A third limitation associated with the above contextual condition is the discovery in 2014 of the predatory flatworm (*Platydemus manokwari*) in the Solomon Islands[111] (Eremae, 2014). This flatworm preys on terrestrial molluscs (Justine et al., 2014, p. 10), and has been used as biological control of *A. fulica* in a number of countries[112] (ibid., p. 8). Newspaper reports (Eremae, 2014; Piringi, 2015) indicate that the flatworm has dramatically reduced the *A. fulica* population in areas covered by this research. This, according to the newspaper articles, has allowed households that had given up growing crops because of the snail to resume this activity (Eremae, 2014); the full extent to which this is occurring, however, is unknown. This study does not take into account these recent events as they have only occurred since my fieldwork was undertaken. Rather than making this research irrelevant, this event makes this study more significant as it is the only research from the Solomon Islands that covers the livelihood impacts of *A. fulica* pre *P. manokwari*. This study therefore provides a

[111] Native to the New Guinea region, the natural range of this species has yet to be determined (Justine, Winsor, Gey, Gros, & Thévenot, 2014, p. 8).
[112] The flatworm is not specific to *A. fulica*. Where it has been introduced in the Pacific region, it has had a serious negative impact on the biodiversity of native snail populations (Justine et al., 2014, p. 12).

baseline on which future livelihood studies of *A. fulica* post *P. manokwari* can be compared.

A fourth limitation is that the fieldwork for this research had to be cut short because of illness. This meant that some emerging themes could not be explored, while others were only touched on. Despite this, I was still able to collect a large amount of data during my time in the field and this forms the basis for this thesis. In addition, contacts made during my fieldwork meant I was able to follow up on certain lines of enquiry remotely via email once back in New Zealand. This process yielded additional information, as well as published and unpublished secondary documents, which contributed to my findings.

4.7 Conclusion

This chapter has outlined the fieldwork processes followed and research methodologies used in undertaking this research. This study primarily uses qualitative methods to explore the livelihoods of the participants and to gain some insight or meaning into their experiences of living with IAS. Stewart-Withers et al. (2014, p. 78) argue that "…in order to understand the meanings attached to a particular phenomenon the qualitative researcher must really understand the local context". Therefore, the following chapters focus on the local context, starting in the next chapter with an introduction to the Solomon Islands and the dominant livelihood strategy practised there.

Chapter 5: Solomon Islands Context and Setting of the Case Studies

5.0 Introduction

This chapter provides an introduction to the Solomon Islands and sets the context for the case studies that follow in subsequent chapters. Underlying this chapter is the premise that the majority of Solomon Island livelihoods are underpinned by subsistence agriculture and that the informal economy is a significant factor in catering for these livelihoods. This premise is explored throughout the different sections of this chapter. What influence IAS have on this important livelihood strategy becomes the focus in later chapters.

Starting with a description of the physical environment encountered in the country, this chapter then briefly covers the history of the Solomon Islands since European contact. The role of subsistence agriculture as a base for Solomon Island livelihoods is introduced here and the chapter then goes on to explore some of the socio-political and socio-economic processes and events that have influenced life in the Solomon Islands. For instance, attention is given to the civil unrest that engulfed the nation between 1998 and 2003, and the impact that had on the lives of many of the people. The chapter then looks at contemporary rural livelihoods within the country and from that discussion outlines a rural livelihoods framework for the Solomon Islands. Rural livelihoods are the focus of this research because that is where most (around 80%) of the population live (SIG, 2009a, p. xxvi). However, in the case of the Solomon Islands, the rural/urban divide is very blurred with a significant proportion of urban households also reliant on subsistence agriculture for their food production (42%) (SIG, 2009b, p. 14) and for cash income (26%) (ibid, p. 17). So although this study focuses on rural households, the discussions are relevant to many urban households as well. The chapter concludes with a detailed description of the study area.

5.1 Background Information

5.1.1 Geography and climate

The Solomon Islands (Figure 5.1) is a widely scattered archipelago of islands and atolls situated in the South Pacific Ocean. Spanning over 1,600km in a south-easterly direction, the Solomon Islands stretch from the Shortland Islands near Bougainville (Papua New Guinea) to the Santa Cruz Islands bordering Vanuatu (Solomon Islands Visitor Bureau, 2010). The Solomon Islands consists of six major islands; Choiseul, Santa Isabel, New Georgia, Guadalcanal, Malaita and Makira (San Cristobel), with hundreds of smaller islands and atolls scattered throughout the main group making up the rest of the country. The larger islands are volcanic in origin and are rugged and mountainous in all but a few locations (such as the Guadalcanal plains). Steep ridge-valley landscapes covered with dense tropical forest dominate most areas (Bourke et al., 2006, p. 13). The northern plains and foothills of Guadalcanal contain extensive grassland areas (ibid). The country is divided into nine provinces; Choiseul, Isabel, Western, Central, Guadalcanal, Malaita, RenBel, Makira and Temotu. The capital, Honiara, is located on the north coast of the island of Guadalcanal.

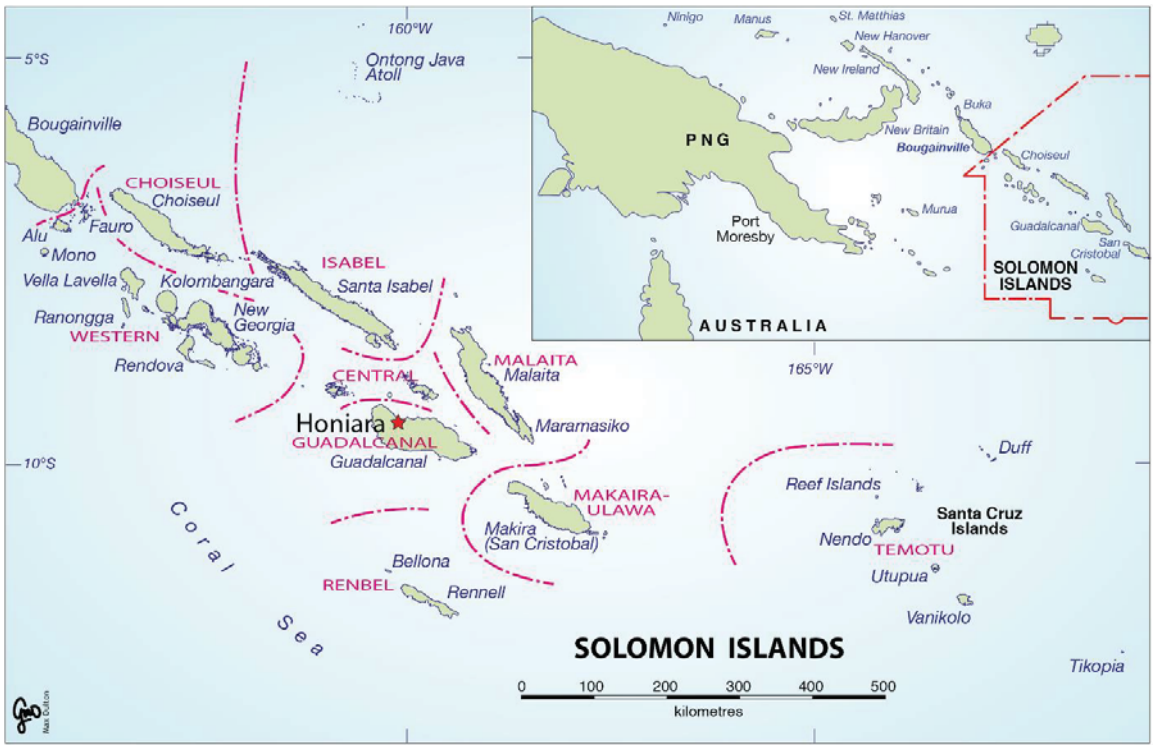

Figure 5.1: Map of the Solomon Islands (Source: Max Oulton, Waikato University, New Zealand)

The Solomon Islands lie within 12 degrees of the equator and have a typical tropical climate, characterised by high and fairly uniform temperatures and humidity, and abundant rainfall (Solomon Islands Metrological Service, n.d.). Temperatures range between 20-31^{o}c year-round (Bourke et al., 2006, p. 13) and the mean annual rainfall for most areas of the country is between 3000-5000mm (ibid, p. 14). The Solomon Islands Meteorological Service (n.d.) notes that;

> The weather and climate of the region can be explained largely by the seasonal movement and development of the equatorial trough; a belt of low pressure that migrates between hemispheres following the apparent movement of the sun, and the subtropical ridge of the southern hemisphere (a belt of high pressure typically located at about latitude 30 to 35 degrees south).

This trough results in a period of west to north-westerly monsoonal winds from about January to March, bringing the heaviest rainfall to most places during this time. From May to October the southeast trade winds blow and heavy rainfall can also occur during this period. Between these two seasons winds are calmer (ibid).

5.1.2 A brief history of the Solomon Islands

The Solomon Islands are part of Near Oceania[113]. The Solomon Islands have a long history of pre-European occupation. Linguistic, archaeological and genetic evidence generally supports two major pulses of human dispersal into Near Oceania (Delfin et al., 2011, p. 1; Ricaut et al., 2010, p. 1161). The first humans arrived between 60,000 to 40,000 years before present (Kirch, 2010, p. 135) and reached the Solomon Islands around 30,000 years before present (Bennett, 1987, p. 7). A second pulse of human migration out of Southeast Asia into Near Oceania occurred 4,000 to 3,500 years before present (Kirch, 2010, p. 136). This second wave led to the emergence of the Lapita cultural complex which expanded into Remote Oceania (ibid, p. 131) and were the ancestors of the present-day Polynesians (Bennett, 1987, p. 7). Back migration and admixing over time resulted in the immense ethno-linguistic and cultural diversity found in the country and region today.

[113] Except for the Reef/Santa Cruz Islands which are considered to be part of Remote Oceania – (Delfin et al., 2011, p. 1). In addition to the Solomon Islands, Near Oceania consists of New Guinea, Australia and the Bismarck Archipelago.

The first recorded contact between Europeans and Solomon Islanders occurred in 1568 when Alvaro de Mendana, a Spanish explorer[114], came ashore on Santa Isabel[115] (Bennett, 1987, p. 19). A long lull followed Mendana's visits and it was not until 1767 that Europeans again sailed these waters. Subsequent occasional visits by explorers and merchants gave way to more regular visits by whalers during the first half of the nineteenth century (ibid, p. 21). Traders and missionaries of various nationalities followed. Access to European traders allowed the expansion of subsistence activities and traditional trading networks to take advantage of, at first barter trade with the Europeans, and later the cash economy (ibid, p. xviii). Bennett (1987, p. xvii) however argues that access to the trade system was not universal, with coastal people better placed to take advantage of the situation than bush dwellers:

> When European whalers and traders came, the coastal folk were placed to reap the benefits from the new goods and opportunities. This relative deprivation was not confined to bush dwellers vis a vis coastal people. In general, the eastern islands, particularly Malaita, had very few products to offer the trader. There, Islanders could obtain few trade goods until they were able to go sell their labor [sic] on the cane-fields of Fiji or Queensland. So begun a tradition of migrant labor [sic] that extended into the plantation era.

Between 1870 and 1910 around 30,000 Solomon Islanders[116] went to Queensland, Fiji, Samoa and New Caledonia as indentured labourers[117] (Bennett, 1987, p. 86; Braithwaite et al., 2010, p. 17; SITRC, 2012, p. 30) to work in the sugar industry (SITRC, 2012, p. 30). Others though had better opportunities at home. Bennett (1987, p. 87) notes that unlike those in the east, whose weak integration into the trade system meant their main opportunities were via out-migration[118], those in the western and central Solomon Islands could make significantly better livings by selling produce to

[114] Sailing out of Peru.
[115] Mendana returned to the Solomon Islands in 1595 and established a colony on Santa Cruz. He died there shortly afterwards and the colony foundered (Bennett, 1987, p. 19).
[116] Mostly Malaitans from the inland districts (Bennett, 1987, p. 87; SITRC, 2012, p. 30).
[117] Some went voluntarily, many did not (Braithwaite et al., 2010, p. 17). Those that went laboured for bonded periods of at least three years (Bennett, 1987, p. 87; SITRC, 2012, p. 30). Conditions were harsh and up to a third never returned (Allan 1919 in Woodley, 2002, p. 126).
[118] To labour in the overseas cane-fields and later in the coconut plantations established in the western and central Solomon Islands.

traders[119]. This, Bennett (1987, p. 87) argues, created a regional divide of relatively rich and poor Solomon Islanders.

In 1893 the Solomon Islands became a British Protectorate[120] (Braithwaite et al., 2010, p. 17). This occurred largely to allay fears held by the Australian and New Zealand colonies regarding Germany's presence and intentions in the region (Braithwaite et al., 2010, p. 17; SITRC, 2012, p. 36). The British established a plantation economy in the Solomon Islands. Coconut plantations (Photo 5.1) were developed on a large scale and copra became the Solomon Islands' principal earner and remained so until well into the late 1960s, early 1970s (Bennett, 1987, p. 330; Braithwaite et al., 2010, p. 18). The dependence on a single product, however, meant that the economy was vulnerable. Copra prices were affected by the global Depression of the 1930s and the industry in the Solomon Islands declined. Many small-scale European planters went under as only the bigger companies had the means to offset some of the effects of the Depression (Bennett, 1987, p. 239). Indigenous copra producers were also severely affected and the general trend was to fall back onto subsistence agriculture for their livelihoods (ibid, p. 242).

Subsistence agriculture had always been the underlying mainstay of Solomon Island livelihoods. Nearly all Solomon Islanders cultivated gardens for survival (ibid, p. xviii) which acted as a safety net when local and global forces acted on the cash economy[121]. For example, when the trochus shell[122] market also collapsed in the mid-1930s, "the people once again concentrated on gardening" (Bennett, 1987, p. 248). The Second World War[123] also had a significant impact on the copra industry in the

[119] Producers only had to work one third as much, at most, to earn the equivalent as those who sold their labour in the plantations (Bennett, 1987, p. 87).
[120] Not all of the islands in present day Solomon Islands were included in this protectorate. For example, at the time the protectorate was formed the Shortland Islands, Choiseul and Santa Isabel were under German administration. They remained so until 1900 when Germany ceded control and they were incorporated into the British Protectorate (Bennett, 1987, p. 129; SITRC, 2012, p. 30).
[121] Bennett (1987, p. 263) notes that by the early 1930s the local economy was highly monetized.
[122] From the coral reef snail *Trochus niloticus*. The exported shells comprised the primary raw material for mother-of-pearl buttons (Heslinga, Orak, & Ngiramengior, 1984, p. 73).
[123] In 1942 Guadalcanal and adjacent islands were the scene of intense fighting between Japanese and American military forces. This was followed in June 1943 by a massive Allied offensive which retook most of the western Solomon Islands from the Japanese (Bennett, 1987, pp. 286-287). The intensity and destructive nature of this conflict is still evident today in the many wrecks, debris, exploded and unexploded munitions which litter the islands (Photo 5.2).

Photo 5.1: Coconut plantation, West Guadalcanal.

Photo 5.2: Exploded WWII munitions on the roadside, East Guadalcanal. WWII debris and unexploded munitions litter the landscape and still pose a significant hazard to locals to this day. I was told by my research assistant that the area in which this photo was taken was considered safe to a depth of six feet.

Solomon Islands, destroying much of the plantation infrastructure which affected its revival following the war (Braithwaite et al., 2010, p. 17). Despite this, post-World War II economic planning continued to focus on the development of the plantation economy (Bourke et al., 2006, p. 3). In addition to copra, other plantations such as oil palm were established on the Guadalcanal plains (Ministry of Agriculture and Livestock: interview # 49).

British administration of the Solomon Islands continued until the nation obtained independence from Britain in 1978. Whilst the post-war years saw the rise of some anti-colonial independence movements in the Solomon Islands[124] there was no nation-wide drive to this end. Bennett (1987, p. 321) argues that independence in the Solomon Islands arose more as a result of Britain's desire to remove itself from the colony rather than a local push for independence:

> Without any general clamour for independence in the Solomons and with the near exhaustion of the worldwide anticolonial movement of the post war decades, Britain was very much the instigator of independence for the Solomons. The British saw the process as one of their gaining independence from the Pacific rather than territories like the Solomon's winning independence from them.

Following independence, fisheries and forestry began to dominate the economy of the Solomon Islands (Bourke et al., 2006, p. 3; Braithwaite et al., 2010, p. 18). By the 1990s timber became the country's key economic driver and extractive industries, such as logging (Photo 5.3) and mining, still dominate the country's economy today (Ministry of Agriculture and Livestock: interview # 49; SIG, 2009b, p. 7).

5.2 The Modern State

5.2.1 Socio-political and socio-economic context

During the independence process a system of national governance based on the British Westminster systems was adopted (Bennett, 1987, p. 7). Under this system a national parliament, consisting of 50 members, is elected on a first-past-the-post basis for a four-year term. Solomon Island governments, however, have been characterised by

[124] See Bennett (1987), Chapter 13 for descriptions of these.

Photo 5.3: Timber packed for export to New Zealand. Logging is a key export earner for the Solomon Islands. A single container like this can make between SBD$20,000 and $40,000 (Ministry of Forestry: interview # 50; Private export timber company: interview # 43).

unstable coalitions, weak party politics[125] and frequent leadership changes (Braithwaite et al., 2010, p. 98). This is largely attributed to the Melanesian political culture which is heavily influenced by the 'big-man' system (Braithwaite et al., 2010, p. 97; SITRC, 2012, p. 35). Traditionally a big-man[126] was

> A particularly influential member of a community who assumed leadership through ceremonial exchange and feast giving (SITRC, 2012, p. 34).

[125] For example, independent candidates won 32 of the 50 seats in the recent 2014 elections (ABC, 2014).

[126] This was not a hereditary position (SITRC, 2012, p. 34). Any man who was ambitious enough and had the ability to gain and sustain a wide following could become a big-man (Bennett, 1987, p. 14). Chiefly systems based on the inheritance of status also existed in parts of the Solomon Islands. In either case, the attributes required to become and remain a leader in the community were the same (ibid, p. 15).

A big-man won followers and sustained his influence by "conspicuous demonstrations of wealth and, above all his generosity" (Bennett, 1987, p. 14) as he "redistributed the wealth among his supporters" (ibid, p. 15).

This big-man system has been translated into contemporary Solomon Island politics (Braithwaite et al., 2010, p. 98; SITRC, 2012, p. 35), where

> Political leaders and public officers are still renowned for employing big-man policies, particularly the dispensing of wealth to kinfolks and immediate supporters (SITRC, 2012, p. 35).

Driven by Melanesian social norms of obligation and reciprocity, politicians often serve their ethnic group or constituency more than their nation (SIG, 2009d, p. 56). Members of Parliament (MPs) that fail during their term in office to be generous to those who voted them in are often voted out at the next election[127]. This has led to a government system characterised by moments of corruption and instability where politicians accept bribes or discretionary funds from the wealthy[128] to act in their interest (Braithwaite et al., 2010, p. 98), rather than impartially focusing on "their institutional responsibilities as lawmakers and overseers of government" (M. Morgan, 2005, p. 12). A proportion of these payments goes to those who voted for the MP, thus ensuring their future support and the politicians continued presence in Parliament (Braithwaite et al., 2010, p. 98). This system is perpetuated by the voting public who support candidates who promise patronage (Braithwaite et al., 2010, p. 99; SITRC, 2012, p. 35).

Despite the adoption of a state governance system during independence, the State is not central to the day-to-day existence for the majority of the population (Braithwaite et al., 2010, p. 13; Wairiu, 2006, p. 409). Instead traditional governance and the Church play a central role (Wairiu, 2006, p. 409). Dinnen (2007, p. 259) argues that:

> Living predominantly in rural communities, bonds of kinship, shared (local) language and ties to ancestral land, along with Christianity, [provide] the basis for individual identities and allegiance, rather than abstract notions of

[127] Braithwaite et al. (2010, p. 98) note that approximately half of Parliament's MPs lose their seat at most elections.
[128] For example, foreign logging companies and fishing fleets (Braithwaite et al., 2010, p. 98).

> "citizenship" or membership of the modern state. Localism [prevails] over nationalism in virtually every sphere of social, political, and economic activity.

As such, a disconnection exists between many Solomon Islanders and the State. As one former Prime Minister, Dr Derek Sikua, put it:

> When we adopted our form of government upon independence what we have done is putting our working customs and traditions outside government. We put our laws, our traditions, our customs, our practices outside of government and we put a government in that [does not] link in very nicely to our worthy customs and traditions and practices, so there is no connection (Parliamentary Inquiry 2009 in Braithwaite et al., 2010, p. 44).

Building this connection, in the face of the country's immense ethno-linguistic and cultural diversity[129], is not a simple task and is still one of the biggest challenges facing the country today (SITRC, 2012, p. 45). Despite its designation as a nation state, the Solomon Islands is still largely "a collage of ethnically diverse localities" (ibid, p. 97). In fact, Braithwaite et al. (2010, p. 1) argue that the Solomon Islands has

> Never consolidated after decades since independence… It [is] not a formed State; up to this point in its history, it has been a State in a process of formation.

It was this lack of consolidation, this "prevalence of local over national identity" (SITRC, 2012, p. 97), which in 1998 enabled political leaders from Guadalcanal to use indigenous grievances in order to stir up ethnic resentment and mobilise sectors of their community for their own political ends (Braithwaite et al., 2010, pp. 128-129; SITRC, 2012, pp. 98-99). This situation, as outlined in the next section, rapidly escalated with disastrous results for the country.

[129] For example, at least 64 living languages are spoken in the Solomon Islands (Braithwaite et al., 2010, p. 1). In addition, different islands have different social norms and customs. For instance, Malaita is largely a patrilineal society, whereas those on Guadalcanal largely follow a matrilineal system (ibid, p. 19).

5.2.1.1 1998-2003 Civil Unrest[130]

In 1998 a militant group, the Guadalcanal Revolutionary Army (GRA)[131] started a violent campaign against the people from Malaita who were living on Guadalcanal (SIG, 2009d, p. 49). Many Malaitans had moved to Guadalcanal during World War II to work for the US military and had subsequently stayed following the end of the war (Braithwaite et al., 2010, p. 18). Braithwaite et al. (2010, p. 18) note that:

> More followed in the post war decades. Subsequent British colonial policy increased incentives to stay by concentrating infrastructure investment where the export investment opportunities were – mainly Guadalcanal, but also Western Province.

A lack of development on Malaita and a demand for workers on Guadalcanal's plantations attracted many people to the island (SITRC, 2012, p. 46). By 1998 around 25% of the population of Guadalcanal and about 60% of Honiara's population were Malaitan (ibid, p. 48). Mass migration into Guadalcanal and the pressure this generated on land resources on the island had been an issue repeatedly raised by the Guale people[132] since independence (ibid, pp. 54-55). A lack of action by successive governments to address this and other socio-historical features led to the deliberate instigation of ethnic antagonism by Guadalcanal political and militant leaders "as a political weapon to emphasise their demands" (SITRC, 2012, p. 738).

As such, the first stage of the conflict was largely ethnically driven[133] as the GRA/IFM sought to remove migrants, mostly Malaitans, from Guadalcanal (Braithwaite et al., 2010, p. 21; SITRC, 2012, p. 98). Escalating violence against Malaitan migrants saw the formation towards the end of 1999 of a counter group, the Malaitan Eagle Force

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[130] I have used the term civil unrest rather than ethnic tension, which it is more often generally referred to (SITRC, 2012, p. 733). The SITRC (2012, pp. 98-99) notes that while ethnicity was the main driving force behind the conflict at first, its importance decreased over time. The SITRC goes on to state that while the importance of ethnicity should not be underrated as a factor, the term 'ethnic tension' is not a good characterization of all the events that occurred during this period (ibid). For a detailed account of this part of the Solomon Islands' history see the Solomon Islands Truth and Reconciliation Commission's 2012 final report.

[131] This group initially consisted of young men from the impoverished Weather Coast region of Guadalcanal. The GRA was later renamed the Isatabu Freedom Movement (IFM) (Braithwaite et al., 2010, p. 21). Other militant factions from Guadalcanal also arose during the course of the conflict (i.e. the Guadalcanal Liberation Front – GLF).

[132] People from Guadalcanal.

[133] This stage of the conflict, however, also saw the GRA harass people from Guadalcanal as well as those from Malaita (SITRC, 2012, p. 67).

(MEF)[134]. The MEF took control of Honiara and forced the resignation of the incumbent prime minister. The capital, along with other parts of Guadalcanal[135] became lawless and unstable as the Government was unable to control the civil unrest (SIG, 2009d, p. 50). It was around this time that the importance of ethnicity as a driver in the conflict declined as the unrest transitioned into a new stage (SITRC, 2012, p. 98). This transition saw increased violence by Guadalcanal and Malaitan militants on people of their own ethnicity as the different factions pursued material gains (ibid) and settled old scores with rivals (ibid., p. 153).

During the conflict businesses, institutions and houses were destroyed, an estimated 30,000[136] or more people were displaced, and up to 200[137] killed (UNDP, 2004, p. 57). In addition to the impact on people's lives, the increasing lawlessness also had an impact on the country's economy. Nationally important industries[138] closed or scaled down operations (SITRC, 2012, p. 650), resulting in a contraction of the economy by around 24% (SIG, 2009d, p. 50; SITRC, 2012, p. 652). Government revenues declined and debts, both foreign and domestic, were defaulted on. By 2002 the Solomon Islands Government was insolvent (SIG, 2009d, p. 50).

Appeals by the Solomon Islands Prime Minister and Parliament to the Australian Government for help to restore law and order and the basic functions of government, eventually resulted in an assistance package being approved in 2003. This package, endorsed by the foreign ministers of the Pacific Forum[139] was implemented under the auspices of a Regional Assistance Mission to Solomon Islands (RAMSI) [140] (ibid, p.

[134] Consisting of disenfranchised Malaitans and the Malaitan dominated paramilitary wing of the police force (SIG, 2009d, p. 50). Other Malaitan militant factions also arose during the course of the conflict (e.g. the 'Mafia', which was essentially a criminal gang that passed themselves off as militants (SITRC, 2012, p. 152)).

[135] Outbreaks of violence by locally operating militants also occurred in other parts of the country, such as Malaita, Western and Choiseul provinces. See SITRC (2012) Chapter 3 for details of these events.

[136] Estimates vary. Braithwaite et al. (2010, p. 24) put it at around 35,000 whereas the SITRC (2012, p. 518) records 11,292 people as being displaced because of the conflict.

[137] Braithwaite et al. (2010, p. 20) believes that this estimate is too low and may be less than half a realistic estimate. The SITRC (2012, p. 397) notes that while they recorded almost 200 deaths, this is just a rough estimate of the actual number killed.

[138] For example, the palm oil plantations on Guadalcanal plains and the Gold Ridge Mine.

[139] The Pacific Forum members are Australia, Cook Islands, Fiji, Federated States of Micronesia, Niue, Kiribati, Nauru, New Zealand, Papua New Guinea, Palau, Republic of the Marshall Islands, Samoa, Solomon Islands, Tuvalu, Tonga, and Vanuatu.

[140] RAMSI is an Australian led coalition of police from Pacific Island states. Military personnel from four countries (Australia, New Zealand, Papua New Guinea, and Tonga) provided support and assistance to RAMSI's Participating Police Force until 30 September 2013. Since then RAMSI has

52). RAMSI's initial focus was on restoring law and order which it quickly achieved (Braithwaite et al., 2010, p. 135). An Economic Governance Program was also established to support the Solomon Islands Government to improve public financial management and reduce debt (Braithwaite et al., 2010, p. 70; RAMSI, n.d.). An economic turnaround followed the RAMSI intervention; external debt decreased, inflation moderated and reserves increased (SIG, 2009d, p. 53), resulting in a government return to surplus (ibid, p. 51).

Nevertheless, despite all the progress to date, the root causes of the conflict still remain present (SITRC, 2012, p. 240). The SITRC (2012, p. 745) notes that due to population pressures and a lack of opportunities on Malaita, many of the Malaitans displaced during the conflict have had no other option than to return to Guadalcanal. The Commission notes that unless precautions are taken this could generate new civil unrest (ibid). While many weapons were turned in at the end of the conflict, a large number of guns[141] taken from police armouries during the tensions remain unaccounted for (Braithwaite et al., 2010, p. 51). One young Guale that I talked to during my fieldwork informed me that unless steps were taken to address the concerns of the Guadalcanal people then the tensions would happen again. He said that he had heard other young men talk about taking up arms again if things did not change (Field notes 21 August 2013). My research assistant also occasionally talked about how there was still an underlying tension between Guadalcanal youths and those from other provinces (Fieldtrip journal: 16 September 2013). How IAS may exacerbate this issue is discussed later in Chapter 8.

The return to Guadalcanal by many of the migrants displaced during the civil unrest highlights a historical development issue for the Solomon Islands; that of uneven development (Bourke et al., 2006, p. 3; UNDP, 2004, p. 5). Both colonial and post-colonial development in the Solomon Islands has largely been concentrated in the Guadalcanal and Western provinces (Braithwaite et al., 2010, p. 18; SITRC, 2012, p. 46). Coupled with this has been the inability of successive governments (both colonial and post-colonial) to effectively redistribute the economic benefits from these areas

been solely a policing mission, working in partnership with the Royal Solomon Islands Police Force (RSIPF) to strengthen this organization (RAMSI, n.d.).

[141] At least 300 (Braithwaite et al., 2010, p. 51).

"to the majority of people living in the 'non-economic' parts of the country" (Bourke et al., 2006, p. 3). This has left many parts of the country reliant on the informal economy (particularly agricultural production) (SIG, 2009b, p. 14) for their main livelihood options.

5.3 Contemporary Rural Livelihoods

The Solomon Islands has a large informal sector which caters for the vast majority of people (SIG, 2009b, p. 5), with Bourke et al. (2006, p. 3) arguing that it is the backbone of the Solomon Islands economy. While the informal economy is generally regarded as encompassing all economic activities outside of the regulated environment (Chant, 2002, p. 208; Chen, 2007, p. 1; 2012, p. 8; ILO, 2014), the SIG (2009b, p. 5) notes that 'economic' usually

> Refers to activities in which money changes hands, either literally or in some less visible way. However, in all countries, there are activities in which money does not change hands but which serve to further the wellbeing of the population, and in Solomon Islands these activities are very important. These "informal" or "subsistence" activities provide food, housing, and other goods and services for much of the rural, and some of the urban, population of Solomon Islands and so can be considered as "economic" but outside the cash economy.

For the Solomon Islands therefore, the informal economy includes all unregulated subsistence and cash earning activities carried out by households.

As noted earlier, around 80% of Solomon Islanders live rurally (SIG, 2009a, p. xxvi) and agriculture is central to many of their livelihoods (Bourke et al., 2006, p. 1; SIG, 2009d, p. 52; Wairiu, 2006, p. 412). Bourke et al. (2006, p. 3) note that Solomon Island households

> Derive their livelihoods from a combination of subsistence agriculture and small-scale income-generating activities, particularly export cash cropping and fresh produce marketing. Their livelihoods are underpinned by communal ownership of land, which enables all members of a customary land-holding group to access resources for both subsistence and income-earning purposes. Rural livelihoods in SI [sic] can thus be conceptualised as two pillars,

subsistence agriculture and cash income, supported by a solid foundation of customary-owned land (ibid, p. 1).

This concept is depicted in Figure 5.2. However, as discussed in Chapter 3, livelihoods are about more than just earning an income, they include non-material or intangible aspects as well. The support people gain from social and kinship networks, the education level and health status of individuals and access to basic infrastructure, for example, are just some of the many non-material aspects which contribute to a household's livelihood and well-being. Additionally, while around 87% of all land is customarily owned (SIG, 2009d, p. 73), not all the households interviewed during this study were reliant on customary land for their livelihoods. Some were occupying other land tenures, such as Government land[142]. Regardless of the tenure, it was the household's access to land which provided the foundation for many rural livelihoods and this is depicted in Figure 5.2.

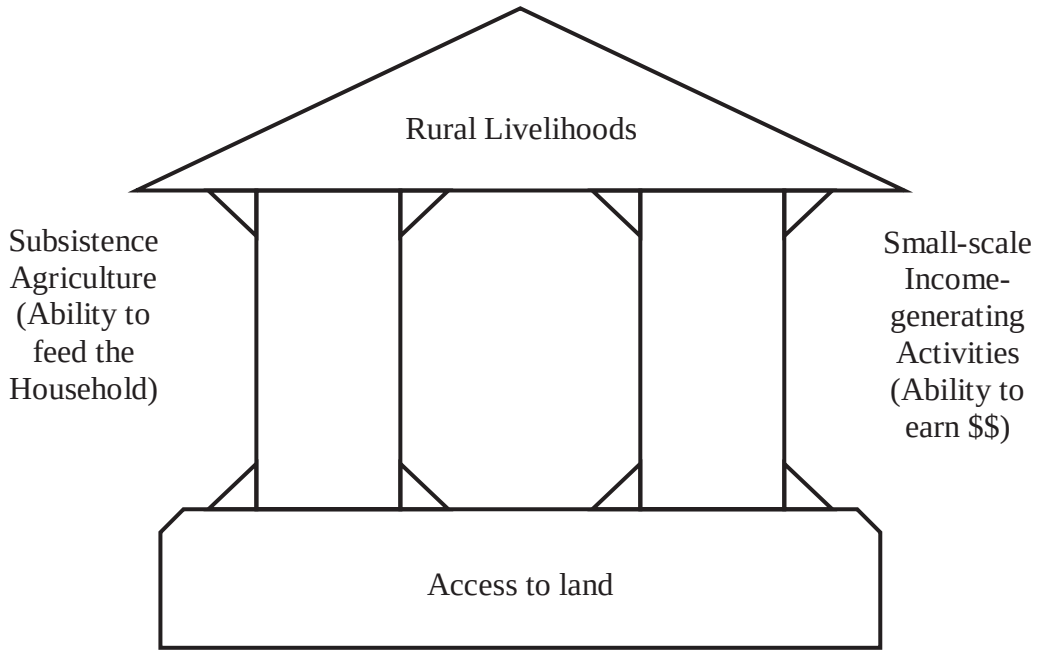

Figure 5.2: Conceptualisation of rural livelihoods in the Solomon Islands (Adapted from Bourke et al., 2006).

[142] Sometimes with, sometimes without permission. For instance, one household I interviewed was occupying an area of government land that had been designated as a site for a school. The school had never been built so the family had taken over the area.

Although households in the Solomon Islands pursue a wide range of livelihood activities and have a range of income sources (SIG, 2009b, p. 13), the vast majority derive their livelihoods from this combination of subsistence agriculture and small-scale income-generating activities[143] (SIG, 2009b, p. 14). These activities form the core of most rural livelihoods. Even those in formal employment[144] typically still rely on these two livelihood pillars to various degrees[145]. For example, rural teachers interviewed during the course of this research told me that in addition to their paid work, they all cultivated gardens to feed the household (pillar one) and sold any surplus produce either locally or at the central market in Honiara (pillar two).

While the emphasis on a particular pillar may vary across households (and even across time within households), the importance of subsistence agriculture (pillar one) in the livelihoods of many Solomon Islanders remains undiminished[146]. Although this activity has "expanded or contracted in response to the fall or rise of produce prices or the rare swings in the labour market" (Bennett, 1987, p. xviii), its importance has persisted throughout the history of the islands (Bennett, 1987, p. xviii; Jansen et al., 2006, p. 44; Wairiu, 2006, p. 412). This is true even to this day. In their study of smallholder agriculture systems in the Solomon Islands, Jansen et al. (2006, p. 2) observe that:

> Subsistence food production provides security for individuals to move in and out of cash-earning activities as such opportunities become attractive enough or available.

In other words, subsistence agriculture is, and always has been, the underlying activity that supports many households in the Solomon Islands.

The importance of this activity was clearly demonstrated during the 1930s Depression when the copra and trochus industries collapsed in the Solomon Islands (as discussed

[143] These income-generating activities can be in either the formal or informal economic sectors (or even a combination of both). However, as noted earlier, the vast majority of Solomon Islanders derive their livelihoods from the informal economy (Bourke et al., 2006, p. 3; Wairiu, 2006, p. 412).
[144] Only 24% of the population is engaged in paid employment (SIG, 2009a, p. 204).
[145] This highlights the fact that the formal and informal economies are not duel economies, as Bourke et al. (2006, p. 3) suggest, but are actually linked to each other. Chen (2007, p. 5) notes that around the world the informal economy "produces for, trades with, distributes for and provides services to the formal economy".
[146] Eighty-nine percent of all households grow some of their own food and the great majority also produce something for the cash sector (SIG, 2009b, p. 14).

above in section 5.1.2). Similarly, its importance can be seen in more recent times, such as on Ontong Java, where livelihoods were significantly impacted following the total ban on beche-de-mer[147] harvesting in the Solomon Islands in 2005. Since the mid-1970s beche-de-mer was the main source of cash income for the people of Ontong Java (Bayliss-Smith, Gough, Christensen, & Kristensen, 2010, p. 64). As the industry grew subsistence agriculture decreased to the point where imported food comprised most of the diet (Christensen, 2011, p. 15). Following the ban, livelihoods changed almost overnight as the local cash economy collapsed. To survive, the residents of the island returned to subsistence activities such as gardening for their livelihoods (ibid, p. 16). Christensen (2011, p. 17) notes that "many households fairly easily went 'back to their roots' of traditional subsistence" which "demonstrated a high degree of adaptive capacity".

Likewise, the universal importance of this component in the livelihoods of Solomon Islanders is also evident from the 1998-2003 civil unrest. While many hardships were inflicted during this period most households were still able to meet their basic food needs (Bourke et al., 2006, p. 1). Braithwaite et al. (2010, p. 32) note that even though the formal economy had collapsed, the informal economy remained resilient in villages, where

> Perhaps 90 per cent of villages continued working at their village economies throughout [the civil unrest], not dependant on the modern state and economy[148] (ibid, p. 2).

Instead, these villages drew on the subsistence sector, primarily agriculture, for their livelihoods (Bourke et al., 2006, p. 1). When the civil unrest ended and conditions improved, households once again increased their reliance on pillar two in their livelihood strategies.

[147] Dried sea cucumbers.

[148] This is not to say that these communities were unaffected by the collapse of the formal economy and role of the State. The loss of government services, such as health and education, had a significant impact on communities. For example, malaria and maternal mortality increased considerably during the civil unrest (SITRC, 2012, p. 663). Some rural clinics ran out of medical supplies and health services declined in many areas (ibid, pp. 664-665). Education services were also affected. Teachers were not paid, forcing them to leave to find alternative income sources. Increased numbers of students in the provinces following the forced displacements also caused problems (ibid, p. 668).

5.3.1 Livelihood diversification in the Solomon Islands

The pattern described above, of subsistence agriculture acting as a safety net during lean times and a springboard into the cash economy when opportunities arise, is a significant feature across the country (Jansen et al., 2006, p. 8). These authors argue that

> Families [seize] temporary economic opportunities for a short period of time and then [disengage] for a period of time, before reengaging with the same or other economic opportunities…. This flexibility acts as a food and social security net in times of stress, including civil unrest or other economic and social stresses. Rural families are able to easily reallocate their labour to increase or decrease subsistence production or dependence in most locations, when needed (ibid).

As outlined in Chapter 3, this "…maintenance and continuous adaptation of a highly diverse portfolio of activities in order to secure survival" (Ellis, 2000b, p. 290) is known as livelihood diversification. Livelihood diversification was universally observed within the households interviewed during this study. As a participant from one focus group explained,

> [The gardens] are used for survival… if there's any [produce] left over they sell it…. Or if they want something else that they cannot produce then they sell to buy. But not everybody does that; he drives the boat, this guy drives the taxi, and he runs a business – his little shop and bus. But there are people who do gardening as well. …Some people work for him[149] and they make their money and survive that way. But they also have a garden on the side, when they are not doing work for someone else they plant things. …There is no genuine concentration of farming for cash crops [here]. …Like there's no one here that's getting up every day to plant melon or cassava for marketing purposes only. They always have this mixture of things. Some days they feel like fishing, so they go fishing. Some days they feel like going to the plantation, so they go to the plantation. Some days they feel like working the gardens for their own consumption, then they do that (Focus group: interview # 18).

[149] Here the participant pointed to the Chief, which is the term he used to describe this particular person.

As this statement suggests, Solomon Island households pursue a wide variety of farm, off-farm and non-farm activities[150] in order to make a living.

This situation is not unique to the Solomon Islands, or even the Pacific. Ellis (1998, p. 29), in his discussion on diversification in rural African households notes that

> Diversification is an infinitely heterogeneous social and economic process, obeying a myriad of pressures and possibilities in the rural economy. It is differentiated in its causes and effects by location, demography, vulnerability, income level, education and many other factors.

In other words, every household is different in the way that it constructs the portfolio of activities that make up its livelihood profile.

However, while the specific makeup of the different livelihood activities may vary between households, the historical and social pre-structuring conditions present in the Solomon Islands[151] means that most rural households are heavily reliant in some way on subsistence agriculture (pillar one) and small-scale income-generating activities[152] (pillar two) as the core component of their livelihood portfolio; as the following interviews typify.

> Dean: What's the main way you earn your income…?
>
> Reply: The market is the main source of income, and …coconut. My husband sometimes gets short-term jobs in town. But these are supplementary to our marketing, which is the main source of income for us (HH female: interview # 8).

> Dean: What are the main income activities for the household?
>
> Reply: Selling food in the market.
>
> Dean: And that's the main source?

[150] Activities encountered during this study included small-scale plantations (coconut, cocoa, palm oil, betel nut), cut flowers, fishing, village shops/canteens/road side stalls, homestay, fishing charter, pig farming, chicken farming, marketing produce etc.

[151] As outlined in Chapter 3, livelihoods are influenced by historical and social conditions which can pre-structure the livelihood portfolio (de Haan & Zoomers, 2005, p. 43). As already noted, agriculture is the mainstay of Solomon Island livelihoods. This, coupled with the development of a plantation economy and the subsequent uneven development by both colonial and post-colonial governments, limits the livelihood portfolio available to many Solomon Island households.

[152] Mostly agricultural related, like selling surplus crops at the market and cash cropping.

> Reply: The people out east [East Guadalcanal plains], we supply most of the town [Honiara]. So our main source of income is the selling of crops and food in the market (HH female: interview # 16).
>
> Most people around here rely entirely on marketing for earning money…. A few have jobs in Honiara. But the majority of people here live on marketing, on what they produce (Focus group: interview # 22).

Martin and Lorenzen (2016, p. 232) note that the evidence from studies conducted in Africa, Asia and South America, show that the effect of non-farm (and off-farm) employment on rural incomes is varied. As the above interviews suggest, while non-farm activities are pursued by rural households in the Solomon Islands, agriculture remains the cornerstone for the livelihoods and welfare of many. Agricultural activities therefore, play a significant role in the livelihood diversification strategies of rural Solomon Island households (Jansen et al., 2006, p. 2).

As discussed in Chapter 3, households diversify to spread their risk and avoid having all their eggs in one basket (Ellis, 2000b, p. 294). The heavy reliance on agricultural based activities within the two pillars of Figure 5.2 means, however, that most rural households in the Solomon Islands do appear to have the majority of their livelihood 'eggs' in the one basket. This can potentially leave them vulnerable to adverse events or shocks (Ellis, 1998, p. 13). Nevertheless, as Campbell (2009, p. 87) notes, despite the extensive discourse on islands being sites of vulnerability, "…thriving [Oceania] communities appear to have been in existence for hundreds of years, if not several millennia" (ibid., p. 88). Central to this existence are traditional agricultural systems (with their high covariance between components), which although modified over time, are still central to the food security, income and livelihoods of many, including those in the Solomon Islands today (UNEP, 2014a, p. 19). Solomon Islanders, "…unlike their statistical counterparts elsewhere in the global south, …enjoy a high degree of subsistence security" (Gough et al., 2010, p. 4). As stated earlier, being vulnerable does not necessarily make one a victim.

One strategy used in the Solomon Islands to minimise this potential vulnerability is agricultural fragmentation. This is where agricultural sites are spatially separated. Campbell (2014, p. 4), in his discussion on climate related impacts in the Pacific, notes

that agricultural fragmentation has been traditionally used throughout the region as a means of limiting the risks to food security. Spatially separated gardens enable some locations "… (based on elevation, different distances from storm centres and aspect or orientation) to experience less harm than others" (ibid.). While

> it may be claimed that land fragmentation developed for a number of reasons such as complex land tenure systems and inheritance procedures; … it also [serves] to reduce the impact of natural extremes on agricultural production (Campbell, 2009, p. 90).

Fragmentation (as a way of diversifying livelihood assets) can also help mitigate the high covariance between agricultural activities, thus increasing the household's resilience.

Spatial separation of agricultural areas was a feature of rural households in the Solomon Islands. For example, when discussing land use with one interviewee, she explained that she grew crops at multiple sites.

> Dean: How much land does she have access to, to use herself?
>
> Interpreter: She cannot tell the exact size because it's not in one area. [She has] different blocks around East Guadalcanal [where she lives] (HH female: interview # 17).

Another interviewee told me how his household relied on their nearby gardens for sustenance and income, along with income from a grove of betel nut palms which were situated at a site much further along the coast (HH male female: interview # 55)[153]. This aspect was also observed during community walk-throughs with interviewees as they showed me the different areas where they grew (and no longer grew) crops.

Another way Solomon Island households dependent on agricultural production make adaptions to limit the risk to their existing income portfolio is by cultivating a variety of crops. Maintaining a diversity of crops (agrobiodiversity) reduces the likelihood of total crop loss due to an adverse event (Campbell, 2006, pp. 15-16; 2009, p. 90) or market vagaries:

[153] For most of the household interviews there was only one participant (even when both husband and wife were present). Where both were present and contributed I have indicated this in the interview citation.

> …you have to plant a variety of crops, because if you only plant one type of crop and the customers do not buy it, then it is bad luck for you (HH male: interview # 1).

Agrobiodiversity has long been a feature of Pacific agricultural systems (Campbell, 2014, p. 4; McMillen et al., 2014, pp. 6-7; Thaman, 2008, p. 104; 2014, p. 180). Although agrobiodiversity is being eroded across the Pacific (Thaman, 2008, p. 104), including the Solomon Islands (Woodley, 2002, pp. 293-294), it is still a significant component of contemporary Pacific agricultural systems for many households (Thaman, 2008, p. 104). The Solomon Islands is "…considered a centre of diversity for wild and cultivated food plants" (Thaman, 2014, p. 181) and Solomon Island households still grow a wide range of crops, as a visit to a local food market demonstrates (French, 2011, p. 1). While agrobiodiversity, as noted earlier, may only provide partial protection from adverse events, this form of agricultural system is considered to be much more resilient than modern monoculture agriculture in Pacific Island countries (Thaman, 2008, p. 104).

As the above discussion indicates, many rural Solomon Island households have livelihood portfolios which rely heavily on agricultural based activities. This means that there is potentially a high covariance between the income activities and the risks that may affect those income streams. Contemporary agricultural systems utilised by households in the Solomon Islands incorporate some of these traditional agricultural resilience practices (i.e. agrobiodiversity, fragmentation) (Campbell, 2006, p. 15) as one way of minimising risks. How robust this core livelihood strategy is in the face of IAS is explored in the following chapters.

5.3.2 The role of gender in Solomon Island livelihoods

As discussed in Chapter 3, and depicted in Figure 3.6, Pacific livelihoods are embedded within cultural and gender processes. Gender roles in the Solomon Islands are not completely fixed and vary between areas (Jansen et al., 2006, p. 10), and even between households within an area[154]. But generally:

[154] Household compositions in this study varied from single men to couples to female headed households. Some households consisted of extended families while other did not. Gender roles within a household were in part dependent on the composition of the household.

> In a typical household, the mother and her daughters are responsible for food production, firewood collection, family chores, child care, community work, and some income-generating activities. Their role in food production involves clearing, hoeing, planting, weeding, harvesting and cooking. Women also collect wild foods, such as ferns from waterways, nuts from forests and marine food from coastal reefs and mangroves. The father is also involved in food production, mainly doing heavy manual jobs such as felling and primary brushing, but most of his time is spent on cash-crop (copra and cocoa) production and fishing (Bourke et al., 2006, p. 12).

While I encountered exceptions to this, the above general pattern was commonly observed during this study. However, because the study was located on the northern Guadalcanal coast with its relatively better opportunities (see section 5.5), women had a greater involvement in income-generating activities[155] than described above and men had greater access to labouring opportunities for additional cash income.

In addition to their roles outlined above, women also assist men with cash crops. Jansen et al. (2006, p. 46) note that their involvement with this activity is largely limited to plantation maintenance and harvesting activities, while men are responsible for the selling. While this was certainly the case for some households interviewed during this study, other stakeholder interviews indicated that in some instances women were more fully involved in all aspects of the household's cash crops. For example, one significant cash-crop on the Guadalcanal plains is palm oil. While the majority of this crop is produced from extensive plantations managed by Guadalcanal Plains Palm Oil Limited (GPPOL), there are over 300 small blocks managed by individual families[156]. According to a GPPOL representative:

> Most of the blocks are managed by the wife. I do not know why; it just turns out that the women look after the money better than the men. So most of these blocks are owned by families and the wives look after the money. Most of the wives also go and manage if they have labourers for harvesting or pruning. And when the money is paid [out by the company], the wives come and collect

[155] Primarily marketing surplus food crops.

[156] These families (or out-growers) sell their harvest to the GPPOL mill. At the time of my interview (7 November 2013) there were 312 registered out-growers occupying a total of 1175 hectares (GPPOL: interview # 38).

> it. For most of the small blocks the man goes and chisels the fruit and the woman comes with the bag for loose fruit. So maybe 40 to 50 percent of the job is done by women (GPPOL: interview # 38).

A similar sentiment was also expressed by staff from the Ministry of Agriculture and Livestock's palm oil section. They noted that the most successful palm oil small-holders were women (Ministry of Agriculture and Livestock: interview # 49). Increased opportunities in recent years have seen women become more involved in the cash economy (Wairiu, 2006, p. 412). However, this has generally been in addition to their existing household roles, such as maintenance of the home. The multiple roles performed by women means that they have heavy workloads and typically have much longer working hours than men (Jansen et al., 2006, p. 45). Okali (2006, p. 18) argues that "…it is time to move away from thinking primarily or even only, of women as subsistence producers"; noting that women are "…key players responsible not only for household food security and production of staple food crops, but also for generating surpluses adequate for asset building, as well as for the growth of the rural economy overall" (ibid., p. 18).

5.3.3 The role of custom in Solomon Island livelihoods

Custom (or kastom) is still an important cultural component in the livelihoods of many Solomon Islanders. Fairbairn-Dunlop (2005, p. 72) argues that Pacific societies developed "…patterns of organisation to ensure that the social, economic, physical and spiritual needs of their members [were] met". Traditionally, these patterns of organisation or customary systems provided social frameworks and oral codes of behaviour that guided people's actions (Nanau, 2011, p. 42). This united individuals and families who were related through tribes and clans with a sense of identity and common objectives, and at the same time, distinguished them from others (ibid., p. 33). Arising out of these traditional indigenous social orders of kinship and kastom is the contemporary wantok[157] system (Schram, 2015, p. 17).

Coined by plantation workers during colonial times "where people from different language groups lived and worked together" (Nanau, 2011, p. 34), the term wantok

[157] Translated as "one talk" (SITRC, 2012, p. 35) or people speaking the same language (Braithwaite et al., 2010, p. 3).

became a way of identifying people based on a common spoken language (ibid). While the term nowadays has many meanings depending on the situation in which it is used[158] (Nanau, 2011, pp. 31-32; Schram, 2015, p. 18), at the local and family level, wantok is a social concept (Nanau, 2011, p. 32; SITRC, 2012, p. 35).

Nanau (2011, p. 35) defines the wantok system at the local level as:

> A way of organising a society for subsistence living that ensured the survival of a group of people. It emphasises reciprocal networks and caring for each other's needs as and when necessary and ensures the security of members from external forces and threats.

This sharing and caring between extended family and related groups, acts as a form of social security system in the Solomon Islands (Bourke et al., 2006, p. 12; Jansen et al., 2006, p. 45; Nanau, 2011, pp. 41-42; SITRC, 2012, p. 36).

The importance of this system was clearly demonstrated during the 1998-2003 civil unrest that affected the country. For example, the SITRC (2012, p. 143) argues that the wantok system alleviated the tremendous impact caused by the forced displacement of thousands of Malaitans from Guadalcanal back to Malaita[159]. Many of those who returned arrived with "nothing more than the clothes on their back and some hastily grabbed utensils" (ibid, p. 45). The assistance provided by extended family to the returnees, in the form of essential needs, such as food and accommodation, helped minimise what could otherwise have been a far greater humanitarian disaster (Nanau, 2011, p. 42; SITRC, 2012, p. 143). The wantok system therefore:

> Plays an important role in sustaining livelihoods and maintaining peace and stability at the local level (Nanau, 2011, p. 50).

[158] Nanau (2011, p. 35) notes that "the term *wantok* can be used at many levels and it has different meanings from these vantage points" (emphasis in original). For example, it has been used in political and trading agreements to reference the whole Melanesian sub-region as one over-arching identity (ibid.).

[159] Not all returnees, however, could count on this support. Some had been away for decades and did not know their wantok. Others had previously been expelled from their villages for wrongdoings, so could not return. Those who had married people from Guadalcanal also found themselves unwelcome in some Malaitan communities. Many though did get support from wantok. This influx of people desperate for housing and food did however place enormous pressure on local resources (SITRC, 2012, p. 143).

Jansen et al. (2006, p. 47) also highlights its importance to livelihoods in the Solomon Islands, noting that it "provides the support network that families need to survive". However, these authors also note that a shift towards the cash economy has seen the erosion of this practice in some areas of the Solomon Islands (ibid); a view echoed during an interview in this study (HH male: interview # 57). Despite this, however, the practice remains the norm for many at the village level (Nanau, 2011, p. 51) and is an important part of Solomon Islanders lives.

5.4 A Rural Livelihoods Framework for the Solomon Islands

Taking the above discussion into consideration, the livelihoods framework depicted in Figure 3.6 (Chapter 3), can be refined to produce a livelihoods framework for the Solomon Islands (Figure 5.3).

Central to this framework are the livelihood strategies practised by contemporary Solomon Islanders (as depicted in Figure 5.2). As this chapter has shown, these strategies are underpinned by subsistence agriculture for the vast majority of Solomon Islanders. Subsistence food production underwrites the country's economy and is considered to be a major strength of the nation (Bourke et al., 2006, p. 22). It provides the security for households to move in and out of income earning activities, particularly cash cropping, which provides the money for basic needs and for expenses such as children's education. Livelihood strategies, based on the two livelihood pillars shown in Figures 5.2 and 5.3, are practised in all provinces across the country (Jansen et al., 2006, p. 14; SIG, 2009b, p. 14).

These livelihood strategies are embedded within cultural and gender processes practised within the Solomon Islands. Cultural obligations, which sees food, money and other resources shared between wantoks, acts as a form of social security that ties individuals and families together and can increase their resilience to external forces and threats. Coupled with this is the gendered division of labour which exists in the livelihood strategies practiced in the Solomon Islands. Women are the main food producers and they play a significant role in household livelihoods and family support (Jansen et al., 2006, p. 45). Their involvement in the cash economy has also increased in recent years, extending their pre-existing heavier workloads and longer working

hours. As a result, women are potentially more vulnerable to events or circumstances that may negatively affect the working environment. Added to this are the wider national and global processes which can shape and influence the livelihood choices and opportunities of Solomon Island households.

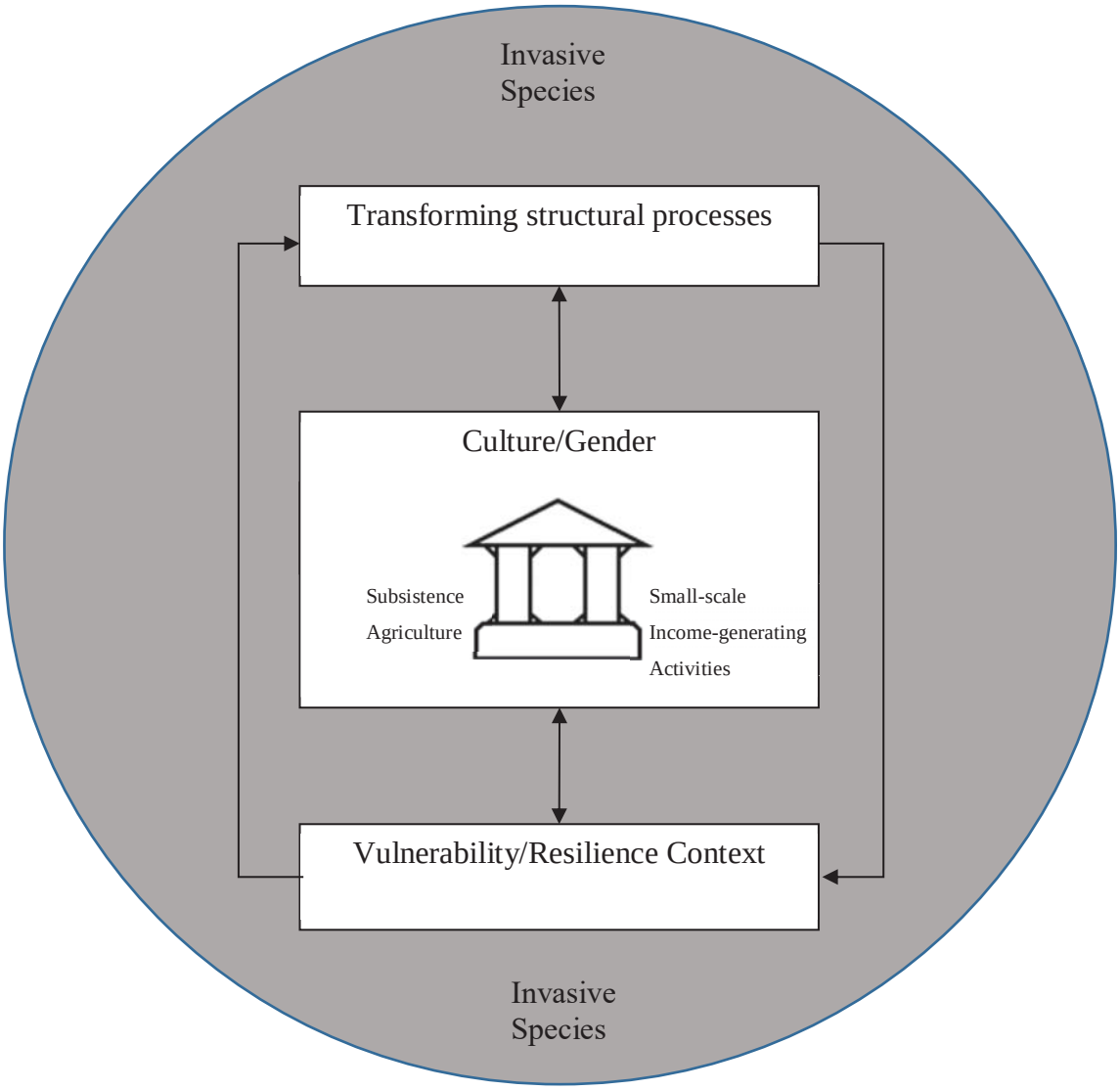

Figure 5.3: Livelihoods framework for the Solomon Islands as seen through the lens of IAS

While the majority of households in the Solomon Islands follow this framework for their livelihoods, it is not a strategy free from stresses and shocks. A number of issues affect the viability of livelihoods captured by this framework. For example, one recognised environmental issue affecting subsistence food production is decreased yields due to a reduction in soil fertility (Bourke et al., 2006, p. 24). Rising populations has seen land use intensified. This has led to reduced fallow periods[160] which has resulted in a reduction of soil fertility and consequently, a reduction in yields (ibid). Bourke et al. (2006, pp. 24-25) note that this problem is widespread in many areas of the country. Another related issue is the loss of traditional agricultural knowledge (Thaman, 2014, p. 182; Woodley, 2002 Chapter 8). Woodley (2002 Chapter 8) argues that changes in agricultural practice in the Solomon Islands has seen an erosion in the number of traditional crops (i.e. a loss of staple food crop diversity) and practices associated with subsistence food production, which can undermine food security. This situation is not unique to the Solomon Islands. Thaman (2014, p. 182) also notes that knowledge of traditional agrobiodiversity, which underpins food and livelihood security across the Pacific, is being lost.

Compounding these problems is the impact that IAS can have on livelihood strategies described by this framework. As outlined in earlier chapters, IAS are one of the most serious but under-acknowledged threats to small island developing states (UNEP, 2014a, p. 13). The influence that IAS have on this framework, and the livelihoods it represents, is examined in the following chapters using two IAS case studies; *Wasmannia auropunctata* (little fire ant) and *Achatina fulica* (giant African snail).

5.5 Study Area Description

Interviews for this study were largely conducted in rural communities along part of the northern coast of Guadalcanal, Guadalcanal Province, Solomon Islands (Figure 5.4)[161]. Due to the high level of migration from other provinces in the Solomon Islands to Guadalcanal, it was inevitable that some of the interviewees encountered in this

[160] Agriculture systems in the Solomon Islands are based on fallowing land to restore the fertility of the soil (Bourke et al., 2006, p. 24; Woodley, 2002, p. 253).

[161] Some interviews were conducted in Honiara. These were mainly with NGOs and Government representatives. A few household interviews were also conducted in Honiara with rural people in town for the day marketing their goods.

study would be from these other provinces. As such, some of the insights provided by these interviewees relate to experiences from their home province. Where relevant, these insights have been included in this study because, as noted in section 5.4 above, the livelihoods framework depicted in Figure 5.3 is representative of the majority of livelihood strategies practised across the country. This is not to say that regional differences do not exist. Variations do occur in the circumstances and opportunities available across locations[162], but as Jansen et al. (2006, p. 14) note, "in all provinces rural families practice a mixture of food production and cash cropping" as a livelihood strategy.

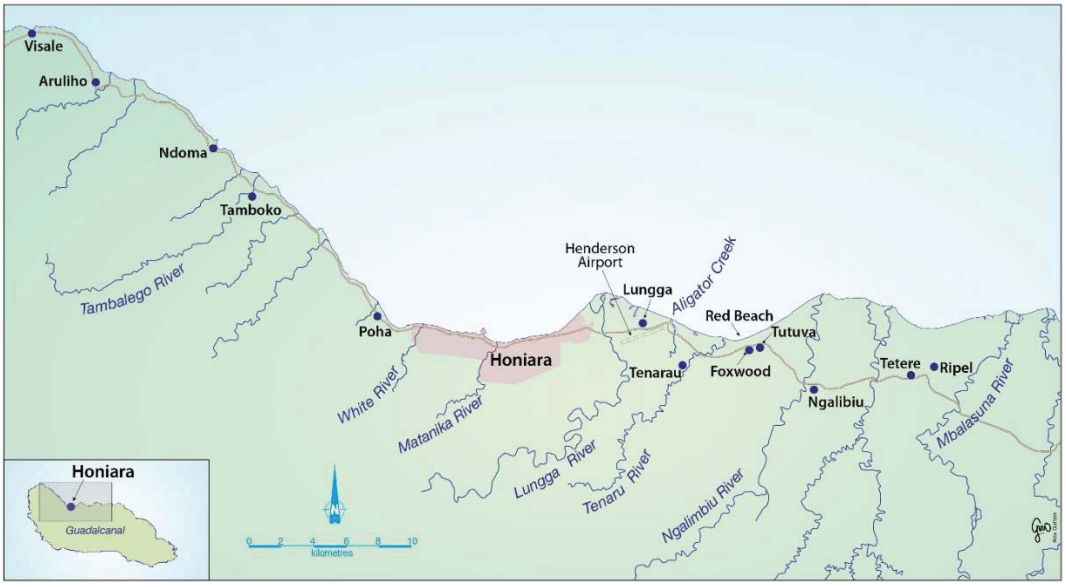

Figure 5.4: Map of the northern coast of Guadalcanal, Solomon Islands. Interviews for this study were conducted in communities along this section of the island (Source: Max Oulton, Waikato University, New Zealand).

Livelihood strategies practiced on Guadalcanal are consistent with the livelihoods framework shown in Figure 5.3. Both subsistence agriculture (pillar one) and income-generating activities (pillar two) form the basis of many rural livelihoods in this

[162] For instance, infrastructure development and access to markets varies across (and within) provinces meaning that opportunities to participate in the cash economy can be limited in some areas. Depending on the opportunities available to them some households are more reliant on the subsistence agriculture pillar, while others place greater emphasis on the income-generating pillar. For a detailed account of the provincial and inter-provincial differences see Allan et al. (2006).

province. According to the 2009 Solomon Islands census data[163] for Guadalcanal Province[164];

> Only 8% of households were not involved in growing any crops. Half of all households grew crops for the purpose of own consumption (subsistence) as well as for sale, and 41% grew crops solely for own consumption. Just 1% of households grew crops for the sole purpose of selling it. …From those households that were involved in growing crops, most grew vegetables and food crops (70%), followed by betel nut (44%), cocoa (37%) and coconut/copra (26%). Another 8% cultivated flowers (SIG, 2009c, p. 40).

Obscured in this aggregate data however, is the fact that "Guadalcanal covers the extremes of situations faced by rural communities in SI [sic]" (Jansen et al., 2006, p. 17).

At one extreme is Guadalcanal's Weather Coast where "people suffer multiple disadvantages" (Allen et al., 2006, p. 38) due to severe weather, steep topography, a lack of infrastructure (particularly transport) and a lack of income-generating activities (ibid). As a result, livelihood opportunities on the Weather Coast are limited and largely revolve around subsistence food production. At the other extreme is the northern coastal area of Guadalcanal, where a wider range of livelihood opportunities exist. This area, particularly the Guadalcanal Plains, contains some of the most fertile soils in the country (Bourke et al., 2006, p. 13), is relatively flat and "receives an adequate, but not excessive rainfall" (Allen et al., 2006, p. 35) making for good agricultural production (ibid). Honiara, which sits on this northern coast, provides waged jobs, not just for urban residents but also for nearby rural households as well (SIG, 2009c, p. 13). The north coast of Guadalcanal has also been the focus of economic development initiatives such as the Gold Ridge Mine and the establishment of an oil palm industry (Photos 5.4 and 5.5). These industries also provide rural households with job opportunities. This is reflected in the fact that wages and salaries make up around 23% of the main household income in Guadalcanal province (SIG, 2009c, p. 40).

[163] The most recent published census data.
[164] This data excludes Honiara.

Photo 5.4: Oil palm nursery (foreground) and established oil palm plantation on the East Guadalcanal plains. The Gold Ridge Mine is located on the middle ridges in the background.

Photo 5.5: Oil palm fruit being harvested on the Guadalcanal plains by Guadalcanal Plains Palm Oil Limited (GPPOL). Those employed by the company to fill the bins are paid on a per tonne basis. Each bin averages around 14 tonnes and a crew will normally average around 8 bins a day, earning a gross of SBD$900-$1000 per fortnight per person (GPPOL: interview # 37).

The main trunk road, stretching along the coast west and east of Honiara, provides rural communities on the northern coast with fairly reliable[165] access to the capital for work, health and education services, and as a place to buy and market their goods. While the road is in need of extensive maintenance and repair in places, regular daily transport services were operating at the time of my fieldwork along the road between Honiara and Visale in the west, and Tetere/Ripel in the east[166] (Photo 5.6). Side roads, vehicle and walking tracks (Photo 5.7) connect the many rural communities and households scattered along the coast to the main trunk road allowing these households greater opportunity to take advantage of income-generating activities, such as those available at roadside markets (Photo 5.8).

Photo 5.6: Downtown Honiara. The white minivans pictured provide regular transport services both within the town limits and also to rural communities along the main trunk road, which runs west and east of Honiara.

[165] The road is vulnerable to disruptions. During the time of my fieldwork for instance severe weather caused bridges in north-east Guadalcanal to be washed out. Newspaper reports at the time noted that this was affecting rural farmers and producers from supplying the Honiara central market with goods (Carter, 2013; Mamu, 2013a; Newter, 2013b).

[166] The road does continue further east than this point. I was advised by staff from an international NGO working in the Solomon Islands, however, not to venture past the Tetere/Ripel area. They said that there was still a lot of mistrust of strangers amongst some of the communities past this area and that recently the occupants of a vehicle had been attacked because the vehicle was not recognised as belonging to the area.

Telecommunications are present in rural areas along the northern coast but they are not always reliable. I experienced this myself when trying to reschedule a visit organised with one community west of Honiara after my research assistant came down with malaria. The cell phone tower was down and I was unable to let the Chief (their description of the community leader) know that we would not be able to come out. The reverse happened a couple of weeks later. My research assistant and I had made another date to visit but when we arrived we were told that the Chief had been suddenly called away to deal with an urgent issue that had arisen. They had tried to let us know but the cell tower was not working again[167].

There are no water or electricity services provided to rural communities. Kerosene lamps are the main lighting source[168] and cooking is mainly done over an open fire in a cookhouse or structure separate to the main living accommodation. Many (38%) rural households on Guadalcanal still rely on rivers or streams for their drinking water. Standpipes, wells and water tanks accounted for most of the other sources of drinking water in the province (SIG, 2009c, p. 44).

Many of the communities along the northern coast of Guadalcanal were severely affected by the 1998-2003 civil unrest. Numerous households were destroyed during this period, often burnt to the ground, and some communities are still in a process of rebuilding. Despite this, in many regards the livelihood opportunities available on north Guadalcanal today provides those living there with a greater choice of livelihood strategies, than in many other parts of the country. But subsistence agriculture still remains a core component.

[167] Despite further attempts I never did catch up with him and since I always sought permission from the community leaders before conducting any research, I never carried out any interviews in this community.
[168] 2009 census data notes that 83% of households in Guadalcanal province are reliant on kerosene lamps for lighting (SIG, 2009c, p. 44).

Photo 5.7: Walking tracks connect the many rural communities and households scattered across the Guadalcanal plains.

Photo 5.8: Henderson Market on the outskirts of Honiara, opposite the international airport. Markets and roadside stalls are a common feature along the main trunk road and provide an alternative outlet to the central market in Honiara for rural households to sell produce.

5.6 Conclusion

This chapter provides some background to life in the Solomon Islands. Drawing on the theoretical concepts discussed in Chapter 3, along with fieldwork observations and Solomon Island livelihoods literature, a contemporary rural livelihoods framework for the Solomon Islands was presented. While rural households pursue a range of livelihood options, many derive their livelihoods from a combination of subsistence agriculture and small-scale income-generating activities (which are largely agriculturally based, such as copra/coconut plantations and/or the marketing of food crops) As such, the framework presented in Figure 5.3 can be considered to be representative of the majority of livelihood strategies practised in the country. The influence of IAS on this framework is examined in the following chapters using two IAS case studies; *W. auropunctata* and *A. fulica*.

Chapter 6: Case Study 1 – The Impacts of *Wasmannia auropunctata* (Little Fire Ant) on Rural Solomon Island Livelihoods

6.0 Introduction

This chapter looks at the impacts *W. auropunctata* are having on the livelihoods of Solomon Islanders and draws largely on the fieldwork component of my research. It covers the arrival and distribution of *W. auropunctata* and looks at the effects this has had on rural livelihood strategies. In particular, it assesses the impacts *W. auropunctata* has had on subsistence agriculture and small-scale income-generating activities which, as described in Chapter 5, forms the basis of the majority of rural livelihoods in the country (Bourke et al., 2006, p. 1; UNEP, 2014a, p. 19). Drawing on the livelihoods approach outlined in Chapter 3, attention is also paid to the impacts *W. auropunctata* may have on some of the non-material or intangible components which also contribute to the livelihood process and help determine people's well-being. These non-financial forms of livelihood capital are often overlooked when dealing with the human dimension of invasive alien species (Pejchar & Mooney, 2009, p. 502). Above all, this chapter seeks to contribute to the primary research question by illustrating how rural livelihoods in the Solomon Islands have been influenced by the presence of *W. auropunctata*.

6.1 Arrival and Distribution

It is unknown exactly when *W. auropunctata* first arrived in the Solomon Islands. Bigger (1984, p. 30) notes that its presence was not recorded by the several Government entomologists working in the Solomon Islands from 1931 until its discovery by J.H. Stapley[169] in 1968[170]. All the Government entomologists up to and including Stapley were engaged in studying ants, because ants are a major control

[169] Government entomologist from 1968 to 1981 (Bigger, 1984, p. 35).

[170] This is earlier than the majority of literature which puts its arrival in the Solomon Islands at 1974 (such as recorded by Danielsen et al., 2010; Fasi, 2009; Fasi et al., 2013; Foucaud et al., 2010; Sarnat et al., 2013). This date of 1974 is largely based on a short SPC information circular by Ikin (1984, p. 8) which states that the ant has been there for at least 10 years. Commonwealth Institute of Entomology records held by CABI (UK) confirm that Stapley collected *W. auropunctata* from the Solomon Islands in 1968 (T. Pollard, CABI (UK) pers. com. 2014).

mechanism for *Amblypelta cocophaga*; an insect pest which causes premature nutfall of coconuts. As copra was a principal national export at this time (Bigger, 1984, p. 1) particular attention was being paid to the premature nutfall problem and the ant communities in the Solomon Islands. Prior to 1968, several collections of the ant fauna in the Solomon Islands had been made, none of which recorded *W. auropunctata* as being present (see Sarnat et al. (2013) for an extensive review of ant collection and research in the Solomon Islands).

It has been suggested that *W. auropunctata* was deliberately introduced to the Solomon Islands (Fasi, 2009, p. 22; Fasi et al., 2013, p. 1) to control *Amblypelta*. This was denied during interviews with past and current Government officials (SIAQS: interview # 59; Ministry of Agriculture and Livestock: interview # 69). Bigger's (1984) review of over 100 reports and papers spanning 60 years of research into premature nutfall in the Solomon Islands also supports the view that there was no deliberate introduction of *W. auropunctata* via official government channels.

It is also unknown where *W. auropunctata* first became established in the Solomon Islands. Bigger (1984, p. 30) records that three *W. auropunctata* specimens held in the Ministry of Agriculture and Livestock collection[171] were collected by Stapley from Tenaru[172] in 1968[173]. By 1984 Bigger reported that *W. auropunctata* were widespread throughout the Solomon Islands, being "…present on Guadalcanal, Malaita, the Russell Islands, Kolombangara, Gizo [*sic*] and the Shortlands…" (Bigger, 1984, p. 30). Subsequent research records them on Makira Island (Danielsen et al., 2010, p. 105; Fasi, 2009, p. 55), Choiseul, Santa Cruz, New Georgia, Rennell (Fasi, 2009, p. 55), Savo, Vulelua, Utupa, (Wetterer & Porter, 2003, p. 14) and the Reef Islands (Macfarlane, 1985, p. 19). Interviews conducted during this study added Isabel (NGO: interview # 63) (see Table 6.1 and Figure 6.1).

[171] Ministry of Agriculture and Livestock Dodo Creek Research Station. This station was destroyed around 2003 during the tensions and the fate of the collection is unknown but presumed destroyed. (H. Tsatsia, Director, Research (Ag) Ministry of Agriculture and Livestock, pers. com. 2013).
[172] An area in northeast Guadalcanal. Bob Macfarlane, who succeeded Stapley, recalls being told by Stapley that he first collected *W. auropunctata* from Yandina in the Russell Islands (SIAQS: interview # 59).
[173] The year Stapley first arrived.

Table 6.1: Reported Location of Wasmannia auropunctata in the Solomon Islands

Province	**Island**	**Source**
Central	Russell Islands	Bigger (1984, p. 30); Macfarlane (1985, p. 19); Fasi (2009, p. 55)
	Savo	Wetterer and Porter (2003, p. 14)
Choiseul	Choiseul	Fasi (2009, p. 55)
Guadalcanal	Guadalcanal	Bigger (1984, p. 30); Wetterer and Porter (2003, p. 14)
	Vulelua	Wetterer and Porter (2003, p. 14)
Isabel	Isabel	NGO: interview # 63
Makira-Ulawa	Makira	Fasi (2009, p. 55); Danielsen et al. (2010, p. 105)
Malaita	Malaita	Bigger (1984, p. 30); Macfarlane (1985, p. 19)
RenBel	Rennell	Fasi (2009, p. 55)
Temotu	Reef Islands	Macfarlane (1985, p. 19)
	Santa Cruz	Fasi (2009, p. 55); Macfarlane (1985, p. 19)
	Utupua	Wetterer and Porter (2003, p. 14)
Western	Kolombangara	Bigger (1984, p. 30)
	Ghizo	Bigger (1984, p. 30); Macfarlane (1985, p. 19)
	Shortland Islands	Bigger (1984, p. 30); Macfarlane (1985, p. 19)
	New Georgia	Fasi (2009, p. 55); Macfarlane (1985, p. 19)

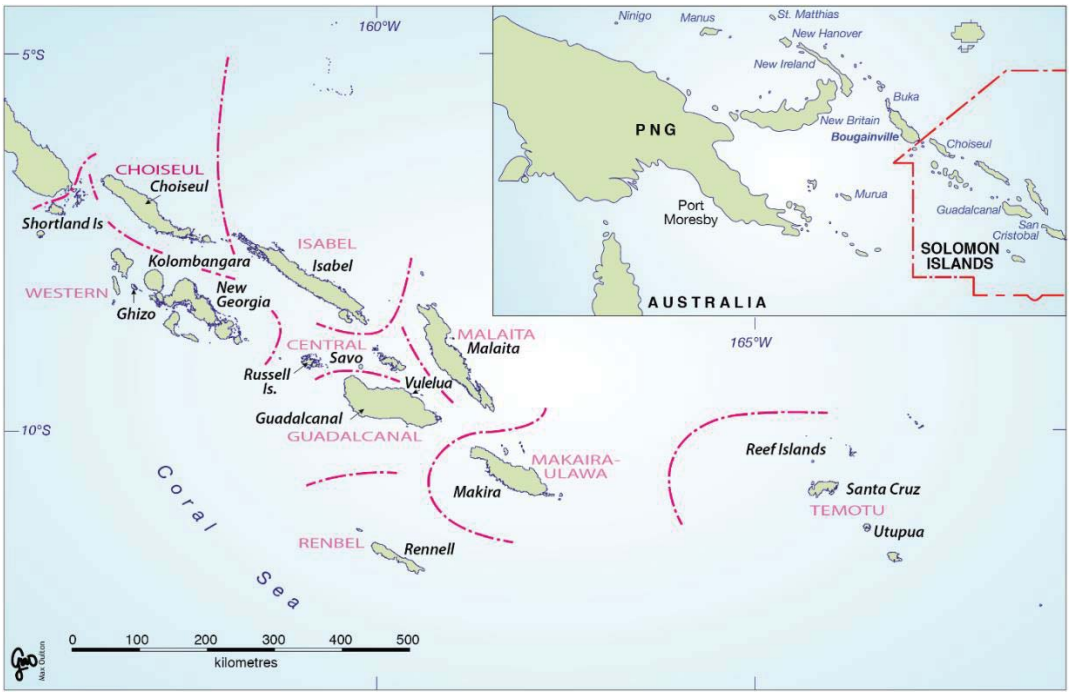

Figure 6.1: Map of the reported locations of Wasmannia auropunctata in the Solomon Islands (Source: Max Oulton, Waikato University, New Zealand).

The Solomon Islands Government has no survey information on how widespread *W. auropunctata* currently are, either across the country or across individual islands within the group. But as Fasi (2009, p. 55) notes, it is now "…highly probable that no islands in the Solomon Islands are spared from the intrusion of *W. auropunctata*". While this species disperses short distances naturally, the most significant means of dispersal is through human activity (SPC, 2010). For example, locals report that they have been carried from the northern coastal plains of Guadalcanal to the Weather Coast by people moving plants, baggage and other materials. As noted below, *W. auropunctata* are easily spread by this means.

Likewise, Macfarlane (1985, p. 19) found that the ant is easily spread in bundles of food and betel nut,

> …the latter being particularly effective in this respect as Wasmania [*sic*] is readily found tending coccids[174] and pseudococcids, especially Planococcus pacificus on betel nut palms.

[174] See footnote 28.

The ease with which it spreads was also highlighted by one interviewee originally from Isabel, now living in Honiara, who recalled:

> I experienced it in Isabel… At the beginning of this year I sent a message to my brothers in Isabel. I said I want you to cut some sago palm leaf for my chicken house. They did this and sent it over by boat. I went down to the wharf to pick it up from the ship and load it on the truck. When I lifted it up from the wharf the fire ants start to burn my hand. I looked on the bundle of this sago palm and saw a lot of them crawling; now there must be a lot more there (NGO: interview # 63).

Others recalled that *W. auropunctata* arrived in their communities[175] following cyclone Namu in 1986. At this time there was a major distribution of seed coconuts from Yandina (Russell Islands) to Guadalcanal (and other provinces) in order to re-establish coconut plantations destroyed by the cyclone (SIAQS: interview # 61). *Wasmannia auropunctata* was well established in the Yandina area prior to the cyclone (Bigger, 1984, p. 30) and was therefore inadvertently distributed with the nuts. This distribution pathway was, however, already operating prior to this event. Bigger (1984, p. 31) recounts how, on a visit he took to Hauhui in Malaita in 1984, the locals told him that the ants had been brought to that location with seed coconuts from Yandina. However, they were unable to recall when this took place.

Despite these accounts, the spread of *W. auropunctata* within the Solomon Islands has not been entirely accidental. Bigger (1984, p. 32) reported that the people of Hauhui on Malaita were disseminating nests of *W. auropunctata*, that they trapped using a length of bamboo baited with fish, around their coconut plantations to use as a control against nutfall. Based on these observations Bigger started experiments where he attempted to introduce *W. auropunctata* into plantations with heavy nutfall on Guadalcanal. His aim being to see if it would establish and displace other ant species which do not control the pests which cause this problem (Bigger, 1984, p. 32; Macfarlane, 1984, p. 27). While there were plans for further investigation of *W. auropunctata* (Macfarlane, 1984, p. 27), no formal trials eventuated (Macfarlane, 1985, p. 19 and pers. com. 2014). Agricultural officials stressed during interviews conducted for this research that it had never been Government policy to promote *W.*

[175] For example, Poha, Tamboko, St Martins, GPPOL area.

auropunctata as a control tool (Ministry of Agriculture and Livestock: interview # 69). There is, however, some evidence that this had occurred unofficially. Fasi (2009, p. 22) states that he personally observed agricultural authorities encouraging the spread of *W. auropunctata* within the Solomon Islands and during a group interview I conducted with farmer representatives from Malaita and Western Provinces, one farmer from Malaita recalled that:

> Farmer: In respect to our location, up in the mountains about seventeen kilometers into the interior, we had a low yield of coconut. The coconut trees had a very low yield. Then the agriculture extension staff, they said you should get some red ants, introduce them. Following their advice, we took them up in the mountains and put them on those coconut plants. Eventually the ants invaded all the forest.
>
> Dean: But the yields are better on those coconuts now?
>
> Farmer: Now the yields are better – they bear many fruits compared to before. So we found out that it works for the coconut and we enjoy those fruits, but then we also found the ant irritates us (Focus group: interview # 42).

Dispersed largely by human means, *W. auropunctata* are now widespread throughout the Solomon Islands. While they are still absent from some areas[176], they have been a relatively long standing and common feature in many rural communities (Photo 6.1). The impacts *W. auropunctata* has had on rural livelihoods in the Solomon Islands are discussed in the following sections.

[176] Locals report that some parts of Guadalcanal, such as the inland central areas, are still free of *W. auropunctata*.

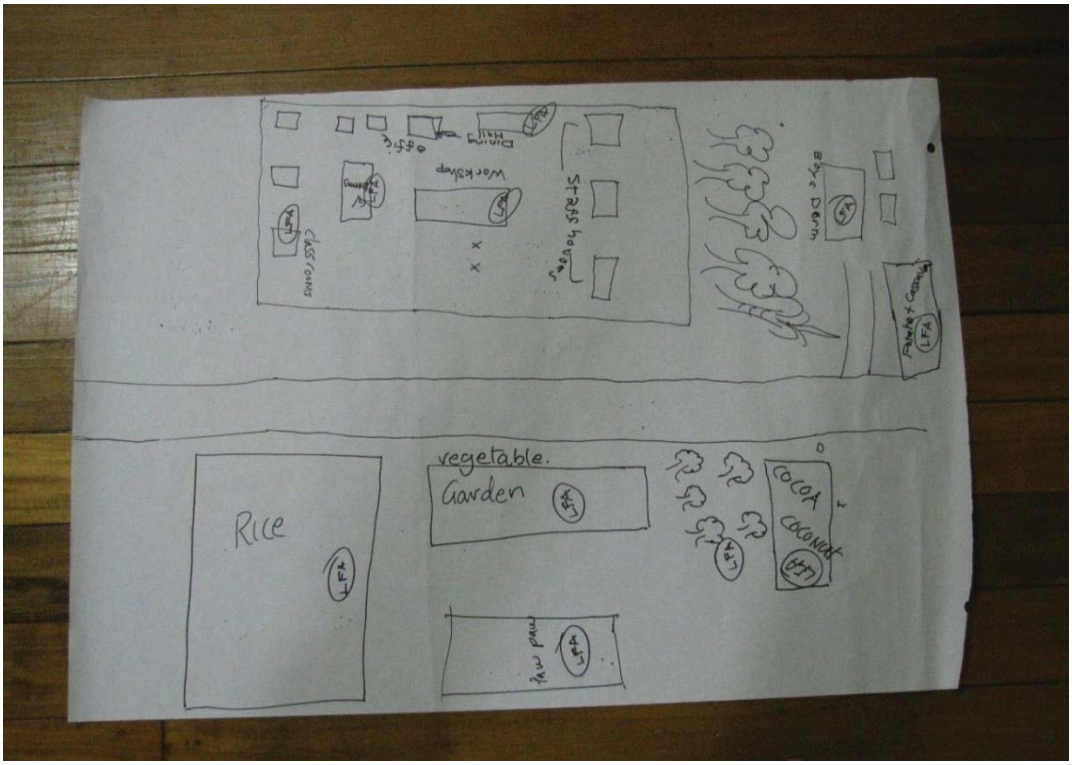

Photo 6.1: Community map produced during a focus group with adult agricultural students from a rural training centre on Guadalcanal. Note the widespread indication of W. auropunctata (designated by the circled letters LFA) from gardens, plantations and bush, to dorms, dining rooms and classrooms.

6.2 Impacts on Subsistence Agriculture

As outlined in Chapter 5, subsistence agriculture forms the first pillar of rural livelihoods in the Solomon Islands (see Figures 5.2 and 5.3) and is an essential safety net for many households. The impacts of *W. auropunctata* on subsistence agriculture are yet to be fully understood (Fasi et al., 2013, p. 2) but they are generally regarded to be an agricultural pest due to their stinging which interferes with agricultural activities and by enhancing populations of Homoptera[177] (Fabres & Brown, 1978, p. 139; Fasi, 2009, p. 69; Fasi et al., 2013, p. 2; Harris & Berry, n.d., p. 3; SPC, 2010; Spencer, 1941, p. 6&9; Wetterer & Porter, 2003, p. 2), which can result in crop loss. The significance of these impacts on rural livelihoods in the Solomon Islands and other Pacific nations has not been assessed but Fasi et al. (2013, p. 7) predict that as *W.*

[177] See footnote 28.

auropunctata spreads through the Pacific region "…crop losses in subsistence gardens will become more common and is expected to be one of the major impacts on island communities". This would have serious consequences for food security across the region. With the importance of agriculture in both feeding and proving cash to the household (pillars one and two, Figures 5.2 and 5.3) one would expect, given the distribution and length of time *W. auropunctata* has been in the country, to see significant impacts on the livelihoods of those engaged in these activities. The rest of section 6.2 looks at the impacts of *W. auropunctata* on subsistence agriculture. Given that subsistence agriculture is also intertwined with the growing of food crops for sale (pillar two, Figures 5.2 and 5.3) the impacts on this income-generating activity are also discussed here.

6.2.1 Impacts on gardening activities in the Solomon Islands

All garden activities are affected by the stinging of *W. auropunctata*, although they are not affected every time they are practised. Men reported that brushing[178] was the most common activity affected by *W. auropunctata*, while women reported it occurred more or less evenly across the board during brushing, weeding and harvesting activities. This is likely a reflection of the roles that men and women play in the gardening process, with men being more heavily involved in brushing rather than other garden activities (see Chapter 5). While men and women are both affected by *W. auropunctata*, women spend more time in the garden and are more likely to be exposed to the ant. This was highlighted in one community where the men noted that *W. auropunctata* was not common around the area (Focus group: interview # 18), whereas the women stated the ant was present "…in the garden, trees, everywhere" (Focus group: interview # 19), was increasing in numbers and was considered a big problem for them; "It stings a lot when people go to the gardens" (ibid). The same was also noted in another community where women also felt that they were more affected by *W. auropunctata* as they were the ones that frequently went to the gardens, whereas "the men stay in the house" (Focus group: interview # 65).

Greater exposure, however, does not always mean greater impact. Despite the ants being present in their gardens two women interviewed claimed they were not really

[178] Brushing was the term used locally to describe pruning, tree felling, and clearing bushes.

affected by them (HH female: interview # 8; HH female: interview # 17). Another noted that while its stinging was a nuisance to her while in the garden she did not worry too much about the ants (HH female: interview # 56). During a focus group with a group of adult agricultural students at a Rural Training Centre, the women in the group noted that working in the garden was better than working in the plantations because in the gardens the crops are low to the ground so the ants are lower down and cannot fall on them as they are working. However, this did not prevent them from being stung on occasion, particularly, they said, while harvesting cassava (Focus group: interview # 64).

Reactions to being stung varied and often reflected where on the body people were stung and how many times they were stung. People rarely reported stopping work in their gardens because of the ant, the common exception being when stung in the eye.

> When we get stung by the ants, on the body, it becomes red and swells, but it does not take long to go down. But when it goes into the eye it will be more serious… You have to stop and find water to wash out the eye…, you will need to rest for the day and next day come back (HH female: interview #17).
>
> For me when I get stung in the eye I just run to the river then go home. That's it for the day (Focus group: interview # 42).

Being stung in the eye was a common complaint with people. Both men and women reported that being stung in the eye was most likely to occur when ants fell on them from overhead vegetation, particularly while performing tasks associated with brushing, although other activities such as harvesting were not immune. As one woman remarked when asked what the main impacts of the ant were:

> It stings you in the garden; in the bananas. It falls in the eye and you cry (Focus group: interview # 47).

But it is not just adults who are affected. Children also have a role in gardening, with girls having a greater involvement than boys (Jansen et al., 2006, p. 45). As one parent put it when discussing who did the work in the garden:

> …most of the time it is usually the women; girls with mothers. Sometimes the boys go and help, but the boys when they go there… they have a lot of excuses (HH male: interview # 66).

Saunders (in Lovatt, 2011, p. 19) described how due to the ants' painful sting, the Kanak people in the Mount Panie region of New Caledonia no longer take their children to the family gardens. This has resulted in a concern regarding the passing of Kanak gardening knowledge and culture on to the next generation. This was not found to be the case in the Solomon Islands. Parents reported that children still go to the gardens despite the ants; although with some reluctance at times on the children's part.

> Dean: Do you still take your children to the gardens. Does it [*W. auropunctata*] affect them?
>
> Women: Yes. Cry! Cry! Cry! Cry! Cry!
>
> Dean: But you still take them?
>
> Women: Yes (Focus group: interview # 19).

A similar sentiment came out during a focus group with male farmers from Malaita and Western Provinces,

> Dean: Has there been any effect on children working in the garden?
>
> Farmer: Young people are always making some kind of excuse not to go to the garden. Young people really complain about the fire ant and do not want to go to the garden. Sometimes it's just excuses (Focus group: interview # 42).

Not all the parents spoken to in this study said their children helped out in the garden. In these instances, the reasons given for children not helping out were due to other factors and not the presence of *W. auropunctata*. Woodley (2002, p. 289) found that nowadays children in the Solomon Islands were spending less time in the garden than in previous generations because of their commitments to school and other activities.

People clearly find *W. auropunctata* to be an annoyance when carrying out tasks in the garden. While the level of annoyance varied, everyone who said they spent time working in the garden was familiar with the ant and its sting:

> A lot of people are really affected because they are working in the garden. They have this attitude during the working time, it causes a lot of frustration. You do not get on well with this one. It's very annoying (Focus group: interview # 42).

For some, this had affected the enjoyment of spending time in the garden:

> …before the arrival of the red ant …we enjoyed going to the garden with the kids, climbing the trees, planting, (Focus group: interview # 42).

Nevertheless, most people stated that the presence of *W. auropunctata* had not changed the way they worked. As the Chief[179] of one village, when asked what the main impact of the ants were, observed:

> Chief: The impact it can cause is when people are working in the gardens, they usually fall down on the people and sometimes into the eyes. It disturbs you doing work and you have to go and find water to wash it off. Especially with new gardens. Cutting, clearing the bush. The brushing.
>
> Dean: Does it prevent that work from happening, or is it just an annoyance?
>
> Chief: No. It does not stop people (HH male: interview # 11).

There are two main reasons why it has not stopped people from working in the gardens. The first is that they have few alternatives. Outside of Honiara there are limited income generating opportunities. As noted, growing food to feed the household and to sell in the market is a major source of livelihoods for most Solomon Islanders (Bourke et al., 2006, p. 1). As one household head put it:

> It does not change how we do the work. Because if we change or stop working we get no money. Nothing to eat (HH male: interview # 1).

Or as another more bluntly put it:

> No work. No Food (Focus group: interview # 47).

As noted earlier in Chapter 5, even many of those in paid employment still practised agriculture to feed the household and supplement their income. This predominance of agriculture in the Solomon Islands provides an essential safety net to its people (SIG, 2009d, p. 188). Because of its widespread nature the presence of *W. auropunctata* is just *fait accompli* for most people:

> …we cannot change the way we do work because fire ants are everywhere so we have to just keep on working (HH male female: interview # 53).

The second reason why it has not stopped people working in the gardens is that garden productivity has not been greatly affected by the presence of the ants. For those that can put up with the stinging there is reward for the effort; in that they can still grow

[179] This was the term used by residents of this community to describe this individual. Also see footnote 126.

enough to feed the household and sell any surplus. The impacts of *W. auropunctata* on garden productivity are discussed further in section 6.2.2 below.

6.2.2 Impacts on garden productivity in the Solomon Islands

People held mixed views on the impacts of *W. auropunctata* on garden productivity. While some felt that the ants had no impact at all on the productivity of their gardens, others reported either positive or negative impacts on crop production. Benefits centred on the protection *W. auropunctata* provided to crops by excluding or controlling other insects that would otherwise cause damage. Negative impacts included the physical damage to new shoots and fruits of plants and the harbouring of other plant pests. Some respondents occasionally reported both positive and negative effects. These views are consistent with ecological studies on ants. In a review of the causes and consequences of ant invasions, Holway et al. (2002) noted that ants can predate both beneficial and harmful insects, form mutualisms which can both benefit and harm plants, and even do direct physical damage to plants themselves. While it is possible to describe the general impacts invasive ants can have on plant production (Holway et al., 2002; Wetterer, 2009), much of this information is largely based on one or two species (Holway et al., 2002, p. 183). Ness and Bronstein (2004, p. 457) note that the effects of invasive ants appear to differ across ant species and *W. auropunctata*, as Foucaud et al. (2010, p. 364) record, is one of the least studied. As a result, there have been very few studies which have looked at the effects of *W. auropunctata* on plant production. Those that have been done have largely focused on cash crops (i.e. cocoa, coffee, citrus – Ulloa-Chacon & Cherix, 1990, p. 282) rather than subsistence gardens (Fasi et al., 2013 being the exception).

The limited studies that have been done show *W. auropunctata* to be an active predator of herbivorous insects (Fowler, Bernardi, Delabie, Forti, & Pereira-da-Silva, 1990; GISD, 2009; Ness & Bronstein, 2004, p. 453) which would otherwise cause damage to plants. In its native range, decreases in herbivorous insects due to *W. auropunctata* predation resulted in increased fruit and seed production, increased plant growth rate and decreased incidence of pathogens attacking leaves (Ness & Bronstein, 2004, p. 452). However, this predation also negatively affected beneficial insects important to the plants such as plant protectors and seed dispersers (ibid, p. 453) which can have

negative consequences for plants. Additionally, *W. auropunctata* feed on plant material themselves (flowers, seeds, leaves, stems – Clark, Guayasamin, Pazmino, Donoso, & de Villacis, 1982, p. 203) which can damage the plants. *Wasmannia auropunctata* are also reliant on honeydew produced by homopterous insects for food (Clark et al., 1982, p. 204; Fowler et al., 1990). Harvesting this product can be beneficial to the plant as it prevents sooty mould infections (Wetterer, 2009, p. 1). However, the protection the ants provide to the insects which produce the honeydew can also allow their numbers to build up, causing direct damage to plants and increasing the plants' susceptibility to pathogens (ibid). The impacts of *W. auropunctata* on plant productivity are therefore both varied and complex and require further investigation, particularly regarding the subsistence agriculture setting.

The complexities outlined above, coupled with the numerous environmental variables (i.e. soil moisture, soil type, soil fertility, disturbance history, presence of other pests, presence of other ant species, for example), meant that teasing out the quantitative impacts of *W. auropunctata* on subsistence garden productivity in the Solomon Islands as a whole was beyond the scope of this study. Information on the impacts *W. auropunctata* were having was therefore reliant on the observations of those who worked their gardens and whose livelihoods depended on its outputs.

Even though rural households in the Solomon Islands are not actively monitoring the impacts of *W. auropunctata* on their crops and are unable to quantify the exact changes to productivity because of them, they are aware of what their gardens are producing and how that productivity influences their livelihoods. Importantly, from a livelihoods perspective, none of the households spoken to reported that the presence of *W. auropunctata* affected the household's ability to grow enough food to feed the family and/or sell in the market. This is also supported by the interviews from two NGOs working on food crops/food security in the Solomon Islands. As one of them noted:

> I have visited a lot of villages, a lot of farmers that have problems with their crops and there are no reports that the fire ants are a problem. Stinging, yes, that would be it (NGO: interview # 54).

Despite *W. auropunctata* being present in the area for around 30 years, farmer representatives from Malaita and Western Province, when asked if households in their areas were still able to grow enough food, confidently replied:

> Yeah, yeah. We do not have a problem with food. But I think the real problem is the annoyance (Focus group: interview # 42).

If *W. auropunctata* was to have a significant impact on food production in the Solomon Islands, the one time this would have been particularly evident would have been during the 1998-2003 civil unrest. During these times rural communities were almost completely reliant on what they grew (Bourke et al., 2006, p. 22) and wild foods for survival, as they were unable to go into Honiara for supplies. Even though *W. auropunctata* was widespread and long established throughout Guadalcanal (and other provinces) by this time, there were no reports of food shortages or malnutrition in communities not directly displaced by the fighting[180]. During a discussion about this with the Chief[181] of one village on the Guadalcanal Plains, my second research assistant noted;

> Assistant: I think the only thing we actually had shortage of goods from town were like kerosene, soap, sugar, household goods. But as far as food crops, we could still survive from the local food.
>
> Dean: There was no malnutrition or anything?
>
> Assistant: No. No, no. Still cassava here, pineapple, kumara. Still get vegetables. Still get fish from the sea, wild pigs from the bush, chickens from the village.

Throughout this discussion the Chief was nodding his agreement[182] (HH male: interview # 11 and Field notes 1 November 2013). My first research assistant made a similar observation. He remarked that after the tensions when the 'boys' came out of the bush, he expected to see them skinny and unhealthy. But instead he said they were all very healthy and strong, because they had been living on traditional foods and not rice and noodles. So despite the concerns raised by Fasi et al. (2013, p. 7) that crop losses in subsistence gardens due to *W. auropunctata* will be a major impact on island communities, there was no evidence to suggest from this study that *W. auropunctata* was impacting on food security in households reliant on subsistence farming practices.

[180] The Kastom Gaden Association (KGA) reported that the tensions impacted on food security for communities caught up in the fighting on the Weather Coast of Guadalcanal (KGA, 2005, p. 23).
[181] See footnote 179.
[182] The interview with this Chief was in English. He spoke good English, understood this conversation and was nodding in complete agreement with what my assistant was telling me.

6.3 Impacts on Small-scale Income-generating Activities

Small-scale income-generating activities form the second pillar of rural livelihoods in the Solomon Islands (see Figures 5.2 and 5.3). While these activities are many and varied[183] small-scale cash cropping of coconut and cocoa, and the marketing of fresh produce dominate (Bourke et al., 2006, p. 25; SIG, 2006, p. 56; 2009d, p. 188 & 245). This section focuses primarily on the impacts of *W. auropunctata* on plantation crops such as coconut and cocoa. The impacts on growing fresh produce for sale are covered in 6.2 above. *Wasmannia auropunctata* have the potential to affect small-scale plantation[184] activities through their stinging (Fabres & Brown, 1978; Fernald, 1947; Lubin, 1984, p. 230; PIAG, 2004; Souza, Follett, Price, & Stacy, 2008, p. 1068; Spencer, 1941) and via the effect they can have on crop productivity (Fabres & Brown, 1978, p. 139; Jourdan, 1997, p. 63; PIAG, 2004). These two avenues are discussed in the sections below.

6.3.1 Impacts on small-scale plantation activities in the Solomon Islands

Interviews conducted with those involved in small-scale plantations found that *W. auropunctata* can impact on both brushing and harvesting activities. The main concern raised being ants falling on people as they work, stinging them on the body or in their eyes as they looked up into the vegetation.

> When you harvest the cocoa, you look up and the ants fall into your eyes. That's what I experience. You have to go to the water and rinse your eyes (HH male female: interview # 53)

This experience with *W. auropunctata* has affected some people's approach and attitudes to work. Discussions during a focus group with farmer representatives from Malaita and Western Province revealed that attitudes of people had changed following the arrival of the ants, with one farmer noting that:

> Before they just go to work… but nowadays when people, before they do the job, they have to take their time and check items that they want to carry or cut…. And they spend some time to check and look carefully at the trees they want to climb. So it changes their attitudes to work compared to before. So

[183] See footnote 150.

[184] I have used this term to describe any sized area being managed as a cash crop by individual households. Sizes varied from a few trees, right up to the abandoned commercial estates, which were now being partially utilized in small-scale operations by neighbouring communities.

> everyone in the community or village, nowadays when they go to do their work they have to look carefully before they work. So they are being more cautious about what they are doing. It's different from before how they worked (Focus group: interview # 42).

My research assistant informed me that from his experience people were more reluctant to climb for coconuts because of the ants (Field notes 30 August 2013). He stated that when he was required to collect coconut for household use he would carefully check the tree for ants before climbing. Sometimes they would smoke the tree first, by burning coconut fronds for example, which caused the ants to fall to the ground. This technique was also mentioned by some small-scale plantation growers but they said they used it during brushing rather than harvesting.

Despite the effects on work output caused by *W. auropunctata*, no one reported that the ants prevented them from permanently working in their plantations:

> Dean: How does the little fire ant affect you when you are working in the cocoa plantation?
>
> Reply: When we do the brushing in the cocoa plantation the ants fall on us and sting us.
>
> Dean: Does that impact on how you do the job?
>
> Reply: It disrupts the work we are doing. We have to rest and take the ants from our bodies…. It slows down the work…
>
> Dean: It does not stop you from doing the work?
>
> Reply: When we get stung we have to rest for a bit, then start work again.
>
> Dean: So it is just slowing down the amount of work?
>
> Reply: Yeah (Focus group: interview # 64).

While there are accounts of *W. auropunctata* stinging agricultural workers in the literature (see references in section 6.3 above), only Spencer (1941, p. 6) and Souza et al. (2008, p. 1073) report plantation workers being prevented or refusing to work in areas as a result of this. Both these reports were from western citrus groves (Florida and Hawaii).

As is the case with those growing crops for household use and the market (outlined in section 6.2.1 above), small-scale plantation owners in the Solomon Islands have few alternatives outside of this activity to make a living. So while the stinging may

interfere with their activities and annoy and frustrate them, in most cases they have no other choice but to put up with it.

6.3.2 Impacts on small-scale plantation productivity in the Solomon Islands

6.3.2.1 Coconut

Coconuts are the most widely grown crop in the Solomon Islands. Young and Pelomo (2014, p. 1) estimate that around 40,000 rural households in the Solomon Islands grow coconuts for household use and as an income-generating activity. Whereas in the past production was dominated by large-scale commercial estates, this sector has declined dramatically and production is now largely confined to small-holder plantations. Regardless, coconut is still an important source of revenue for the national economy and is a significant contributor to small-holder livelihoods (ibid).

As outlined in section 6.1, *W. auropunctata* has been deliberately introduced into some coconut plantations in the past by locals in the belief that it controls plantation pests, particularly the coreid bug *Amblypelta cocophaga*. As observed by one NGO representative:

> …for some coconut, you see a big difference. Like, where you have got this population of fire ants you find these coconuts bear good fruit. And this might be due to the fire ants controlling this *Amblypelta* insect, the one that causes premature fall of the coconuts. But previously we read more in the literature that *Oecophylla* ants, they control this *Amblypelta*. But some people believe that even the fire ants might be doing a similar job (NGO: interview # 54).

Feeding by *Amblypelta* on coconut causes damage, which leads to the young fruit falling to the ground when they are still very small (Phillips, 1940, p. 296). Those damaged nuts that are retained on the palm are stunted and contain less copra than those that have not been attacked by *Amblypelta* (Brown, 1959, p. 126). Premature nutfall occurs on most islands within the Solomons[185], but Guadalcanal, Malaita and Nggela are the most affected (Brown, 1959, p. 123; Tsatsia & Jackson, n.d.). While the national loss of production due to *Amblypelta* was estimated to be between 10 and 20% (Bigger, 1984, p. 10), this was derived from work conducted on the commercial estates. Bigger (1984, p. 11), however, noted that the problem was most acute on

[185] *Amblypelta cocophanga* is not present on Russell Island or Ontong Java (Brown, 1959, p. 119).

small-holder coconut groves where the canopy was dense and was in close contact with uncleared bush. He observed that in some areas nutfall was as high as 100%, causing considerable hardship to small-scale farmers reliant on their plantations for income and food (ibid, p. 2).

Premature nutfall has been a long standing issue for the coconut sector in the Solomon Islands (Bigger, 1984; Lever, 1933, p. 253; Phillips, 1940; Tsatsia & Jackson, n.d.), and was the focus of a lot of research during the 1900s. Entomologists working in the country prior to World War II had observed the association of certain ant species with the presence of nutfall and this research was continued post-war. This research found that there were four dominant ant species[186] which competed for control of coconut palms (Greenslade, 1971, p. 348). Of these, *Oecophylla smaragdina* and *Anoplolepis longipes* are able to control *Amblypelta* in coconut groves, protecting the palm from attack, which resulted in good yields of coconut. But where *Iridomyrmex cordatus* or *Pheidole megacephala* dominated, yields were poor as neither species provided any protection against *Amblypelta* (Brown, 1959; Greenslade, 1971; Phillips, 1940). While competition between the ant species is complex, resulting in periodic changes in dominance by the different species over a particular area, the research found that in general the non-protectors (*I. cordatus* and *P. megacephala*) were better at outcompeting the protectors (especially *O. smaragdina*) (Greenslade, 1971, p. 348).

The bulk of this research was completed prior to *W. auropunctata* arriving in the Solomon Islands and by the mid-1970s the work on coconut nutfall had ceased (Bigger, 1984, p. 6). This meant that the influence of *W. auropunctata* went unrecorded until Bigger undertook a review of the previous 60 years of research in 1984. During this review he visited the community of Hauhui in Central Malaita which he records had been surveyed in 1954 by the entomologist E.S. Brown. Brown (in Bigger, 1984, p. 31) reported heavy nutfall associated with *I. cordatus* at this location. Bigger (1984, p. 31) states that;

[186] These species are *Oecophylla smaragdina*, *Iridomyrmex cordatus* (native to the Solomon Islands), *Pheidole megacephala* and *Anoplolepis longipes* (introduced) (Greenslade, 1971, 1972).

> A sample of 25 palms to the south of the village made by [Brown] showed a Vidaka Damage Rate[187] of 87% and average of only 13 nuts per annum. In an area to the north the nutfall was even worse with a V.D.R. of 94% and a crop of only 4 n.p.a. A small area in the village itself was occupied by *O. smaragdina* and here the crop was normal[188]. Today a large area to the north of the village is occupied by *W. auropunctata* which is foraging on the palms, crops are normal and no nutfall is evident.

As outlined in section 6.1 above this was not an isolated case. A similar observation was made during the focus group with a NGOs farmer representatives, who stated that in north Malaita yields had dramatically increased following the introduction of *W. auropunctata* (Focus group: interview # 42).

Bigger concluded from his observations that there was strong evidence that *W. auropunctata* not only protected coconut palms from *Amblypelta*, but that it also displaced *I. cordatus* which provided no protection (Bigger, 1984, p. 32). Subsequent observations by Macfarlane (1985, p. 19) in coconut and cocoa plantations on Guadalcanal noted that *W. auropunctata* drove out *I. cordatus*, *P. megacephala* and unfortunately *O. smaragdina*. He also noted that where this occurred *Amblypelta* damage in coconut plantations had been much reduced. This ability of *W. auropunctata* to dominate other ant species in areas it has invaded has been shown elsewhere (Le Breton et al., 2003, p. 204; Lubin, 1984, p. 235).

Because this is not an ecological study I did not look at the ant assemblages within plantations or the level of *Amblypelta* damage. Until such ecological studies are done it cannot be confirmed that *W. auropunctata* is the dominant ant species within Solomon Island plantations and is assisting coconut production by protecting against attack by *Amblypelta*. However, all the growers interviewed reported that despite *W. auropunctata* being common throughout their plantations they did not have an issue

[187] The Vidaka Damage Rate (VDR) is an assessment method developed by Vanderplank (1958) to measure nutfall in coconut in Zanzibar. It expresses, as a percentage, the number of nuts affected by the feeding of *Amblypelta*. Broadly speaking, "the V.D.R. gives some indication of the intensity of *Amblypelta* attack, and therefore the loss this causes" (Brown, 1959, p. 99).

[188] Bigger does not record what normal is for this location. Yields can vary by location due to different climatic conditions and tree age for example. A survey of 3456 palms conducted by Brown (1959, p. 111) in other areas free of nutfall showed an average of 63 nuts per palm per annum. Bigger calculated 126 nuts per palm per annum for an area free of nutfall on Guadalcanal.

with the productivity of their coconut palms. While this does not confirm the positive impacts of *W. auropunctata* it does suggest that there are at least no significant negative impacts by the ant on production. So from a livelihoods perspective, while there are a number of issues that negatively affect coconut production in the Solomon Islands[189], it appears as though *W. auropunctata* is not one of them. Further research into the impacts of *W. auropunctata* on *Amblypelta* and the ant fauna of the Solomon Islands is required to confirm this.

6.3.2.2 Cocoa

Wasmannia auropunctata are widespread within cocoa plantations, with one farmer on the Guadalcanal plains estimating that they cover around 90% of his trees (GPPOL: interview # 37). None of those interviewed felt that the productivity of their plantations was affected by *W. auropunctata* to the point that it impacted on their livelihoods. This is illustrated in Box 6.1, where despite *W. auropunctata* being common in their plantation, cocoa production was still the mainstay of this household's livelihood and production was being expanded.

During a focus group with agricultural students from a Rural Training Centre it was stated that *W. auropunctata* benefitted cocoa by keeping pest insects away from the crop (Focus group: interview # 64). This view was supported by AusAIDs Cocoa Livelihoods Improvement Project (CLIP) in its instruction manual for Solomon Island cocoa farmers (CLIP, 2010, p. 83). Macfarlane (1985, p. 19) observed that where *W. auropunctata* had taken over cocoa plantations on Guadalcanal no damage from *Amblypelta*[190] was seen. While he noted that *W. auropunctata* appeared to be at least partially beneficial, he cautioned that further work was required before any absolute assurances could be made. There are a number of pests and diseases that affect cocoa production in the Solomon Islands[191] (CLIP, 2010). Further work is required to tease out the impacts of *W. auropunctata* on cocoa production.

[189] For example, tree age and a lack of successional planting, soil fertility, and a lack of infrastructure and transport services (Young & Pelomo, 2014).
[190] *Amblypelta* is also a significant pest of cocoa and can have a major impact on production (CLIP, 2010, p. 96).
[191] CLIP (2010) lists ten diseases, fungi, and stem, leaf, root and pod feeding insects for example.

By international standards cocoa yields in the Solomon Islands are low[192] (CLIP, 2010, p. 5; Vadnjal & Pelomo, 2014, p. 15) and this is considered to be the main challenge facing small-holders (Vadnjal & Pelomo, 2014, p. 25). These low yields are largely due to poor management (CLIP, 2010, p. 5)[193]. Evidence of this was observed during a field inspection with an official from the Ministry of Agriculture and Livestock who commented on the poor maintenance of cocoa growing in the Tenaru area (Field notes 11 May 2013). As illustrated in Box 6.1, and also from interviews with other cocoa growers, the presence of *W. auropunctata* is not preventing growers from working in their plantations, despite the annoyance it can cause. *Wasmannia auropunctata* therefore is unlikely to be the reason plantations are not being managed properly. A recent World Bank report on the Solomon Islands cocoa industry identifies a lack of husbandry services and support for growers as a cause of the low productivity (Vadnjal & Pelomo, 2014, pp. 24-25).

6.3.3 Impacts on other income-generating activities

As noted in Chapter 5 rural households in the Solomon Islands engage in a number of livelihood activities in order to derive income. One activity that *W. auropunctata* has the potential to impact on is chicken farming, as there are reports in the literature of them negatively affecting birds (Causton et al., 2005, p. 160; Danielsen et al., 2010, p. 105; Wetterer & Porter, 2003, pp. 23-24). Fasi (2009, p. 58) recorded that *W. auropunctata* blinded domesticated birds on Makira Island, which often led to their death.

Three small-scale chicken farmers were interviewed during the course of this study. The size of their operations varied from 1000 to 250 to 100 birds, and they had been farming chickens for 10 years, three years and six months respectively. The birds were brought as day old chicks from a wholesaler[194] and raised to six weeks before being slaughtered and sold in the central market, to members of their community, to mining companies or to catering businesses servicing such industries.

[192] Estimated yields are around 340 kg/ha in the Solomon Islands compared to an average of 550 kg/ha for the three largest cocoa producing countries (Vadnjal & Pelomo, 2014, p. 17).
[193] Also poor genetic stock (Vadnjal & Pelomo, 2014, p. 25).
[194] I approached the wholesaler for an interview but they were not interested in participating in the research.

Box 6.1: Livelihood Profile - Cocoa Small-holder

Mary and John* are a couple in their mid-20s. They have three children (two of whom are at school, the third is still a small baby). They live in a community of about 15 scattered households on the Guadalcanal Plains approximately 6km from the coast. An unsealed road leads to the main highway (around 5km away) where they are able to catch public transport into Honiara (SBD$10[β] each way per person). The community was settled around 50 – 60 years ago and the little fire ants arrived in the area in the 1980s, before Mary was born. She has known *W. auropunctata* all her life and observed that it was common all over the plants around the area. Mary and John are the registered owners of the land, which they use to grow cocoa. Cocoa production is their main livelihood activity. This is supplemented by growing food crops for the household and to sell in the market at Honiara once a week for which they earn SBD $200 - $300.

Both Mary and John work in the cocoa plantation and harvest the cocoa. *Wasmannia auropunctata* disturbs them during this work by stinging them on the body and in their eyes. When the ants fall into their eyes they have to wash them out with water and wait for the pain to ease before starting work again. Despite this discomfort the presence of the ants has not changed the way they work. They still maintain the plantation and harvest the cocoa pods every two weeks.

Their income from cocoa has increased due to the rising price of cocoa and through the expansion of their plantation to around four hectares. During the high season[§], revenue from their cocoa is more than enough to cover their household needs and expenses (such as school fees). During the low season they earn just enough to survive. At its peak they can collect eight to ten 20kg rice sacks full of cocoa[†] from their four hectares, which is sold as wet beans for between SBD$3 – 5 per kg, depending on the current price (HH male female: interview # 52).

*Not their real names.

β At the time of my research SBD $1 = NZ 0.16c

§The high season is from April to July. The low season is from October to January (CLIP, 2010, p. 79).

† A 20kg rice sack of wet cocoa beans would weigh around 35 to 37 kg.

Two of the farmers reported losses due to *W. auropunctata*. As one of the farmers explained:

> The chicken food, when it mixes with water it attracts the little fire ant. So when the chicken comes to the feed, the ants can crawl up on the body of the chicken and sting it. They start stinging the chicken and this affects the chicken (HH male: interview # 12).

The farmer explained that the young chicks are the most vulnerable with most of his losses occurring after restocking with day old chicks. As with the farmer in Box 6.2, no records were kept as to the extent of the losses. He did, however, note that his worst loss was around 100 birds and that the losses occurred frequently enough for him to put up his prices to SBD$90 for a 2kg bird in an attempt to cover this. The third farmer, the most recent entrant into this activity, stated they had yet to experience any losses due to *W. auropunctata*, even though the ant is present in the community. They are, however, aware that *W. auropunctata* can be an issue and clear the area around their chicken pen of leaf litter to stop the ants from moving into the area and establishing nests and from there invading the pen (see Photo 6.2).

Of greater concern to their livelihood was the importation of frozen chicken which had recently flooded the market (Mamu, 2013b), forcing them to drop their prices. These imports had resulted in local poultry farmers calling on the government to put a ban on the import of chicken because of the pressure it was putting on their livelihoods (Newter, 2013a). Newspaper articles at this time reported that 2kg of imported chicken, which was normally sold on a par with locally produced chickens at SBD$80, had recently been reduced to SBD$60 before slumping to SBD$44 (Mamu, 2013b) due to the glut. This situation had only recently occurred at the time I completed my fieldwork so the long term impacts on chicken farmers are unknown.

Photo 6.2: Small-scale village chicken farm. Note leaf litter is regularly swept from around the pen (piled bottom left) to prevent W. auropunctata from establishing nests near the pen.

Chickens are also kept in villages where they roam freely in a semi-feral state with little or no management. They are generally kept for use by the household rather than as an income source. Households regularly reported that *W. auropunctata* affected the eyes of the chickens, causing blindness. Young chickens, especially the newly hatched, were sometimes killed. Overall though, losses due to *W. auropunctata* were not considered to be much of a problem. However, this could have been due to the fact that the populations are not managed at all and so the true impacts on numbers are not known to the household. Bourke et al. (2006, p. 33) noted that mortality of chicks in these village situations was generally high anyway due to exposure, diseases and predation by dogs and hawks. Whether *W. auropunctata* plays a role in increasing the vulnerability of chickens to these effects[195] is unknown.

[195] For instance, partially blinded chickens being unable to see the approach of predators.

Box 6.2: Livelihood Profile – Chicken Farmer

Amongst the hustling throng of the Honiara central market sits Nancy* in a folding chair, two chilly bins of frozen chickens at her feet. Frequenting the market periodically on Thursdays, Fridays, and Saturdays, the contents of her chilly bins represent the main source of income for the household.

Nancy and her husband have three small children and operate a small-scale chicken farm on West Kola Ridge on the outskirts of Honiara. They have been farming chickens for three years. Starting with 50 chickens they have increased production over that period and are now feeding 250 birds. Their chickens are bought as day old chicks from a wholesaler in Chinatown for SBD$15 and raised to six weeks of age, when they are slaughtered and sold at the market for SBD$85. Depending on the demand and the availability of their chickens, she can sell 50 to 100 chickens over the three days she is at the market. Both Nancy and her husband work in the chicken farm (their children are still too small to help out) and the money that they earn is just enough to meet their household expenses.

Wasmannia auropunctata is present in the area in which they farm and Nancy believes that the population is increasing because she said it can be found everywhere now. The ants affect their chickens by stinging them in the eye causing them to go blind. Sometimes it's only one eye, sometimes it's both. Those that are completely blinded die because they cannot find their food. Others are stung on the body which causes irritating rash-like symptoms. This affects the behaviour of the chickens, making them aggressive and causing them to move around a lot in the pens, which in turn disrupts other birds.

Nancy does not know how many birds they lose to the ants - only that they do lose a few and that higher losses would impact on their ability to meet their household expenses. While they have not been controlling *W. auropunctata* to date it is something that she is considering: however, she is not sure where or how she can get information or help from (HH female: interview # 13).

*Not her real name

6.4 Impacts on Social Activities

As outlined in Chapter 3, livelihoods comprise more than just making an income; they include non-material or intangible aspects as well (see section 3.1). The livelihoods of people, and their well-being, are dependent on a range of interconnected capital and these can all be affected by the presence of invasive species either directly or indirectly. This section discusses the impacts *W. auropunctata* has on some of these other livelihood components.

6.4.1 Sexual relations

One social activity that *W. auropunctata* has had an impact on is sexual relationships. This sensitive subject was never raised directly with me during interviews and I never specifically asked the question[196]. However, following three of the focus groups, while we were having a cup of tea with the participants, my research assistant was approached discreetly by male participants who volunteered this information. Following one of these focus groups my research assistant recalled that:

> [one of the participants][197] said one of the activities commonly affected by little fire ants is in the past boys and girls use to date each other in the forest; that's common before. Nowadays, because of the abundance of the little fire ant, they are disturbing the people during those activities. He said now people who go on dating each other they do not like to go to places where it has vegetation because of the disturbance and stinging caused by the fire ants. So nowadays when people talk about dating they also talk about the fire ants in the bush. These days they avoid going on dates in the forest.

According to my research assistant, sexual relationships between young men and women on Guadalcanal are still strongly influenced by traditional moral values. Hogbin (1934, p. 244) observed within a community he was studying on Guadalcanal that while premarital sex was publicly considered wrong, there was, providing it was discrete, a degree of licence surrounding the practice. However, to be discovered in an 'intrigue' always caused a scandal resulting in a forced marriage or compensation having to be paid. This account is similar to the one told to me by my research

[196] I did ask if there were any social activities that were affected by *W. auropunctata.*
[197] My insert in order to retain anonymity of the participant.

assistant. While discussing the approaches made to him following the focus groups he stated that there were formal traditional practices that you had to follow if you wanted to go out with any girls. If you were caught doing otherwise, then you had to pay compensation. He noted that because of this it was common for boys and girls (and even older people) to discretely go out into the bush in order to spend time together. *Wasmannia auropunctata* impacted on these liaisons and he observed that it was a common complaint amongst young people and was considered a really serious issue for them.

6.4.2 Household impacts

Wasmannia auropunctata are not just a problem for people in the garden or the bush. They also cause a problem by invading houses, which affects people's well-being. One household issue is *W. auropunctata* getting into people's bedding and stinging them while they slept. One household head noted that while he could tolerate the ants when they fell on him in the bush, he was not at all happy with them when sleeping in the hut and they rained down on him from the roof. He said that *W. auropunctata* infested the thatch on the roof and when the wind blew it shook the thatch causing the ants to fall down on them (Field notes 11 May 2013). In a similar vein, they were also known to drop off the corrugated iron roofs during the heat of the day (HH male: interview # 11).

This issue of interrupting sleep was a source of complaint for many of those interviewed, with one interviewee observing that:

> It covers everywhere and you cannot sleep at night. It crawls over the beds when you sleep and it's painful when it bites, and you cannot sleep at night (NGO: interview # 63).

Others observed that:

> The fire ants crawl up the bed and stings you when you are sleeping. Especially if you do not clean your bed properly. Or if you lean against the wall you get stung by the ants (Focus group: interview # 64).

Keeping things clean helped keep the ants at bay. As one women noted:

> When you keep a lot of rubbish around the house they are going after the rubbish and from that they will go into the house. So they spoil people's…,

> disturb people during their sleep at night… The negative thing about the ants is that if you do not keep your house clean they will end up in your bed and in the house (HH female: interview # 17).

In an attempt to look on the bright side of things, participants during one focus group stated that:

> …the good side of it, it rids the bed bug …since there are no bed bugs annoying people at night (Focus group; interview # 42).

However, they had to concede that the cure was no better, if not worse, than the cause.

The search for food is what normally brings the ants into the house where "it attacks sugar, goods from the shop, the sweets" (HH male: interview # 4). Spencer (1941, p. 10) records that *W. auropunctata* can contaminate food and this was supported during a women's focus group where they observed that it "spoils cooked food… [and] sometimes they get sick by eating the food the ants have got into" (Focus group: interview # 65). Others also raised this issue during some of the household interviews.

Having the ants inside the house was also an issue for mothers taking care of babies. As one mother explained, it was normal practice to place babies on a mat on the ground while they did things around the house. She said the risk is that the babies get covered with the ants causing them to cry and become distressed (Field notes 21 August 2013). A similar problem existed for those infants sleeping. The participants of one focus group noted that you had to be really careful looking after babies, particularly making sure the ants did not get into their eyes. They claimed that

> when the baby cries in bed it has been bitten by the red ant. That's the usual suspect (Focus group: interview # 42).

Similar concerns were raised during the household and other focus group discussions. One women stating that

> the babies are most affected because it takes a long time for them to recover. When it stings the small babies you see the body is red. [For them] … the ant is a really serious problem (HH male female: interview # 53).

Another interviewee noted that you can tell when the babies are affected

> …by their skin. If you let them play on the ground, they get stung. They cry and you see the red marks (HH male: interview # 62).

While this meant for some that "babies cannot be put on the ground" (HH male: interview # 1), others noted that you just need to be conscious of the issue and that "you must sweep and mop the floor properly before the baby is laid down" (Focus group: interview # 65). All recognised that due to their vulnerability to *W. auropunctata*, care needed to be taken with infants.

Only through regular cleaning do most households minimise the impacts *W. auropunctata* has within the home. As one household head observed

> you must clean the house daily, sweep the floors to keep the red ants away (HH male: interview # 11).

While another noted

> to control the ant, you must keep the village clean, the home clean (HH female; interview # 17).

This task invariably fell to the women of the household as part of their normal daily activities.

6.5 Conclusion

Most Solomon Islanders live in rural areas where subsistence agriculture and small-scale income-generating activities play an important part of their livelihood strategies. *Wasmannia auropunctata* has been a longstanding feature of many communities and all know of its effects. Many Solomon Islanders have a *fait accompli* attitude to the ant, accepting it as part of the landscape, even though the ant does affect aspects of their livelihoods.

The ants' sting can be of considerable annoyance to people as they go about their daily activities; however, their presence has not prevented those activities from taking place. There were no reports of *W. auropunctata* having an economic impact or impacting on food security in households reliant on subsistence agriculture or small-scale income-generating activities. In fact, there was some evidence that certain sectors, such as coconut and cocoa producers, may well benefit from the presence of the ants as they control pests of economically important crops. Further research however is required to confirm this. While these potential benefits are accrued by some, the costs are borne by everyone; and for the majority these outweigh any potential benefits.

Although women were potentially more exposed to *W. auropunctata* because of the roles they perform in Solomon Island society, most of the impacts raised by people were gender neutral, such as being stung while asleep, or being stung in their eyes from *W. auropunctata* falling from overhead vegetation. By and large the main impacts reported were on non-financial capitals which influenced people's well-being. Overall though, there had been little or no change in livelihood strategies in the Solomon Islands as a result of *W. auropunctata*.

Chapter 7: Case Study 2 – The Impacts of *Achatina fulica* (Giant African Snail) on Rural Solomon Island Livelihoods

7.0 Introduction

This chapter covers the impacts *Achatina fulica* (giant African snail) are having on the livelihoods of Solomon Islanders. As with Chapter 6, it draws largely on the fieldwork component of my research. This chapter covers the arrival and distribution of *A. fulica* in the Solomon Islands, the official response to this incursion, and most importantly the effects *A. fulica* is having on the livelihood strategies practised by rural households in the Solomon Islands. Attention is also given to the way *A. fulica* has influenced the intangible components that make up livelihoods in the Solomon Islands. By illustrating how *A. fulica* interacts with rural livelihoods, this chapter seeks to contribute to the primary research question posed in Chapter 1.

7.1 Arrival and Distribution

Achatina fulica was first recorded in the Solomon Islands in 2006. It was initially discovered on Guadalcanal when workers at Earthmovers Company Ltd reported large numbers of an unidentified snail moving around their premises at the Ranandi industrial area in Honiara (SIDT, n.d.-a). Investigations by the Solomon Islands Agriculture Quarantine Services (SIAQS) identified the snail as *A. fulica* and found that the snail was already widespread and established in the area. Analysis of the age cohorts present indicated that *A. fulica* had probably arrived there as early as 2001 or 2002 (SIAQS: interview # 61).

While it cannot be confirmed with any certainty, the origin of the incursion was believed to be from Malaysia. The Ranandi industrial area was used by various logging companies as a landing and discharge area for overseas cargoes and logging equipment[198] from around 2000 to 2005. The majority of the logging companies using the site at this time were from Malaysia (SIAQS, 2008, p. 1). *Achatina fulica* have been established in Malaysia since 1911 (Mead, 1961, p. 11) and based on the

[198] For example, earthmoving machinery and vehicles such as bulldozers and trucks.

circumstantial evidence available this is considered by SIAQS to be the most likely pathway for its arrival into the Solomon Islands.

A second incursion occurred in 2010 at the Solomon Islands' second international port in Noro[199], when used machinery brought in from Bougainville[200] was infested with *A. fulica*. Fortunately, Quarantine officials were quickly alerted to the issue and were able to eradicate the population before it became too widespread (SIAQS: interview # 60).

Since its arrival in the Solomon Islands, *A. fulica* has been in a rapid expansion phase in both numbers and distribution and can now be found in several locations (see Table 7.1 and Map 7.1).

Table 7.1: Known Location of Achatina fulica in the Solomon Islands

Province	**Location[201]**	**Source**
Choiseul	Choiseul	SIAQS: interview # 60
Guadalcanal	Honiara (Burns Creek)[202]	SIAQS: interview # 60
	Honiara (Chinatown)	SIAQS: interview # 60
	Honiara (Chinatown no.3)	SIAQS: interview # 60
	Honiara (Feraladoa)	SIAQS (2008, p. 2)
	Honiara (Fijian Quarter)	SIAQS: interview # 60
	Honiara (Gwaimaoa)	SIAQS: interview # 60
	Honiara (JBM)	SIAQS: interview # 60
	Honiara (Koa Hill)	SIAQS: interview # 60
	Honiara (Kola'ale)	SIAQS: interview # 60
	Honiara (Mbokonavera)	SIAQS: interview # 60
	Honiara (Namoliki)	SIAQS: interview # 60
	Honiara (Nggossi)	SIAQS: interview # 60
	Honiara (Panatina)	SIAQS: interview # 60
	Honiara (Ranandi)	SIAQS: interview # 60
	Honiara (SINU)	SIAQS: interview # 60

[199] On New Georgia Island in the Western Province.
[200] *A. fulica* have been present in Bougainville since 1970 (Mead, 1979, p. 10)
[201] Locations are approximate only as SIAQS does not hold complete records. There has been no delineation of the incursion boundaries by SIAQS at each of these sites so it is unknown how widespread *A. fulica* is at each location. For instance, SIAQS assumes that *A. fulica* now covers the area from Foxwood to Honiara (SIAQS: interview # 61), but interviews with households around Alligator Creek near the Henderson Airport indicated that *A. fulica* is yet to spread into that area (HH male: interview # 62; HH male: interview # 1). This list is also likely to be incomplete as SIAQS does not undertake active surveillance for *A. fulica*. Additionally, media reports following the 2014 flooding on Guadalcanal stated that flood waters had spread *A. fulica* to new areas on the Guadalcanal plains (SIBC, 2014).
[202] The name in brackets denotes a community within Honiara.

	Honiara (Skyline)	SIAQS: interview # 60
	Honiara (Vara Creek)	SIAQS: interview # 60
	Honiara (Varamata)	SIAQS: interview # 60
	Honiara (White River)	SIAQS: interview # 60
	Foxwood/Okea	SIAQS: interview # 60
	Ghoroboko	SIAQS: interview # 60;
	GPPOL 1	SIAQS: interview # 60
	GPPOL 3	SIAQS: interview # 61
	Henderson	SIAQS: interview # 60
	Lungga	SIAQS: interview # 60
	Ndoma	SIAQS: interview # 60
	Poha/Mamara	SIAQS: interview # 60
Isabel	Isabel[203]	SIAQS: interview # 60 & 61; Zoleveke (2014)
Makira-Ulawa	Makira[204]	SIAQS: interview # 60 & 61
Malaita	Auki[205]	Ekotani (2014, 20 June)
Western	Noro[206]	SIAQS: interview # 60 & 61
	Ghizo[207]	Pagepitu (2015)

While confined largely to the north coast of Guadalcanal there are reports of *A. fulica* reaching other islands within the Solomon Islands (SIAQS: interview # 60; Ekotani, 2014, 20 June; Pagepitu, 2015). The distribution of *A. fulica* within the Solomon Islands has largely been human assisted, both intentionally and unintentionally. One of the main pathways to date is via the movement of machinery from infested sites to new sites; *A. fulica* either hitching a ride attached to the equipment or as eggs in soil attached to the machines. The arrival of *A. fulica* at Feraladoa[208] and Foxwood[209] can be traced back to the movement of machinery from Ranandi to these sites (SIAQS, 2008, p. 2). Likewise, reports of its presence on other islands within the Solomon Islands has invariably been linked back to the movement of machines, largely connected with the logging industry, from Ranandi (SIAQS: interview # 60).

[203] SIAQS staff indicated during an interview in 2013 that this incursion had been eradicated (SIAQS: interview # 61). However a subsequent news article quotes SIAQS staff as confirming that *A. fulica* has reportedly been seen in Isabel province in recent times (Zoleveke, 2014).
[204] SIAQS staff indicated during an interview in 2013 that this incursion had been eradicated (SIAQS: interview # 60).
[205] This is a new incursion that has occurred subsequently to my fieldwork. Media reports state that the snails arrived in machinery from Honiara (Ekotani, 2014, 20 June).
[206] SIAQS staff indicated during an interview in 2013 that this incursion had been eradicated (SIAQS: interview # 60 & 61).
[207] This is a new report that has occurred subsequent to my fieldwork.
[208] A settlement within Honiara.
[209] A group of communities approximately 11 kilometers East of Honiara.

Infrastructure development is another area of concern regarding the spread of *A. fulica* within the Solomon Islands. For instance, the construction of telecommunication towers by Solomon Telekom [sic] throughout the islands has resulted in some new incursions. In addition to the machines used, gravel taken from Honiara for use on these sites has also sometimes contained snails, resulting in new infestations (ibid).

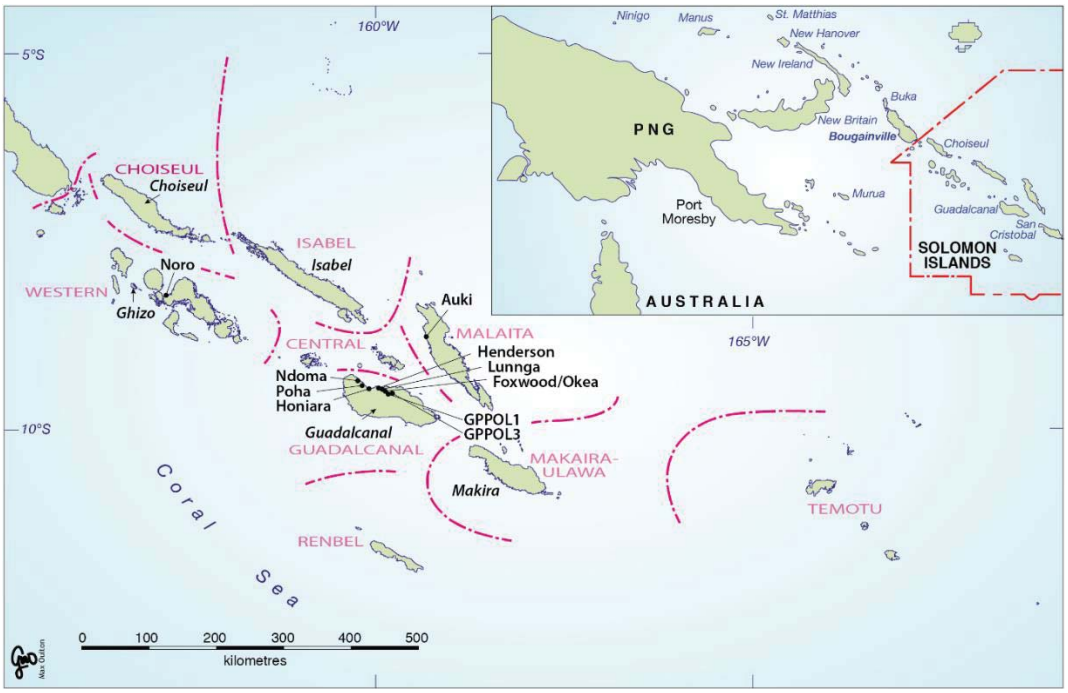

Figure 7.1: Map of the known locations of Achatina fulica in the Solomon Islands (Source: Max Oulton, Waikato University, New Zealand).

During interviews with households in Poha and Mamara[210] all the respondents told of how *A. fulica* arrived when work was being conducted on the highway bridge. As one women explained:

> They came with the big machines: bulldozers, excavators, loaders that came and worked on the bridge. That was where they usually left the machines [points to an area nearby where the machinery was parked up each night]. It spreads from there because we did not have them before the machines came here (HH female: interview # 56).

[210] Two adjoining communities approximately four kilometers West of Honiara.

Similarly, a farmer at Henderson[211] reported *A. fulica* arrived at his location when a construction company from Honiara placed a shipping container infested with the snail on the roadside outside his property (HH male: interview # 39).

Human-assisted movement of *A. fulica*, however, has not always been unintentional. As a SIAQS official explained:

> The reason why it spread to some parts of Guadalcanal is because there was a newspaper report saying that it was good for feeding pigs. So [people] collected it from Honiara and they took it out [to their communities] (SIAQS: interview # 60).

At Toghasui[212] it is believed that *A. fulica* were deliberately brought to the area and dumped near the road bridge which crosses the Ngalimbiu River (HH female: interview # 66), causing one resident to lament that "we ourselves, destroy ourselves" (Community walk-through: interview # 67). *Achatina fulica* are now established on both sides of the river downstream of the bridge[213] (Field notes 11 November 2013).

While the primary agent of dispersal of *A. fulica* is humans, once established in a location they also disperse naturally. Studies report a range of dispersal rates, which tend to be in the order of hundreds of metres per annum (for example see GISD, 2010; Venette & Larson, 2004, p. 15). This, however, can be increased by natural events such as floods. Mead (1961, p. 97) notes that *A. fulica* can survive long periods of immersion in fresh water[214] which permits the snail to survive flood events and colonise new areas. Such a situation occurred during the April 2014 flash floods on Guadalcanal[215]. Following this event, it was reported that flood waters had spread *A. fulica* to new areas on the Guadalcanal plains; to the determent of residents living there (SIBC, 2014). How *A. fulica* affects the livelihoods of rural communities in the Solomon Islands is discussed in sections 7.2 to 7.4 below.

[211] An area to the East of Honiara, where the international airport is situated.
[212] A community approximately 20km East of Honiara on the Guadalcanal plains in the GPPOL-1 area.
[213] *Achatina fulica* are also present upstream of the bridge at Ngalimera. It is unknown if they have moved up from the bridge incursion site, or whether they have spread naturally from the Okea area at Foxwood.
[214] Up to 24 hours or more (Mead, 1961, p. 97).
[215] Three days of heavy rain from a tropical depression (which later became Cyclone Ita) caused severe flooding in the Solomon Islands; killing 22 and displacing over 50,000 people (UNOCHA, 2014).

7.1.1 Official response to the arrival of Achatina fulica

Following the initial discovery of *A. fulica* in 2006, control measures by SIAQS focused on the Ranandi industrial area, with a range of measures put in place. These included baiting with toxins, the application of salt water spray, hand picking, awareness programmes, restricted movement of machinery and the establishment of wash-down and cleaning facilities for machinery (SIAQS, 2008, p. 3). This, however, did not prevent the spread of *A. fulica*, with satellite populations becoming established[216]. Effective control of the initial spread of *A. fulica* was hampered by budget and capacity constraints. For example, at Foxwood the initial control programme involved hiring members of the local community to clear the vegetation throughout the area, which was then hand broadcast with toxic[217] baits by SIQAS. This technique,

> worked very well with the community. But [then] there's no more funds [so] we stopped. And in the meantime the breeding continues, the population increases. Then we got the money again [and] the work starts again…, [but] the next time we go out to work we have to extend the boundary. So it goes on like that. Until we come up with no more resources. (SIQAS: interview # 60).

The lack of sustained resources meant that any gains made were quickly lost once control ceased. By the time work started again the *A. fulica* population had not only increased but had dispersed further; eventually reaching a point that was too big to manage effectively with the limited resources available. The problem at this point was then largely left to the community and individual households to self-manage.

Finance and capacity[218] are still the major issues for the SIAQS in dealing with *A. fulica* (SIAQS: interview # 60 & 61). While the Solomon Islands Government has ramped up its funding of this organisation, it still falls a long way short of what is required. The SIAQS 2013 budget was SBD$2 million for all pests. Of this, two thirds was spent on *A. fulica* alone[219] (SIAQS: interview # 61). SIAQS estimate that effective management of *A. fulica* in the Solomon Islands would require around SBD$10

[216] The Feraladoa population had already become established before measures were taken to stop their spread. The Foxwood population was established soon after measures were implemented (SIAQS, 2008, p. 2).
[217] Containing the chemical metaldehyde.
[218] Both technical capacity (i.e. specialist planning and advice) and numbers of staff available.
[219] Nothing is spent on *W. auropunctata.*

million per annum, on an ongoing basis (ibid). This cost is only likely to increase as *A. fulica* extends its range across the country.

Working within a budget means prioritising responses, and this is reflected in SIAQS' current approach to *A. fulica* in the Solomon Islands. The primary focus of SIAQS is on awareness within the high risk industries/pathways which are most likely to see *A. fulica* being transported to the other provinces[220]. There is no active surveillance for *A. fulica* by SIAQS so the identification of new incursions in the provinces relies on public/industry feedback. As such, awareness programmes form a large part of the current approach. There are also no emergency response funds available to address any new incursions in the provinces, should they be identified (SIAQS: interview # 60). Therefore, control of any new incursions requires SIAQS to work closely with industry to assist with funding and logistics to ensure an adequate response is implemented (ibid).

The need to prioritise nationally, however, comes at a cost locally. The focus by SIAQS on preventing the establishment of *A. fulica* in other provinces has left a void on Guadalcanal with communities largely being left to their own devices to deal with the situation. This has created a feeling of abandonment in some communities:

> Our Government has done nothing, even Quarantine, they have done nothing (Focus group: interview # 22).
>
> When the snail came [Quarantine] just came and said a few words. Then they thanked the Chief and went away and they never came back again. …It's like a culture of neglect, they just neglect us. You know, [well maybe] not neglect, but they just do not worry about us (Focus group: interview # 18).

The shift to a national focus and the lack of capacity within SIAQS to maintain a liaison with local communities has left the impression within these communities that nothing is being done by the government. SIAQS is the only government agency working on *A. fulica*. Some local NGOs[221] working on food crops/food security in the Solomon Islands provide some advice about the snail; however, this only extends to

[220] Such as the logging industry moving machinery out of the Ranandi industrial area in Honiara.
[221] For example, Kastom Gaden Association.

those communities/farmers working directly with the NGO[222]. None of the communities interviewed during this study were involved with these organisations[223].

Awareness programmes are running on Guadalcanal, and this is the main focus of SIAQS in this province. These awareness programmes consist largely of information pamphlets/posters (Photo 7.1), radio and newspaper articles. The primary message is around self-help. However, the messages SIAQS are promoting are not getting through to a lot of rural communities. An example of this is that of SIAQS providing free snail bait to households affected by *A. fulica*.

> SIAQS: We have the baits. People are responsible to get the baits, it's free. And this has been said through the radio. And some people are doing it. [But] some people are not. They will just sit there, they will want somebody to drive [out] and throw [the baits around]. It's not our responsibility [to do the control], it's your responsibility. If you are responsible for your income and your livelihood you should do something. Do not just sit there and wait [to be] spoon fed. It's an attitude [here], it's…
>
> Dean: Frustrating?
>
> SIAQS: Yes. We are providing a service, but we do not have to spoon feed everyone (SIAQS: interview # 60).

Many of the households I spoke to, however, were unaware that they could get free baits from SIAQS. What was perceived by SIAQS as an attitude problem and a lack of self-responsibility was, for a number of households, just a lack of access to awareness information.

[222] The 2013 SIG RAMSI People's Survey (ANU, 2013, pp. 48-50) notes that only 11% of respondents (men twice as likely than women) received agricultural information of any type from agricultural extension services and less than 3% from all other sources such as NGOs like Kastom Gaden Association.

[223] Forty-seven percent of respondent in the 2013 SIG RAMSI People's Survey (ANU, 2013, pp. 48-50) said that they do not receive any agricultural information, with respondents from Guadalcanal the most likely to say they had never received any information (ibid.).

Photo 7.1: A SIAQS Achatina fulica awareness poster (Source: SIAQS)

My research assistant noted during a discussion on awareness with one household that many people in rural villages do not have access to radios[224], so this medium was not ideal for accessing rural communities. Similarly, with newspapers. Only those in Honiara had regular access to them.[225] A better option for these areas may have been an announcement at the local church service or, as my research assistant noted, a physical visit to the village;

> When you get a village like this people would say, ah there's a group coming. We'll go and listen to what they are here [for]. Even if they do not know why they are [coming] they would [still] come and see this group and be willing to listen (Research assistant *in* HH male: interview # 3).

Other than in the Foxwood area, where some face to face awareness had been conducted on SIAQS' behalf by a local NGO[226], many of the households I interviewed had not come across any awareness regarding *A. fulica*. For those that had, the information was inadequate.

> Dean: Has anyone been here to talk to you about the snails?
>
> Reply: Not yet. [I] just heard it on the radio. No one goes around.
>
> Dean: Is there a lot of media about the snails?
>
> Reply: Not really.
>
> Dean: Has there been enough information?
>
> Reply: It's better to go out like you two are doing[227]. Listening to the media is just listening. We want someone to face [us in person] and explain what it is, how it can destroy things, things like that (HH male: interview # 51).

[224] The 2013 SIG RAMSI People's Survey notes that only 13% of respondents on Guadalcanal did not have access to radios (ANU, 2013, p. 65). Importantly though, only 35% of respondents from Guadalcanal said they could listen to SIBC any time, with 51% only being able to listen sometimes due to poor reception. More than 13% had no SIBC reception (ANU, 2013, p. 62) (FM broadcasts were 6%, 12% and 80% respectively) (ANU, 2013, p. 64). Of more importance is that the survey found that "men and young men were noticeably more likely than female respondents to say they could listen to SIBC in their community, which suggests that male respondents had better access to radios" (ibid., p 62).

[225] I would buy a newspaper before travelling by bus to and from the rural villages to conduct my interviews. On a number of occasions, this was passed around the bus because newspapers were not readily available in rural areas.

[226] And even here some of the messages, such as the free bait, were not getting through to all households.

[227] Referring to the household visits my research assistant and I were doing. Many of the households thanked us for our visit and said that we were the first people ever to come and talk to them about invasive species and the issues that these were causing them.

As noted above, SIAQS has attempted to address this through contracting a local NGO to undertake awareness programmes in local communities on Guadalcanal[228] (SIAQS: interview # 60). In practice however, this has only occurred in the Foxwood area to date. For many communities, little or no information on how to manage this issue is getting through to them, which reinforces their sense of abandonment by the Government.

Awareness on its own though is not enough. Even with knowledge of the problem and what to do, many households are struggling with the impacts *A. fulica* are having on their livelihoods (see Box 7.1 for example). These livelihood impacts are discussed further in the sections below.

7.2 Impacts on Subsistence Agriculture

As discussed in Chapter 5, the growing of crops, either for subsistence purposes or as an income-generating activity, is a common livelihood strategy for many rural households in the Solomon Islands. The arrival of *A. fulica*, has placed this livelihood strategy at risk due to its significance as a crop pest. The remainder of section 7.2 looks at the impacts *A. fulica* is having on rural households reliant on vegetable gardens for their livelihoods in the Solomon Islands. This is further broken down into the impacts *A. fulica* have on gardening activities, and their impact on garden productivity. As was the case in Chapter 6, both subsistence agriculture (i.e. the growing of vegetable crops to feed the household - pillar one of Figures 5.2 and 5.3) and the growing of vegetable crops for income (pillar two of Figures 5.2 and 5.3) are discussed together, due to the intertwined nature of the two practices.

[228] This NGO has produced some good awareness material, including a comic book in Solomon Island pijin and use of a theatre group to promote awareness messages to villagers. However, it has also created a lot of false expectations regarding the control of *A. fulica* within the communities it has presented to. This was evident in many of the household interviews I conducted where there was a strong belief that a bounty system would be implemented which would solve the problem. As Wilson (2008, p. 3) notes, "bounties are mostly a problematic tool in pest management and represent a poor return on investment compared to other available control measures". Interviews with SIAQS indicated that this method, while discussed during planning with the NGO, had not been subsequently approved (SIAQS: interview # 60 & 61). This inconsistency between the message communities were getting from the NGO and the realities of what SIAQS was committing, or not committing to, meant that from the communities' perspective promises were not being delivered. This only added to the communities' belief that the Government was neglecting them.

Box 7.1: Livelihood Profile – Henry's Story

Henry* lives with his wife and four school-aged children in a small, six household rural community on the Guadalcanal Plains, east of Honiara. Nowadays they make their living by selling betel nut, coconut and cigarettes in a roadside stall not far from their home. Money is very tight. Profits from the stall are used to buy food for the household but earnings are irregular and there are days when they have little to eat. Their gardens produce next to nothing and even the wild foods they collect to supplement their diet is becoming increasing hard to find; all due to the presence of *A. fulica*.

Henry was born in the area and is a traditional landowner. Before the snails arrived here in 2010, Henry's livelihood was typical of many rural Solomon Island households. The family had large established gardens, which Henry estimates were around 100m x 100m in size. The gardens not only fed the household but they also provided income from the surplus sold at the central market in Honiara. Additional income was earned from their cocoa and coconut trees. Then *A. fulica* arrived.

At first Henry and his family attempted to control the snail by using salt and by hand picking and burning them in fires; but they multiplied too fast and soon their gardens were overrun and their crops destroyed. Garden sizes have since decreased dramatically to around 10m x 15m, as larger gardens are impossible to control. These gardens no longer support the household, let alone provide any income. Cash crops have also taken a hit. *Achatina fulica* have invaded Henry's cocoa trees, where they eat the flowers, thus preventing fruiting. Henry estimates that his cocoa production has fallen by 80% since the snails arrived.

The presence of *A. fulica* means that Henry's previous livelihood strategy, a mainstay for the vast majority of rural Solomon Island households, is no longer viable. This has forced him to turn to alternative, and less profitable, livelihood strategies in an effort to support his family (HH male: interview #36).

*Not his real name.

7.2.1 Impacts of Achatina fulica on gardening activities in the Solomon Islands

The primary influence *A. fulica* has on gardening activities is via its effects on labour. One labour intensive job, directly attributed to *A. fulica*, is its control and management. *Achatina fulica* is currently in its initial rapid expansion phase in the Solomon Islands. All households affected by this snail reported that its numbers were steadily increasing. *Achatina fulica* can reach sexual maturity in five to eight months under field conditions (Raut & Barker, 2002, p. 68). Given that one snail can potentially lay up to 1800 eggs per annum[229] (ibid, p. 72), it only takes a few to survive and reach maturity to ensure an ongoing additional workload for those involved in the control and management of *A. fulica* in their gardens.

Mead (1961, p. 98) observed that for subsistence farmers, hand picking and destroying *A. fulica* was the most effective and inexpensive method available. As such, he noted that this method was being applied far more often than any other around subsistence gardens. He also observed that:

> Because the eggs and young are easily overlooked and because of the tremendous reproductive potential of these snails, the task of collecting resolves itself into an indefinite, daily harvesting (ibid, p. 99).

This ceaseless daily toil of managing the snail problem in subsistence gardens was highlighted during a garden visit I undertook. During this visit the woman showing me around her garden pulled back some tomato plants to expose numerous juvenile *A. fulica* (Photos 7.2 & 7.3). The sheer numbers exposed in such a small area highlighted the scale of the problem she had to deal with. It also emphasised the difficulty involved in managing the problem and reinforced Mead's point of how easily the eggs and young could be overlooked.

[229] Raut and Barker (2002, pp. 71-72) cite a number of studies where *A. fulica* fecundity ranges from 100 up to around 1800 eggs annually depending on the age class of the snail.

Photo 7.2: Juvenile Achatina fulica beneath tomato plants (which have been pulled back to reveal their presence) in a subsistence garden on the Guadalcanal plains. The hashed box indicates one aggregation consisting of over 100 snails and is shown enlarged in Photo 7.3 below. Note the size of the foot in the top left corner of the photo as an indication of the size comparison.

Photo 7.3: Enlarged area from Photo 7.2 showing juvenile Achatina fulica which have clustered together beneath tomato plants in a subsistence garden on the Guadalcanal plains.

Although dismissive of "…the tall tales which liken *A. fulica* to a plague of migrating locusts" (Mead, 1961, pp. 58-59), Mead acknowledges that in localised areas, under favourable conditions, damage by the snail can be near absolute (ibid, p. 59). He further notes that:

> A *not uncommon* example of this is found in the small, unprotected, [subsistence] garden plot surrounded by snail infested bush. The first rains after the dry season may cause the snails to come out of estivation, move into the garden plot en masse and virtually clean it out overnight. But even under these conditions the alert [subsistence farmer] can anticipate this damage and take effective steps to reduce it very considerably (ibid – my emphasis).

What Mead does not consider is that for the subsistence farmer, whose situation he so lightly describes, 'effective steps' can be a very labour intensive process and add to what is an already considerable workload; particularly for women.

As indicated earlier, the primary method of control for many of the households interviewed during this study, was the hand-picking of snails[230]. This was a job which, although not exclusively so, often fell to women due to their primary gardening roles.

> For us, the women usually work in the gardens. We men also do gardening, but we usually clear the harder parts and then the women do the rest. They feed the family. They have most of the concern for the snail (HH male: interview # 44).

Many of the women spoken to said that collecting snails was now part of the gardening routine. As one explained, she now regularly spent up to one hour each morning checking her vegetable garden for *A. fulica*. This she said was additional work to the routine she practised before the snails reached the village (HH female: interview # 58). Another described how she also spent each morning collecting *A. fulica* from her garden and burning them in a fire (HH female: interview # 25 – Photo 7.4). As she showed me around her garden she recalled that when she first started collecting the snails the other women laughed at her. She said that they stopped laughing a few days later once the snails had spread into their gardens as well (Community walk-through: interview # 23).

[230] Which were then usually thrown into a fire or put in bags and left in the hot sun to die.

Photo 7.4: One morning's collection of Achatina fulica from a small subsistence garden measuring approximately 25m x 10m on the Guadalcanal plains.

During another interview, a woman explained that each time she went to the garden she spent up to three hours collecting snails (HH female: interview # 16). While for another:

> In my experience, … in the morning when I go to the garden to do my job …I find the snails there. So instead of doing my [gardening] I start collecting them. So it [interrupts] me from doing my job. So I keep busy with that and it ends up [that] in the evening I come back without doing anything that day. Sometimes I just spend the whole day picking up those snails (HH female: interview # 55).

Men also recognised the threat *A. fulica* posed, mentioning the need to constantly monitor the garden. One interviewee noting that

> If you want the crops to bear fruit, you have to check and clean the garden [of snails] in the morning, during the day and at night (HH male: interview # 24).

This practice of constantly monitoring the garden not only requires more labour, it has also changed traditional gardening practices;

> Before, during the times of our fathers and grandparents, they would just go and work in the morning. But now we have to keep on checking the garden all day. Not just in the morning. Today we have to check it regularly during the day. We have to monitor the garden in the evening, when the sun is down and it's cooler (HH male: interview #15).

Another control strategy that some are practising is the clearing of ground around the gardens to act as a barrier to slow down the spread of *A. fulica*. Clearing out additional ground around the garden however is "…extra hard work…" (HH female: interview # 56) for those involved. Other households have cut (brushed) and burnt areas of vegetation, such as along roadways, in an effort to slow down the spread of *A. fulica* (Photo 7.5). Reducing the vegetation cover opens the area up to sunlight making the habitat less suitable for the snails. As one man explained to me:

> Man: You have to do some extra precautions. Get the boys to brush the road [and] do the cleaning up around the area.
>
> Dean: So that's all extra work you have to do?
>
> Man: Yes (Community walk-through: interview # 67).

Raut and Barker (2002, p. 84) note that such strategies have long been practised in other parts of the world as a control mechanism for *A. fulica*. These techniques, however, are only temporary measures and on their own have not prevented the spread of *A. fulica* into vulnerable garden areas.

Very few households interviewed were using toxins to control *A. fulica*. At over SBD$2000 per 20kg bag from shops in Honiara (HH male: interview # 66), purchasing bait was beyond most households. While snail baits containing metaldehyde were being made available for free by the SIAQS, many households were unaware of this, as noted above, despite the awareness programme conducted by this agency. Also, for those that were making use of the free baits, fluctuating supplies meant that control was sporadic and not sustained. This meant that any gains made were quickly lost once the bait was no longer available for application.

Photo 7.5: Brushing and burning of vegetation along the roadside in an attempt to reduce snail habitat and limit their spread into areas on the right hand side of the road, which was still largely snail free.

In sum then, the arrival of *A. fulica* in the Solomon Islands has created additional workloads for rural households. Women have borne a large proportion of this increase due to the roles they perform in both the home and the garden. The high numbers of *A. fulica* means that a lot of effort has to be put into their control and management by rural households when the snail arrives in an area. This is required in order to protect vulnerable garden sites, which form a crucial part of many rural livelihoods. The impacts *A. fulica* have on garden productivity are discussed in the following section.

7.2.2 Impacts of Achatina fulica on garden productivity in the Solomon Islands

All rural households interviewed in areas where *A. fulica* had established were unanimous in declaring that the snails' herbivory had affected their garden productivity to some degree. The levels of loss generally reflected the level of infestation and the length of time *A. fulica* had been in the area. For these affected communities, the impact *A. fulica* was having on food security was a significant concern (NGO: interview # 41; SIDT n.d.). With a reputation as a voracious herbivore

(Raut & Barker, 2002, p. 78), *A. fulica* can have major impacts on the productivity of subsistence gardens.

Photo 7.6: Achatina fulica damage on eggplant and tomato in a subsistence garden, East Guadalcanal plains.

In their synopsis of *A. fulica* as a pest of tropical agriculture, Raut and Barker (2002, p. 78) observed that the "production of some crops has proved unsustainable in certain [*A. fulica*] infested areas". This is certainly the case for parts of the Guadalcanal plains. For instance, during interviews with households in the Foxwood area, one household head described which crops he was no longer able to grow because of the snails.

> HH Head: No more potato[231], no more melon, no more beans…, no more planting of Chinese cabbage[232].
>
> Dean: So what are you growing now?
>
> HH Head: I only plant cassava (HH male: interview # 31).

One of his neighbours supplied a similar list.

[231] Sweet potato or kumara (*Ipomoea batatas*). Locals used all three terms to describe this plant.
[232] Bok-choy (*Brassica rapa* var. *chinensis*). Locals used both terms to describe this plant.

> Slippery cabbage[233], tomato, pepper, Chinese cabbage, cucumber, everything. Now no more (HH female: interview # 29).

Even in communities where *A. fulica* was a more recent arrival, households were reporting the inability to grow certain crops.

> We use to plant cabbages, [but] we are no longer planting those crops here now (HH female: interview # 16).
>
> The snail invades the slippery cabbage and eats all the leaves. So we no longer plant slippery cabbage (HH female: interview # 56).

Jansen et al. (2006, p. 58) note that in the Solomon Islands slippery cabbage[234] is a major food crop and is an important leafy green consumed by the household. Not only important for household nutrition, this plant is also an important crop for income, being sold in many rural and urban markets. Although affected by other pests, *A. fulica* is compounding this impact and is placing additional pressure on this important crop; affecting not only food security but also household income-generating opportunities.

Another important crop affected by *A. fulica* in the Solomon Islands is the sweet potato or kumara.

> Before we used to plant all sorts of crops like kumara. Now we do not plant kumara anymore because the snails eat it (HH male: interview # 21).

Sweet potato is the most important staple food cultivated in the Solomon Islands. It is extensively grown, with almost all rural households planting it (Jansen et al., 2006, p. 53; Woodley, 2002, p. 263) (Photo 7.7 and 7.8). Sweet potato has been severely affected in areas infested with *A. fulica*, with extensive damage being reported by those still trying to grow it (Photo 7.9 and 7.10). For example, households reported that

> Most of the crops we plant, especially the kumara, will be destroyed by the snail (HH male: interview # 39).
>
> For the kumara, the snails chew up the vine and the leaves (HH male, female: interview # 45).
>
> All the kumara, they only have vines but no leaves (HH male, female: interview # 55).

---

[233] Slippery cabbage (*Abelmoschus manihot*) is a branched shrub up to 2m or more high. The young leaves, which are cooked and eaten, are slimy unless steamed or fried. It is a very nutritious plant (French, 2010, p. 67).

[234] Jansen et al. (2006, p. 58) use the term slippery kabis to describe this plant. I have followed the nomenclature used by French (2010) in *Food Plants of the Solomon Islands*.

Even the tubers were not safe, with *A. fulica* burrowing into the ground after these.

> Even food crops like kumara, they can go under the ground and eat up all the [tubers]. When you go to dig, if you pull the vine, the snail comes out (HH male, female: interview # 53).

With such an important crop vulnerable to *A. fulica*, the food security of many rural households has been significantly threatened.

Because of the impact *A. fulica* was having on garden productivity, some households reported suffering food shortages.

> I just get a small proportion of what I plant. Everything goes to the snail and only a little bit to me (HH female: interview # 25).

Worst off were the households that, before *A. fulica* arrived, were totally reliant on growing vegetables for food and income.

> Some [people] rely entirely on their vegetable gardens. They [are] affected more than the guy who drives the taxi, or the bus. People who plant their vegetables and use them for marketing, they probably have more sleepless nights than those of us that are driving. There are a lot of people like that here (Focus group: interview # 18).

These households have had to try and find alternative income sources in order to buy food. This has proved to be a struggle as the women of one community explained to me:

> Focus Group: What [we] do now is we go and buy crops or betel nut from other places and resell it at the stalls. Or we make buns, bakery, and sell them at the stalls on the side of the road.
>
> Dean: So because you have to buy your food now, are you able to earn enough at the market to cover that?
>
> Focus Group: It's not enough. Every day we try our best to earn a bit of money just for lunch, dinner. If you cannot sell anything that day – no food. (Focus group: interview # 19).

Other households also reported that since the arrival of *A. fulica* there were days that they now went without food if they were unable to earn enough.

Photo 7.7: Sweet potato grown in an area free of Achatina fulica, East Guadalcanal plains.

Photo 7.8: Sweet potato grown in an area free of Achatina fulica, East Guadalcanal plains. Newly planted mounds bottom left.

Photo 7.9: Defoliated sweet potato in an Achatina fulica infested garden, East Guadalcanal plains.

Photo 7.10: Defoliated sweet potato in an Achatina fulica infested garden, West Guadalcanal plains.

Many households reported that *A. fulica* had had a serious impact on the income they earned from marketing vegetables. During a garden visit with two women interviewees, one explained that

> Before I earned money from marketing, the selling of crops. Now the snail eats up everything. So the money I earn is just enough to buy a packet of rice and a few other goods. Just for daily survival – not like before (Garden walk-through: interview # 23).

In the worst affected areas people had stopped marketing altogether. Even in areas where the snail has been present a short time[235], incomes from marketing were on the decline.

> HH: In the past, we used to go to the market three times a week and earned SBD$200-$300 [a day], which we used for food. But nowadays, since [the snail] we only go one day. Now we only have money from that one day's marketing for survival, for food and basic needs.
>
> Dean: So your income has dropped by about two thirds?
>
> HH: Yeah (HH male, female: interview # 55).

For those households yet to feel the financial effects, what they have seen happening to their neighbours and other communities is of grave concern to them.

> This year is ok, but I do not know what will happen next year and the following year. I am worried about the problem and do not know who is going to come and help (HH female: interview # 56).

As discussed in section 7.1.1.1, this feeling of being on their own was a common theme amongst the communities affected by *A. fulica*.

7.3 Impacts on Small-scale Income-generating Activities

As outlined in earlier chapters, small-scale income-generating activities in the Solomon Islands are dominated by cash crops such as coconut and cocoa, and the marketing of fresh garden produce. As the impacts of *A. fulica* on growing and marketing fresh vegetables is covered in section 7.2 above, this section focuses on the impacts *A. fulica* has on some of the other income-generating crops[236] grown by rural

[235] For around two plus years.

[236] Many of these are also grown for household use as well, which reflects the intertwined nature of these two practices.

households in the Solomon Islands. Since little control is carried out by households outside of the garden area, these impacts largely reflect the effect *A. fulica* has on crop productivity.

7.3.1 Coconut

As described in section 6.3.2.1, coconuts are the most widely grown cash crop in the Solomon Islands and are a significant contributor to rural livelihoods. Mead (1961, p. 42 & 52) notes that coconut is not damaged by *A. fulica* and that the snail is not a threat to this crop. This was supported from the interviews in this study. Although *A. fulica* utilises the tree for shade and can be present in large numbers, no households growing coconut reported any impacts on this crop due to *A. fulica*.

7.3.2 Cocoa

Cocoa is widely grown in the Solomon Islands, including those places containing *A. fulica*. While all households growing cocoa in these *A. fulica* areas reported that the snail was present in their cocoa trees (Photo 7.11), only growers in the Foxwood area, where the snail had been the longest[237], reported any losses. Growers in the Foxwood area stated that *A. fulica* ate the flowers and new shoots, as well as the cocoa pods themselves. All of which had a significant effect on production.

> Dean: Has the productivity of the cocoa gone down since the snails?
>
> Grower: Really goes down.
>
> Dean: Can you tell me how many kilos you get now, compared to how many you got before?
>
> Grower: Before the snails we usually harvested the white beans[238] of the cocoa and we filled up the bags of a whole three tonne truck. But this time, we can only fill up three or four 20kg bags (HH male: interview # 35).

Another grower explained:

[237] Around six plus years, compared to two plus years in these other areas.

[238] Wet (white) beans are unprocessed beans removed from the cocoa pod. While sold for a lower price than those that have been processed (fermented and dried) it is a quicker cash option and requires less labour and infrastructure (i.e. fermenting boxes and dryers) for most small-holders. It is also a lower risk option as beans can be damaged during the fermenting and drying process which also affects the price.

> Before [the snails] if I harvested one plot of area I could get 10 bags of 20kg. But now I can make two bags where the snails have damaged the cocoa (HH male: interview # 36).

On the way back from a garden visit, one of the women showing me around described how:

> The snails have eaten up the cocoa. The ripe ones. So before the snails came I could collect four or five bags in one harvest in my plot. But now I can make just one and a half bags (Garden visit: interview # 23).

Growers in other areas affected by *A. fulica* were aware of the damage the snail was doing to cocoa in the Foxwood area:

> I went there to see the cocoa for myself. They [have] destroyed it (HH male: interview # 66).

These growers knew it was only a matter of time before it affected them as well.

> One of the reasons why they do not affect the cocoa at the moment I think is [because of] the [low] snail population in the area. When the population of the snails in the area or vicinity of my village increases in number, then that will be the time we [will] see the changes (GPPOL: interview # 37).

These impacts on cocoa, coupled with the impacts on vegetable gardens meant that the livelihood strategies of many households were, or soon would be, seriously compromised.

Another potential issue for cocoa growers is that *A. fulica* have been reported to distribute in their faeces, the spores of *Phytophthora palmivora*, which causes black pod disease in cocoa (Raut & Barker, 2002, p. 61) (Photo 7.12). This disease has been present in the Solomon Islands long before *A. fulica* arrived[239] and is spread by various insect and mechanical means[240]. How much of an influence *A. fulica* has had on the prevalence of this problem since its arrival is unknown and requires further investigation.

[239] For example, research was being conducted on *P. palmivora* in the Solomon Islands in the 1970s (Newhook & Jackson, 1977).

[240] Ants and termites for example can transport infected soil up the trunks of trees and deposit the spores on the trunks and pods. Heavy rain and wind can also transfer the spores between pods (CLIP, 2010, p. 100).

Photo 7.11: Achatina fulica in a cocoa tree. The damage they do to the flowers, shoots and pods is having a serious impact on productivity in areas on the Guadalcanal plains. Note the pile of Achatina fulica faeces on the branch to the right of the cocoa pod. Achatina. fulica can distribute the spores of Phytophthora palmivora in its faeces, which causes black pod disease in cocoa.

Photo 7.12: Black pod disease in cocoa, East Guadalcanal plains.

7.3.3 Betel nut[241]

Chewing betel nut is widely practised throughout the Solomon Islands (Maebuta & Maebuta, 2009, p. 123; SIG, 2009b, p. 23; Woodley, 2002, p. 107) and many people sell it to earn income[242]. It is common to see stalls selling betel nut not only in Honiara, but also along rural roadsides particularly in areas where people tend to congregate. Betel nut is an important commodity in the livelihoods of many households, especially the poor, who buy and on sell it. A number of households interviewed in this study, who had given up marketing their own crops because of *A. fulica*, had turned to buying and selling betel nut to survive (see Box 7.1 for example). As one household explained:

> We go to town, White River[243]. We can buy each fruit for 50c and come and sell it here[244] for SBD$1 (HH female: interview # 32).

While on the face of it a 100% profit seems like a good return, in reality only small amounts of revenue were made. Transport cost between Foxwood and White River were around SBD$26 return (the equivalent of 52 fruit) and, as my research assistant explained to me, the fresh fruit only lasted about one week before it started to ripen and the nut inside started to go hard, which most people did not prefer (Field notes 22 August 2013). This meant that people selling betel nut as a livelihood strategy had to strike a balance between buying enough fruit to exceed their costs but not too many that they lost money on fruit they could not sell.

I only encountered two households who actually grew betel nut within the area of Guadalcanal containing *A. fulica*. Both households were in the same village and the two women interviewed turned out to be sisters[245]. Both women expressed concerns over the impact *A. fulica* was having on their betel nut palms, with one explaining that *A. fulica* had

> Started to go into the betel nut plantation and eat all the skin and bark of the betel nut palms (HH female: interview # 56).

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[241] Betel nut is not a true nut but rather a drupe (stone fruit) (Staples & Bevacqua, 2006, p. 4).
[242] A livelihoods survey of urban squatter settlements in Honiara found that just over 36% of households reported selling betel nut and cigarettes as their primary source of income (Maebuta & Maebuta, 2009, p. 123).
[243] An area on the western side of Honiara.
[244] Foxwood.
[245] It is possible that they were talking about one betel nut plantation which they shared access to.

The other also stated that *A. fulica* was having a big impact on betel nut, eating the young palms (HH female: interview # 58). This was of significant concern to her because betel nut was one of the main earners for her at the market (ibid). While the damage inflicted to date had not affected her income from this crop[246], she was concerned about what would happen as snail numbers increased further.

Raut and Barker (2002, p. 80) include betel nut in a list of economically important plants which have been reported as being subject to losses due to *A. fulica*. However, they do not note if these losses are economically significant. The mere presence of *A. fulica* in a crop or plantation, even if some damage is evident, does not automatically equate to an economic impact on producers. The number of betel nut growers interviewed in this study are too few[247] to draw any conclusions on whether *A. fulica* is having an economic impact on this commodity. However, given the significance betel nut has in Solomon Island society, especially as a major income source for the nation's poor, any potential impacts *A. fulica* may have on this crop should be investigated further. Any significant reductions in its production would have wide ranging effects on Solomon Island society.

7.3.4 Banana

Banana[248] is an important crop in the Solomon Islands, not only as food for the household, but also as a source of income. Jansen et al. (2006, p. 57) observe that;

> On the Guadalcanal plains, the supply of bananas to Honiara markets is fairly lucrative and probably provides a better return to labour than vegetable production.

Households growing banana in areas occupied by *A. fulica* report that the snail is having an impact on this crop (Photo 7.13);

> [With] banana, if the fruit gets ripe [the snail] will climb up and eat all the fruits (HH male: interview # 66).

[246] *A. fulica* had only been in this location for around two years.
[247] As noted, I only encountered two households growing betel nut within the areas occupied by *A. fulica*. Unfortunately, these two households turned out to be my last interviews before I came down with Malaria. So I was unable to follow up on this line of enquiry any further by seeking out other growers.
[248] Both cooking and sweet varieties.

> The snails climb up the bananas and eat the leaves, and if the bananas have fruit, [the snails] go into the bunch and live there and wait for the banana to ripen. So when the banana fruit ripen, they start eating the banana (Community walk-through: interview # 24).

These observations were also supported by a staff member from a NGO working on food crops in the Solomon Islands who had also seen the impact of *A. fulica* in Bougainville.

> From what I was seeing in Bougainville, if the population of this snail is high then they destroy all the crops; like cocoa, banana… Mostly banana in Bougainville. Some bananas around here, just next to the bridge here you can [see them]: just a stem, no leaves (NGO: interview # 41).

The damage inflicted on banana in the Solomon Islands varied by location. Even in the areas worst affected by *A. fulica*, such as Foxwood, banana was still being grown by some households. However, dead and dying banana trees, which locals attributed to *A. fulica*, were observed in this area during a community walk-through (Field notes 21 August 2013). Other households in this location reported that they no longer marketed banana because of the snail.

The significance of banana as a cash crop and the risk *A. fulica* poses to this livelihood activity was illustrated during a focus group with a community on the West Guadalcanal plains. *Achatina fulica* has yet to reach this community[249] but they were well aware of the threat it posed.

> If the snail was here there would be no more marketing for the women. Banana is the main crop for income… If the snail comes here it will be a disaster for the whole village. (Focus group: interview # 47).

The women in the focus group explained that at least some of them were at the central market in Honiara every day selling banana. On Fridays and Saturdays, the whole village went, catching the 6am transport. It was a lucrative activity for them, earning some of them SBD$3000 or more a week. Well aware of the ease in which *A. fulica*

[249] The snail did reach the village once. A single specimen hitched a ride on a vehicle that had come out from Honiara to the village. Fortunately, it was seen by members of the community and destroyed.

could reach their village, they were very concerned about the risk it posed to their livelihoods.

Photo 7.13: Achatina fulica consuming banana. Households reported that the snail also damaged the trees by stripping the leaves.

7.3.5 Taro

The importance of taro as a staple crop has decreased significantly in the Solomon Islands (Jansen et al., 2006, p. 54; Woodley, 2002, p. 258) with its place being taken by sweet potato, cassava and imported rice (Woodley, 2002, p. 259). Despite this, taro still has an important cultural value and as Jansen et al. (2006, p. 54) observe, this has:

> Translated into high economic value in rural and urban markets and taro usually fetches three to five times the price of sweet potato in markets. Demand is sustained even at high prices because of the customary use of taro at feasts and other important events.

Few households on the Guadalcanal plains were marketing taro. The Honiara market is supplied largely by growers from Malaita and Temotu (NGO: interview # 41). The

very few times I did encounter taro in areas containing *A. fulica* it was only a very minor garden component grown for household use. Damage caused by *A. fulica* was variable[250] and because of this I was unable to directly assess whether *A. fulica* was having any significant impact on this crop.

However, interviews with representatives from two NGOs working on food crops/food security in the Solomon Islands highlighted the potential threat *A. fulica* poses to taro growers in areas such as Malaita and Temotu, where taro is still a main staple food for the household and an important cash crop (Focus group: interview # 42). Both interviewees had seen the impacts of *A. fulica* in other Pacific countries/territories; one in Samoa and the other in Bougainville:

> In Samoa it is really one of the main pests of taro. Because of the snail some [had to] cut their export of taro to New Zealand (NGO: interview # 54).
>
> Back in 1999 we went to Bougainville after the tensions, and the snail was everywhere up on the mountains and it destroyed all the crops… They had food shortages because their taro was destroyed. Their main staple diet is taro and yams and sweet potato. The African snail was destroying all the leaves of the potatoes and all the taro and the yams. The children, you saw the children with malnutrition (NGO: interview # 48).

Recent newspaper reports from the Solomon Islands (Ekotani, 2014, 20 June) indicate that *A. fulica* have now established on Malaita. The potential for *A. fulica* to have a significant impact on this crop and the livelihoods it supports is high and a full assessment of the threat is warranted.

7.3.6 Flowers

Eight percent of households on Guadalcanal cultivate flowers (SIG, 2009c, p. 40). For the women of one community I visited on the Guadalcanal plains, the selling of flowers was an important source of income for them. Grown in flower beds around the village houses, the arrival of *A. fulica* had jeopardised this income-generating activity. As one women explained:

> Women: [The snails] eat the flowers. We used to make floral arrangements to sell.

[250] From completely defoliating the plant through to no damage at all.

> Dean: Can you still do that?
>
> Women: We still do. But we have to check the flowers every morning and collect the snails and throw them on the fire (HH female: interview # 56).

Another said:

> One of the things we are trying to do to earn money is flowers. But giant snails are in them now and are destroying them, chewing them up (HH female: interview # 55).

Mead (1961, p. 49) noted that garden flowers and ornamentals are very susceptible to attacks by *A. fulica*. In order to maintain this income source the women explained how they have to spend an hour every morning searching through the village flower beds removing *A. fulica*. This was additional work for them but they had little choice if they wanted to maintain this income stream. The snail was a recent arrival in this village (two plus years) and all interviewees reported that numbers were increasing rapidly. While they could still practise this income-generating activity now, all were concerned about what the future held.

7.4 Impacts on Other Livelihood Activities

The impacts of *A. fulica* are not solely restricted to areas of food production and income generation. As outlined in earlier chapters, livelihoods are dependent on a range of capitals which can be affected by the presence of invasive species. How *A. fulica* influences some of these other livelihood components is outlined in this section.

7.4.1 Health

There are a number of health issues associated with *A. fulica* that warrant further investigation in the Solomon Islands. These are discussed further below.

7.4.1.1 Eosinophilic Meningitis

The parasitic rat-lungworm nematode *Angiostrongulus cantonensis* is a major cause of eosinophilic meningitis in humans and is considered to be an emerging infectious disease in a number of countries (Cowie, 2013, p. 70; Diaz, 2010, p. 115; Lv et al., 2009, p. 1). *Achatina fulica* is recognised as an important intermediate host for this

parasite, with people becoming infected through eating raw or undercooked snails[251] (Cowie, 2013, p. 71; Fontanilla & Wade, 2012, p. 642). *Angiostrongulus cantonensis* is known to be present in rats[252] in the Solomon Islands (Alicata, 1966, p. 1046) so there is a potential public health risk if people eat *A. fulica*.

Snails are traditionally eaten in the Solomon Islands although it is not a universal practice. During a focus group discussion with farmer representatives from Malaita and Western Province, a farmer from Malaita noted that if *A. fulica* reached that island then people might eat it:

> Because some of our people eat other snails (Focus group: interview # 42).

Others in the group however expressed surprise that people would eat snails. During a community walk-through, one of the locals showing me around told me that they traditionally ate the snails they collected from the river mangroves (Community walk-through: interview # 67). While in another village I observed a man cooking mangrove snails directly in the hot coals of an open fire. He told me that he regularly ate these snails but had not tried *A. fulica*, which at that point had yet to reach his village (Field notes 17 August 2013).

Some though were eating *A. fulica*. Following a visit to the GPPOL company offices I encountered a group of men and women waiting outside. One of the men told me that he regularly ate *A. fulica*. He said he encouraged others to collect them because they were free food. (Field notes 7 November 2013). Two GPPOL employees also told me that they had eaten them (Field notes 11 November 2013). During interviews with two different NGOs working with local communities, both stated that they had had reports of people eating *A. fulica* (NGO: interview # 41 & 63), and I heard similar second-hand accounts during household interviews, focus groups and community walk-throughs. Unless thoroughly cooked, people may be putting their health at risk by consuming *A. fulica*.

[251] Either deliberately or inadvertently, such as by eating contaminated salad crops.

[252] Rats are common in the Guadalcanal plains communities that I interviewed during this study. They were raised as an issue during focus groups (i.e. Focus group: interview # 19 & 47), household interviews (HH male: interview # 51), Government interviews (SIAQS: interview # 59) and were a significant pest in and around the palm oil plantations (GPPOL: interview # 37 & 38).

Officials spoken to at the Ministry of Health observed that although cases of meningitis occur in the Solomon Islands there are no trace-back investigations undertaken into the cause. They also conceded that no records regarding the incidence of eosinophilic meningitis are kept so it would not be possible to determine if the rate had increased following the establishment of *A. fulica* (Field notes 30 October 2013). Because *A. fulica* are being consumed in the Solomon Islands a risk assessment of this activity needs to be undertaken to establish the level of threat and provide health authorities with baseline data for awareness campaigns around the safe consumption of this snail.

7.4.1.2 Mosquito Borne Diseases

A notable feature of the visits made to communities affected by *A. fulica* were the large number of empty snail shells littering the surroundings (Photo 7.14 and 7.15). Experiments by Jayashankar and Reddy (2010, p. 38) in India[253] found that empty *A. fulica* shells served as a good breeding site for disease transmitting mosquitos. These included *Aedes aegypti*, [254] which is also present in the Solomon Islands[255], and is a known vector for dengue fever and Zika virus[256]. Trpis (1973, p. 447) observed that in a region in Tanzania, where *A. fulica* shell density was estimated at 228 per hectare, 11 to 35% of the shells were positive for mosquito larvae, with *A. aegypti* found in 82 to 84% of the positive shells. Dengue is a significant health issue for the Solomon Islands, with outbreaks in 2013 and 2014 (Solomon Star, 2015). Zika virus is also a significant health issue. Zika virus was recorded in the Solomon Islands in 2015 (WHO, 2016c). Dengue and Zika virus awareness campaigns have included messages regarding keeping the environment clean of mosquito breeding sites such as rubbish,

[253] *A. fulica* has been established in India since 1847 (Mead, 1961, p. 9).
[254] Jayashankar and Reddy (2010, p. 38) also recorded the successful breeding of an *Anopheles spp.* mosquito in *A. fulica* shells in the laboratory. *Anopheles spp*. mosquitos are vectors for malaria. However, the preferred breeding sites for malaria mosquitos are streams, ponds and standing water so it is unlikely that this species would use *A. fulica* shells under field conditions.
[255] As another invasive species.
[256] "Zika virus is a mosquito-borne flavivirus that was first identified in …humans in 1952 in Uganda and the United Republic of Tanzania. Outbreaks of Zika virus disease have been recorded in Africa, the Americas, Asia and the Pacific. From the 1960s to 1980s, human infections were found across Africa and Asia, typically accompanied by mild illness. The first large outbreak of disease caused by Zika infection was reported from the Island of Yap (Federated States of Micronesia) in 2007. In July 2015 Brazil reported an association between Zika virus infection and Guillain-Barré syndrome" (WHO, 2016d) ["a rare condition in which a person's immune system attacks their peripheral nerves (WHO, 2016a)]. "In October 2015 Brazil reported an association between Zika virus infection and microcephaly" (WHO, 2016d) ["a condition where a baby is born with a small head or the head stops growing after birth" (WHO, 2016b)].

plastic cups, water containers, and even upturned coconut shells (WHO, 2015, 2016c). For those living in areas containing *A. fulica*, these messages should also highlight the shells of this snail.

7.4.1.3 Flies

Another potential health issue (and a definite nuisance factor) raised during household interviews in two different communities was the increase in the number of flies following the arrival and build-up of *A. fulica*. As one household observed:

> Another problem we experience is the flies. If we get a lot of dead snails it produces flies. The environment here [means] you cannot eat outside; if you eat [outside], you just eat with flies. That is what happens, flies all over the place (HH male: interview # 66).

Because *A. fulica* multiply in such numbers, they also die in great quantity, and these:

> Thousands upon thousands of dead and dying snails in a heavily infested area form potent breeding sources for filth flies which are carriers of enteric diseases (Mead, 1961, p. 55).

While the particular households that raised this issue did not identify any health issues associated with this increase in fly abundance, this aspect of the *A. fulica* invasion is one that should be of concern to health officials.

7.4.2 Education

Achatina fulica is having an impact on children's education in the Solomon Islands. As outlined in section 7.3, *A. fulica* has had major financial impacts on some households and this in turn has had an effect on their ability to support their children's education.

> The people rely on their food gardens, they grow things and they sell it in the market, [then they] take the money to pay for school fees and other commitments. But when the snails started to damage this whole area, some [people] have had to lift [their children] out of school. They cannot even afford to pay for their school books (HH male: interview # 26).

Because of the reduced income, household expenses, such as those going towards education, had been cut completely or severely reduced. S. Shackleton (2005, p. 11) observed that human capital, such as the education of children, is built when financial

Photo 7.14: Empty Achatina fulica shells littering the undergrowth on the East Guadalcanal plains.

Photo 7.15: Empty Achatina fulica shells. Note the centre two shells contain water which studies have shown can be used as a breading site for disease transmitting mosquitos, such as Aedes aegypti, which is a vector for dengue fever and Zika virus.

capital from particular household activities is reinvested into this area. And the reverse is also true. When financial capital dries up, investment may be cut or stopped altogether, which can have negative consequences for areas such as education.

This reduction has forced some families into making some hard decisions around their children's education.

> Some are in school, some are not. [There is] not enough money for everyone to be in school because of the snail (HH male: interview # 34).

Others faced similar dilemmas. As one women explained, the loss of income following the arrival of *A. fulica* meant that:

> Women: Only our daughter is in school now. One day at school, one day off. Because there's no money.
>
> Dean: So how many of your children are not in school?
>
> Women: Two boys are not in school. They went to school first, but because [there is] no marketing [now] because of the snail, they had to come out of school.
>
> Dean: And then you sent your daughter to school?
>
> Women: Yeah. So only one in school right now. Yesterday our daughter did not go to school because of no bus fare. So she had to go up to the GPPOL area, where the oil palm plantation is, and collect the eatable fern to go and sell in the market for bus fare. Today she was in school again.
>
> Dean: And how old is she?
>
> Women: About 14 years old. But we have SBD$450 outstanding to be paid [to the school]. So if we do not pay up the school fee then she will have to leave the school (HH male, female: interview # 29).

These decisions around pulling children from school were not only hard on the parents, but also on the children. As this same woman explained with regards to one of her boys:

> When he left school he came here and was involved in a lot of drinking; because he was angry at us for pulling him out of school. So he was angry and started smoking marijuana and drinking beers and alcohol (ibid).

On a positive note the son was later given a place in a theology school, with the school subsidising the majority of the costs. According to his mother, "now he is a good boy. Now he comes and preaches" (HH male, female: interview # 29). All the households

interviewed recognised the importance of an education for their children. Pulling children from school was considered a last resort.

Despite the financial hardships, many households did what they could to keep the children's education going.

> Dean: What about other expenses, like school fees, can you meet those?
>
> Reply: I had to find employment and now work on the cattle farm to be able to find money for school fees.
>
> Dean: Are your kids still in school?
>
> Reply: Yes. Three in school.
>
> Dean: And you are able to meet those fees from your work in the cattle farm?
>
> Reply: It's not enough, so I had to buy a small proportion of the school fee.
>
> Dean: So you are paying it off a bit at a time?
>
> Reply: Yes (HH male: interview # 24).

Many households whose incomes were affected by *A. fulica* reported that keeping their children in school was a real struggle.

Even when households, despite all the financial pressures they were under, did manage to keep their children in school, *A. fulica* could still have an impact.

> Dean: Do the snails come into the house and affect the household?
>
> Reply: Yes. It comes into the house. If we are not looking when the snails get into the house they can spoil the school papers of the kids.
>
> Dean: It eats their school books?
>
> Reply: Yeah. They read books and just put them down and the snails come and they eat up the books and papers. The snail really likes eating paper (HH female: interview # 32).

Teachers from a local school also identified this as a problem; *A. fulica* getting into the classrooms and eating the books and papers[257] (Focus group: interview # 22). While such indirect impacts are not discussed in the literature, they can add additional pressure to households already struggling to ensure the education of their children.

[257] So of course I then had to ask the obvious question, "so do the kids use this as an excuse – the snail ate my homework?" The teachers just laughed (Focus group: interview # 22).

7.4.3 Household impacts

As noted above *A. fulica* frequently entered the houses of those living in infested areas where its slime trails and faeces not only dirtied the house, cooking and eating utensils, but also things such as bedding and clothing. Invariably it fell to the women to clean up the mess they left behind.

> Dean; Do the snails come in the house?
>
> Reply: Yes.
>
> Dean: Who deals with that, is it the women who have to clean the house?
>
> Reply: Yes, the women clean the house.
>
> Dean: Has that increased the amount of work that the women have to do?
>
> Reply: Yes (HH male: interview # 35).

Cleaning up after the snails has become regular additional work for the women of many households in areas affected by *A. fulica*.

Achatina fulica also creates other nuisance issues for the household when it gets inside. Its prevalence for eating paper being a prime example. This was illustrated by one man as he recounted the time his daughter brought out a bank statement and left it for him:

> So my daughter brought a letter from [the bank] and put it inside the house. So when I came [home] to find out my balance from the letter, I was looking around, asking [where's] the letter; but the snails had already eaten it. I was very angry, because the snails ate all the letter (HH male: interview # 31).

While annoying at the time, he could now see the funny side of the situation. However, for other households, this prevalence for eating paper potentially had more serious consequences:

> One time my sister, [she] dropped a two dollar [note] during the night. So when we were looking for the two dollar note in the morning we saw that [it was] already eaten up by the snails (HH female: interview # 32).

For a household already financially impacted by *A. fulica* through the loss of marketing opportunities, the direct consumption of their money was an additional area of concern. The women explained that she now kept her money in a plastic bottle to protect it from the snails (ibid). While the nuisance factor of *A. fulica* does not, as Mead (1961, p. 54) suggests "far outweigh any damage they may do to vegetation"; it does have a marked impact on the livelihoods and well-being of those households dealing with this snail.

7.4.4 Cultural obligations

7.4.4.1 The Wantok System

As outlined in Chapter 5, the wantok system is an important cultural and social component of Solomon Island society at the local and family level. While the adoption of a cash economy has seen some erosion of this practice (Jansen et al., 2006, p. 47), for many it remains an important part of Solomon Island life; acting as a safety net by helping to minimise any adverse effects resulting from natural and man-made disasters[258]. Nanau (2011, p. 50) notes that:

> The wantok system… plays an important role in sustaining livelihoods at the local level.

To do so, the system relies on the reciprocal provision of assistance between wantok (ibid, p. 42). While there are many reasons why households may no longer assist wantok[259], *A. fulica* is a contributing factor in undermining this system by compromising the livelihood strategies of some rural households; thus affecting their ability to participate effectively in this arrangement. For instance:

> We do not give anymore to other wantok. So no more giving and sharing of food. We only give to people who want to pay, who want to buy from our gardens. But no more free giving; because we have to meet the bus fare and the school fees of the children. Because we are not working. Before we gave, before the snails came; we were practising the wantok system of giving and sharing, [but] not this time. There is a shortage of food (HH male, female: interview # 29).

Other households expressed similar sentiments.

> Dean: Do you practise the tradition of sharing with wantok?
>
> Reply: We do not practise it in the household. Because of the snail we cannot do the system of exchanging and giving to other members (HH female: interview # 33).

These households were in the Foxwood area, one of the worst affected by *A. fulica*. Before the arrival of the snail they were entirely reliant on their vegetable gardens for feeding the household and for income from marketing. These households are now

[258] Such as the 1998-2003 civil unrest, as discussed in Chapter 5.

[259] For example, as noted in Chapter 5, some may have been expelled from their villages for wrong doings, and are no longer able to rely on the support of wantok (SITRC, 2012, p. 143).

struggling to support their immediate family and as such have stopped providing food or financial support to wantok. Nanau (2011, p. 47) notes that wantok groups have a moral obligation to assist their members, so situations such as this have the potential to create division within wantok and places additional stress on these households.

Nevertheless, other households in this area, along with households in areas with a shorter history of *A. fulica*, were still fully engaged in these exchanges. However, they admitted that since the arrival of *A. fulica* it had become a struggle to meet obligations.

> Dean: With the wantok system, do you still practise that process with relatives?
> Reply: We still practise it. When wantok come we still give food or anything we have, but it's more difficult than before. We do not have enough food…, but we still practise it (HH female: interview # 32).

The obligation to assist wantok can be difficult for households even at the best of time:

> The wantok system has always been here…. We always have the wantok system. It's taxing for the main bread winner but it's one of the means for people who cannot survive on their own. They live with wantoks. And it's helping to alleviate a shorter term stress, but the long term stress is still with the main bread winner in the end (Focus group: interview # 18).

For those households totally reliant on their gardens for their livelihoods, the arrival of *A. fulica* has made meeting this obligation even more difficult and taxing.

The wantok system is one of both giving and receiving (Nanau, 2011, p. 37). The widespread nature of *A. fulica* in some communities has meant that being able to rely on wantok in times of need, has at times become more difficult, as those being relied on for assistance are in the same position as those requiring assistance.

> Dean: Have you had to call on other family members to provide you with food because of the snail?
> Reply: Yes, that is what we do.
> Dean: Have you had to do this more often than you used to?
> Reply: Yes. There would be a problem if all of those who were supporting us relied entirely on gardens. But we are fortunate because some people are working and they support us with money.
> Dean: So does that mean that the snails are everywhere your extended family is, the ones you call on?

Reply: Yes. Everywhere.

Dean: So it's only because some are working that they are able to provide support?

Reply: Yes (HH male: interview # 20).

While the presence of *A. fulica* is placing a strain on some households to meet their cultural obligations, for many households affected by *A. fulica* the wantok system is providing a safety net. Without this system, many more households in the areas worst affected by *A. fulica* would be in dire trouble.

7.5 Conclusion

As outlined in earlier chapters the combination of subsistence agriculture and small-scale income-generating activities underpins the livelihoods of many rural households in the Solomon Islands. This, coupled with the non-financial forms of livelihood capital, influence people's well-being. The arrival of *A. fulica* into the Solomon Islands has had a serious impact on activities within the informal sector and has placed many livelihoods at risk.

Of primary concern is the threat *A. fulica* poses to the food security of rural households. Its high numbers and veracious feeding is seriously affecting garden productivity in areas it occupies on the Guadalcanal plains. This not only compromises the ability of the household to feed itself, but also affects the income that would otherwise be generated from the sale of surplus crops. Other income-generating activities, such as cocoa production, are also under threat by *A. fulica*. In the worst affected areas cocoa producers have experienced losses in production of up to 80%.

The economic impacts experienced by households in areas affected by *A. fulica* have had flow on effects into areas such as children's education. Some households have reported that they have had to pull children from school as a direct result of the impacts *A. fulica* are having. Social networks are also being compromised, with some households abandoning traditional practices of support between wantok.

All this has led to changes in the livelihood strategies practised by a number of households in areas affected by *A. fulica*. These changes have for the most part been

negative, with many households reporting that they are worse off now than they were before *A. fulica* arrived. This aspect is taken up in Part 1 of the next chapter (Chapter 8), where the vulnerability/resilience of Solomon Island livelihoods, in the face of IAS, is examined in more detail.

Chapter 8: Invasive Alien Species – A Livelihood Issue

8.0 Introduction

Collectively Chapters 6 and 7 have broadly examined the influence *Wasmannia auropunctata* and *Achatina fulica* have had on the core livelihood strategy practiced by the vast majority of Solomon Islanders, namely a diversified mixture of food production and cash cropping. In this chapter, attention is turned in the first instance to the second of the secondary research questions (i.e. how do IAS affect the vulnerability and/or resilience of Solomon Island livelihoods?). As argued in Chapter 5, agriculture forms the cornerstone for the livelihoods and welfare of the majority of rural Solomon Island households. As such, agricultural activities play a significant role in the livelihood diversification strategies practised by these households. This means that the income earning opportunities available to rural households (i.e. from own farm production and agricultural wage labour) have a high correlation between the risks attached to the alternative income stream, thus making them vulnerable to any one particular adverse event or shock (Ellis, 1998, p. 13).

However, as discussed in Chapter 3, vulnerability is a function of sensitivity and exposure to shocks and stresses. Being vulnerable does not necessary equate to a poor livelihood if there is a low chance of the shock happening, or when it does occur, the impact is manageable. Coupled with this is the household's resilience. This consists of a household's ability to absorb or endure shocks and stresses and bounce back or adapt without undermining their livelihood. In Part 1 of this chapter, the influence *W. auropunctata* and *A. fulica* have had on the core livelihood strategy practised in the Solomon Islands, and how vulnerable and resilient households following this strategy are to these IAS, is examined.

The second part of this chapter looks at development policies operating in the Solomon Islands. These development policies form part of the wider structural processes, which as explained in Chapter 3 (and shown in Figure 5.3), shape and influence the livelihood strategies that are available to Solomon Island households. By examining this aspect of the livelihoods framework the second part of this chapter seeks to address the third secondary research question; namely, to what extent do the livelihood impacts of IAS

pose a challenge to current development policy in the Solomon Islands? As noted in Chapter 1, IAS cut across all three of the sustainable development pillars, but largely go unrecognised as a development issue. Using an important development driver operating in the country (the Solomon Islands National Development Strategy 2011-2020[260]) the second part of this chapter examines the challenges IAS pose to the objectives of this strategy, and consequently the livelihoods of those living in the Solomon Islands.

PART 1: THE VULNERABILITY/RESILIENCE OF RURAL SOLOMON ISLAND LIVELIHOODS TO INVASIVE ALIEN SPECIES

As noted above, the first part of this chapter examines the influence *W. auropunctata* and *A. fulica* have had on the vulnerability and resilience of rural households underwritten by the core livelihood strategy shown in Figure 5.3.

8.1 The Influence of *Wasmannia auropunctata*

By and large, *W. auropunctata* has not altered the vulnerability of rural households in the Solomon Islands. Despite its widespread presence (exposure) there has been little or no change in the livelihood strategies of rural Solomon Island households due to *W. auropunctata*. Households affected by the ant are still able to rely on the core livelihood components of subsistence agriculture and small-scale income-generating activities as the basis of their income portfolio. This is because crop management activities and crop productivity in the Solomon Islands have not been greatly affected by the presence of the ant. None of the households interviewed during this study reported that they had had to switch to alternative livelihood strategies because of *W. auropunctata*. This, however, in no way means that households were unaffected by *W. auropunctata*. As Chapter 6 describes, *W. auropunctata* are widespread throughout the country and, as was found by Wetterer and Porter (2003, p. 24), virtually every household interviewed during this study was familiar with the ant's sting. For many households the impacts *W. auropunctata* caused were on the non-financial aspects of

[260] This is the strategy that was current during the time of my fieldwork (2013). With the onset of a new government at the end of 2014, the Ministry of Development Planning & Aid Coordination (MDPAC) was mandated to review the NDS 2011-2020 and extend it to a 20-year period. The substance of the new NDS (2016-2036) will largely be the same as the current strategy (S Koti, MDPAC, pers. com. 2015). At the time of writing (May 2016) the new strategy had still yet to be released.

their livelihoods. While households have shown resilience by being able to absorb and endure their impact without compromising their livelihood options, *W. auropunctata* has affected their general well-being.

Despite their inconvenience, evidence presented in Chapter 6 suggests that *W. auropunctata* may benefit some households due to their ability to control economically important crop pests, particularly in coconut and cocoa, two of the most widely grown cash crops by households in the country. As illustrated by Box 6.1 (Chapter 6), rural households dependent on these cash crops for their livelihood are not only able to maintain this activity in the presence of *W. auropunctata*, but are also able to expand the assets on which this livelihood depends. Even where *W. auropunctata* are having a negative effect on a household's activities, this has not prevented those households from maintaining and expanding their asset base. For example, as described in Box 6.2 and section 6.3.3 (Chapter 6), those households farming chickens as an income-generating activity report that they frequently suffer losses to *W. auropunctata*. Despite this, these households have also been able to increase their assets, increasing the number of birds they are rearing and their income earning opportunities. Ellis (2000b, p. 296) argues that making investments in assets in order to increase income-generating capabilities in the future is an important aspect of livelihood diversification. As noted in Chapter 3, these households are exhibiting progressive-pull diversification practices, which is regarded as evidence of a resilient livelihood (Nygren & Myatt-Hirvonen, 2009, p. 837). While the widespread nature of *W. auropunctata* makes virtually all rural households vulnerable to their impacts, the magnitude of the shock has not been beyond the ability of households to absorb, or endure.

Importantly, the presence of *W. auropunctata* has not compromised the livelihood options available to rural women. As shown in Figure 5.3 (Chapter 5) the core household livelihood strategy prominent in the Solomon Islands is embedded within gender processes practised in the country. As explained in Chapter 5, this core strategy provides opportunities for rural women, albeit within the "…culturally grounded, roles of men and women in household food and livelihood systems" (Niehof, 2004, p. 330). Gender plays a prominent role in the livelihood diversification process (Ellis, 1998, p. 11; Niehof, 2004, pp. 329-330), enhancing or supressing available opportunities

according to the gendered division of labour. While "…the widespread social assignment of women to domestic duties means that their ability to participate in income earning opportunities outside the household…is likely, in most cases, to be more circumscribed than is the case for men" (Ellis, 1998, p. 24), some opportunities do exist. In the Solomon Islands the gendered division of labour means that these opportunities largely centre on growing food crops for subsistence and marketing the excess food crop production. Although, as noted in earlier chapters, women are also involved in dedicated cash crops; for example, palm oil (as discussed in Chapter 5) and cut flowers (as discussed in Chapter 7), just to name two[261]. While women were potentially more exposed to *W. auropunctata* due to the tasks they performed, the impacts the ant caused did not inhibit women participating in those livelihood opportunities or change the opportunities that are available to them. In fact, despite the widespread presence of *W. auropunctata*, women, as Wairiu (2006, p. 412) points out, are becoming more involved in the cash economy. This can potentially lead to more diversity in their livelihood portfolios and increase the household's resilience.

Another important resilience indicator is food security (McMillen et al., 2014, p. 7). There was no evidence from this study that *W. auropunctata* was having an impact on food security in the Solomon Islands. Women play a significant role in the food security of rural households in the Solomon Islands, as food crops grown by rural women are used to feed the household (Jansen et al., 2006, p. 45). Despite the concerns raised by Fasi et al. (2013, p. 7) that crop losses due to *W. auropunctata* may become a major impact for Pacific Island communities, none of the women (or men) interviewed in this study reported that *W. auropunctata* had affected garden productivity to any noticeable extent. As already noted, despite the widespread presence of *W. auropunctata*, households were still able to practise subsistence agriculture and sell the excess production for additional income. Being a dominant income earning activity for women, the sale of excess crops also contributed to household food security because women, as noted by a number of authors (Agarwal, 1989, p. 47; Kabeer, 2003, pp. 162-165; Niehof, 2004, p. 331; Robaa & Tolossa, 2016,

[261] While most rural women interviewed during this study were in informal employment, I also encountered some who were formally employed (for example teachers at rural training centres or schools or workers on the palm oil estates).

p. 109; Scott & Foster, 2008, p. 352), are more likely to spend their income on meeting the household's basic needs, such as food.

Likewise, there was no evidence from this study that *W. auropunctata* was contributing to household poverty in the Solomon Islands. Adelman et al. (2015, p. 27) note that 10.6%[262] of the Solomon Island population fall below the food poverty line[263] and 22.7%[264] fall below the total poverty line[265]. Critically Adelman et al. (2015, p. 28) argue that

> There may be a sizable portion of the population that is consuming… enough to only hover above the poverty line. Such people are often among the most vulnerable to falling into hardship as a result of …shocks.

IAS can be one such shock. Although Adelman et al. (2015) do not distinguish between rural and urban dwellers in their figures, rural households that were struggling to make ends meet were encountered during this research. These households, for the most part, were migrant households[266] with very limited access to land on which to grow and produce food crops for consumption and marketing[267].

As one such household head explained to me, the limited space available[268] for their garden meant that they were only able to produce enough surplus to sell one day a week at the central market in Honiara. For this they earnt around SBD$250.

> The money we get from the market has to be managed well and spent on food and other things to sustain the family until the new week… Not to buy beer,

[262] "World Bank staff estimates based on [the 2006] Household Income and Expenditure [Survey] and existing poverty analysis" (Adelman et al., 2015, p. 27).
[263] This poverty measurement is "…based on the Cost of Basic Needs (CBN) approach. The CBN approach is a commonly used method that attempts to define the minimum resources needed for long-term physical well-being, usually in terms of consumption…. Using this approach, a poverty line is defined as the amount of spending required to obtain those resources. A list of 'basic needs' defines the minimum resources, and consists of food and non-food (clothing, shelter, services) items. The poverty line reflecting food needs is called a food or 'extreme' poverty line. The poverty line reflecting both food and non-food needs is called a total poverty line" (Adelman et al., 2015, p. 24).
[264] See footnote 262.
[265] See footnote 263.
[266] As discussed in Chapter 5, there is a high level of migration from other provinces in the Solomon Islands to Guadalcanal. While the men (and a few women) seek employment in the plantations and industries on Guadalcanal, the wages are low so households are reliant on the crops they grow to help them survive (HH male: interview # 26; HH male: interview # 30).
[267] As depicted in Figure 5.2, access to land is the foundation for the majority of rural Solomon Island livelihoods.
[268] This particular household was occupying a small strip of government land on the edge of a major industrial complex.

not to buy smokes… you have to manage your money [carefully] (HH male: interview # 1).

This meant living week to week for the household. This household was not immune to shocks, with the area in which they were living prone to flooding, particularly during the cyclone season. During these periods the household survived on any savings they were able to make each week and on assistance from wantok. Despite living on the margins and experiencing episodes of progressive-pull and distress-push diversification, *W. auropunctata* was not contributing to the hardship of this household (HH male: interview # 1). The main problem this household experienced with the ant was the disruption it caused to their sleep. Similar sentiments were expressed during other household, stakeholder and NGO interviews.

So, while in no way annoyance free, households have been able to cope and adapt to the presence of *W. auropunctata* in the Solomon Islands, without undermining their chosen livelihood portfolio. Overall the vulnerability of most rural households has not increased due to the presence of *W. auropunctata*. Households reliant on the core livelihood strategy shown in Figure 5.3, as many in the Solomon Islands are, can be considered to be resilient to *W. auropunctata*. While this may be true for *W. auropunctata* the same cannot be said for *A. fulica*.

8.2 The Influence of *Achatina fulica*

Households affected by *A. fulica* have had their core livelihood components of subsistence agriculture and small-scale income-generating activities compromised due to the presence of the snail. In particular, the impacts *A. fulica* are having on garden productivity are placing a strain on those households reliant on the growing of food crops as a livelihood strategy[269]. Food security is a significant concern for these households, as is the loss of income derived from the selling of surplus crops. As outlined in Chapter 3, households often implement a wide range of resilience tactics to cope with an adverse event or shock, including those caused by IAS. While every household's situation was different, all took steps, at least initially, to maintain their

[269] Due, as outlined in Chapter 6, to the high sensitivity of garden crops to the voracious feeding habits of *A. fulica* and the high numbers crops are exposed to. Similarly, those reliant on cash crops (such as cocoa) were also greatly affected.

core livelihood strategy the best they could, following the arrival of *A. fulica*. While the measures undertaken varied, a general pattern emerged from the interviews, and this is discussed in the following section.

8.2.1 Household response to Achatina fulica incursions into gardens

While hand picking and destroying[270] *A. fulica* was the primary response of households to the arrival of the snails in their gardens, many households reported that they were soon overwhelmed by the sheer numbers and the effort required to keep on top of their impacts.

> [The snail] increases every day. The numbers are still increasing despite the control measures (HH male: interview # 40)

> When it's raining… the snails are just like gravel on the ground (Garden visit, female: interview # 23).

> This giant snail, [it's] crawling like wild pigs … in the garden (NGO: interview # 63).

> We have tried everything, but it does not work. We burn it on the fire, throw salt on them, but it does not work (HH male: interview # 34).

For the traditional rural landowners, their initial response to being overwhelmed by the snails was to move their gardens to a new area free of *A. fulica*.

The setting up of a new garden takes time and labour for both the men and women of the household. As one women explained, it took two days for the men just to clear the bush, before the women could then start replanting everything (HH female: interview # 16). She further explained that care needed to be taken with the replanting as they had to:

> Check all the crops that we replant in the new locations, because [if] it has [the] eggs of the giant snail, it will spread to that place (ibid.).

This added extra time and labour to their task; and as noted earlier in Chapter 7, the small size of the eggs and juveniles made it difficult to achieve with any confidence.

[270] Primarily by burning in fires (as shown in Photo 7.3), by placing in plastic bags and leaving out in the sun, or by placing salt on them.

Despite these precautions, moving was only ever a temporary respite as *A. fulica* eventually reached the new gardens, setting off the moving process again. The particular household cited above[271] for instance had moved their garden three times in the space of eight months (ibid.). Another reported they had moved twice that year[272] (HH male: interview # 15). For others though, the inevitable had occurred and they had run out of snail free land to move to. As one traditional landowner explained to me:

> HH Head: We used to make gardens up on the other side of the road, but the snails damaged all the gardens so we moved here.
>
> Dean: Was [the snail] here when you first put the gardens in here?
>
> HH Head: The first time we came to make gardens here it was not here.
>
> Dean: Are there snails in the gardens [now]?
>
> HH Head: Yes
>
> Dean: Are you able to move this garden again. Do you have more land that you can move to?
>
> HH Head: No (HH male: interview # 20).

Without the ability to move the garden to an area free of *A. fulica*, nor the ability to keep on top of the snail impacts, many rural households in areas severely affected by *A. fulica* have resorted to downsizing their gardens. As one household explained:

> We just make small sized gardens [because] it's easier to control the small area from the snails (HH male: interview # 24).

While another said that:

> Before we made really big farms. We used tractors to plough the ground. Now it's reduced to about five percent of what it used to be. Really small. If you see the gardens nowadays you would think it belonged to kids or something. If you make big gardens they get eaten up by the snails (HH male: interview # 34).

As this description indicates, the reduction can be dramatic; even to the point where production no longer supports the household.

[271] HH female: interview # 16.
[272] As of August 2013.

Dean: Are the size of the gardens you've got here, are they smaller than what you used to have before the snail?

HH Head: It goes down. It's reduced a lot. Where we use to make gardens before it [was a] big space, compared to here.

Dean: Are you able to estimate how much your gardens have reduced to?

HH Head: Maybe ten percent.

Dean: This is about ten percent of what you used to have?

HH Head: Yes

Dean: Are you able to grow enough food to feed the household now?

HH Head: [It's] not enough (HH male: interview # 20).

Despite this situation most households still attempted to grow as wide a range of crops as possible, at least initially. Households in this situation were moving out of the first phase of coping as described in Chapter 3 (Ellis, 1998, p. 14; Niehof, 2004, pp. 328-329). The failure of initial positive coping tactics (control and moving the garden to new areas) had led to the implementation of greater austerity measures and the adoption of more erosive coping strategies.

Where households were unable to maintain a diversity of crops following downsizing of the area under cultivation, they reported that they had had to switch to *A. fulica* resistant crops. Crop choices however were limited, as one interviewee noted:

> Only cassava and tobacco are the crops that are not really affected by the snail (HH male: interview # 30).

For a number of households in the areas worst affected by *A. fulica*, cassava[273] was the only crop they were growing.

[273] Cassava (*Manihot esculenta*) is one of the few crops grown by subsistence households in the Solomon Islands that can tolerate browsing by *A. fulica*. While young plants are vulnerable to *A. fulica* browse and need additional monitoring during their early stages, older plants are not heavily browsed (HH male/female: interview # 29). Cassava has been reported to be heavily browsed by *A. fulica* elsewhere (Mead, 1961, p. 42). The susceptibility of plant species to *A. fulica* varies between regions and the literature contains numerous examples of conflicting reports of damage to particular species (see Mead (1961, pp. 39-49) and Raut and Barker (2002, pp. 78-82) for examples).

> It's damaging everything…, so we only rely on cassava (HH male: interview # 26).

Some households reported that they had avoided downsizing by moving directly into changing the types of crops that they grew. For instance, one household stated that they used the same garden area but instead of the range of crops they used to grow, they now only planted cassava (HH male: interview # 21). The opportunity losses resulting from the enforced change to a few *A. fulica* resistant crops is a recognised agricultural cost of this snail (Raut & Barker, 2002, p. 77).

Ultimately some households, where the struggle to control *A. fulica* and manage the damage they caused to their gardens was too much, gave up growing their own food altogether (Photo 8.1 and 8.2).

> Before we grew all types of crops, now we do not make any more gardens. We tried it, but the snail kept destroying it (HH male: interview #35).

> Dean: The people who used to grow their gardens here, where do they grow them now?
>
> Reply: Many of these people just do not make gardens anymore (Community walk-through: interview # 24).

Mead (1961, p. 98) reported similar outcomes elsewhere in the world where *A. fulica* had invaded, noting that:

> People despair of the seemingly endless and ineffective collecting, discontinue their efforts, and let the snails 'take over'.

This despair was evident with a number of households interviewed during this study. Many seemed overwhelmed by the situation and did not know what they could do about the snail. These households had reached the second phase of coping where assets critical for future survival were abandoned (Ellis, 1998, p. 14; Niehof, 2004, pp. 328-329).

Photo 8.1: An abandoned garden area near the Ngalimbiu River, East Guadalcanal, which was in use up until mid-2012. The site was abandoned because of the high number of snails (see Photo 8.2 below). (Community walk-through: interview # 67).

Photo 8.2: Achatina fulica in an abandoned garden area on the banks of the Ngalimbiu River, East Guadalcanal.

Non-traditional landowners[274] affected by *A. fulica* followed the same path. The only exception being that they did not have the option of moving their gardens as an initial response to escape the snails. Figure 8.1 illustrates the general response sequence taken by rural households in the Solomon Islands following the arrival of *A. fulica* within a community. Different communities within the Solomon Islands are in different stages, depending on the length of time *A. fulica* has been locally present. Even within communities, different households are at different stages, with some households being more vulnerable to the effects than others. This could be for various reasons, such as how much help was available within the household to undertake control, or even the location of the household within the community. For example, one man told me that he was less affected by *A. fulica* than his brothers were because he lived further away from the road than they did. He said that *A. fulica* first turned up by the roadside, where numbers are now highest, and are slowly spreading out from there (HH male: interview # 15). Currently, only in those areas where *A. fulica* has been the longest, such as the Foxwood area, have some rural households abandoned all attempts to grow vegetables for consumption and/or income. Many others though are struggling to maintain this option as a viable livelihood strategy.

[274] This includes migrant households occupying (with or without permission) traditional lands, alienated land and privately owned land.

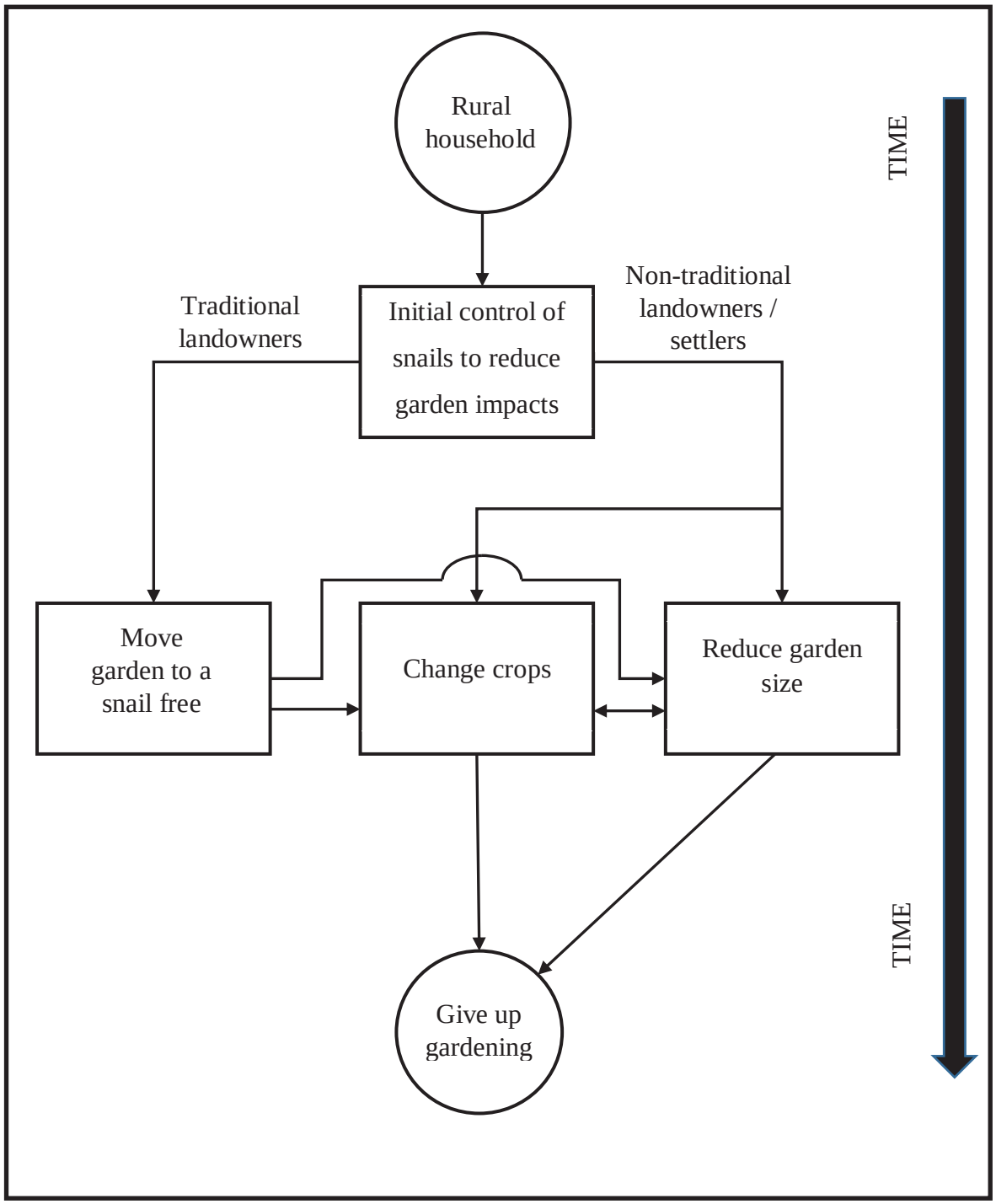

Figure 8.1: Sequence of impacts on rural households practising subsistence agriculture in the Solomon Islands following the arrival of Achatina fulica within a community.

8.2.2 Coping with Achatina fulica

As shown in Figure 8.1, one of the first coping mechanisms utilised by traditional landowners was to move their garden to an area free of *A. fulica*. As noted in Chapter 5, taking advantage of spatially separated sites is an adaption process traditionally used in the Solomon Islands to limit food insecurity and livelihood risks. However, as Goulden et al. (2013, p. 915) found in their study of livelihood diversification adaptions to climate stresses amongst rural households in Africa, spatial diversity[275] only contributes to resilience if the spatial range of activities is larger than that of the climate impacts. Likewise, for the impacts of *A. fulica* in the Solomon Islands. Those households with assets completely outside the range of *A. fulica* reported that they had an adequate life[276] based on the core livelihood strategy of subsistence agriculture and small-scale income generating activities. Even those with assets partly outside the snail infested area reported that they were better able to cope than those whose assets were completely enclosed within the range of *A. fulica*. For instance, two neighbouring households within one community reported to me that *A. fulica* was having a significant effect on their garden productivity and therefore their income[277]. Both households were reliant on growing and marketing food and cash crops (coconut, cocoa, betel nut) for their livelihoods. One household (HH male: interview # 57), whose assets were completely within the area occupied by *A. fulica*, reported that due to the financial difficulties they were facing they had had to pull some of their children from school. The other household (HH male female: interview # 55) had some cash crops (betel nut and cocoa) outside of the range of *A. fulica*. The revenue from this, they reported, allowed them to continue to meet the costs of keeping their children in school and meet most of their basic needs. In this instance the spatial diversity of assets only provided an advantage while it did not match up with the spatial distribution of *A. fulica*.

[275] Which they define as the "…geographic spread of activities [involving] spatially separated assets…" (Goulden et al., 2013, p. 908).

[276] Rural livelihoods in the Solomon Islands are far from idyllic. Life can be hard and as described in Chapter 5, lacking in a number of infrastructure components. Despite this, most rural households are able to meet their basic needs from the core livelihood strategy.

[277] One household (HH male female: interview # 55) estimated that their income from their garden had decreased by about two thirds. The other (HH male: interview # 57) was unable to estimate how much their income had decreased but noted that they had gone from selling garden crops in the market twice a week to once a week because of the lost production due to *A. fulica*.

Having a diversity of crops was also no protection against *A. fulica*. As noted earlier, agrobiodiversity, as a form of risk reduction and livelihood diversification, has long been a feature of Pacific food and livelihood security. However, as discussed earlier, virtually all garden crops[278] and even cash crops[279] commonly grown by Solomon Island households are highly susceptible to *A. fulica*. This is having a major effect on food security of rural households, with many households (both migrant and traditional landowners) reporting that they suffered food shortages as a direct result of *A. fulica*. As outlined above, many rural households sit just above the poverty line (Adelman et al., 2015, p. 28) and are vulnerable to shocks which can push them into hardship. As the above discussion indicates *A. fulica* is directly contributing to the hardship of many rural households in the Solomon Islands.

Women in particular have felt the impacts of *A. fulica* on their livelihood options, with one interviewee noting:

> [The snail] affects the women because [marketing food crops is] the only place they earn money from (HH male: interview # 26).

Ellis (1998, p. 24) argues that:

> Gender… affects diversification options, in terms of which income earning opportunities are taken up and which are discarded….

As outlined above, in the Solomon Islands the opportunities available to rural women largely (but not exclusively) centre on growing and marketing food crops from their gardens due to the gendered division of labour. This activity has been severely affected by *A. fulica*. For example, the women in one community told me that:

> Before the snail came our livelihood was mainly the planting of crops that we sold in the market. Since the snail dispersed here we cannot rely on agricultural activities for our livelihoods (Focus group: interview # 19).

Alternative income opportunities for these women were limited. Those participating in the focus group reported that they had switched to less profitable activities such as buying produce at the central market in Honiara and reselling it at the local roadside stalls (ibid.).

[278] With the exception of cassava (see footnote 273).
[279] With the exception of coconut (see Chapter 7, section 7.3.1.).

Other women interviewed during the household interviews reported similar practices; for example:

> Gwen[280]: The snail has destroyed all the vegetables, all the fruit, all the… plantings like sugarcane.… So I am doing black marketing here… because of the snail. I go and buy bags of crops, or fruit, or things from the market, then come and resell it. That is how we earn money [now] to buy food and other things…
>
> Dean: Is that income that you make, is it enough to keep the household fed and pay for your expenses?
>
> Gwen: Sometimes it is enough. But sometimes it depends on the money we earn from reselling. Sometimes it is not enough.
>
> Dean: And on those times that it is not enough, what happens then…?
>
> Gwen: We go hungry (HH female: interview # 33).

Other income earning opportunities available to women were also impacted. For instance, those women reliant on cut flowers for income (see Chapter 7, section 7.3.6) were also greatly concerned about the impacts *A. fulica* was having on their livelihood options now and into the future.

The high susceptibility (sensitivity) of food and cash crops to the voracious feeding habits of *A. fulica*, coupled with the high numbers that invade these crops on a daily basis (exposure), makes rural households dependent on the core livelihood strategy depicted in Figure 5.3, highly vulnerable to this IAS. In the presence of *A. fulica* distress-push diversification practices have been employed by households in the Solomon Islands and assets have been abandoned. Food security has also been compromised as the crops on which many rural households depend for the basis of their livelihood have been consumed by the snail. To date, Solomon Island households have largely been unable to cope and adapt to the presence of *A. fulica*. The implementation of negative coping strategies has seen livelihood portfolios reduced to fewer less profitable activities, as the example in Box 7.1 (Chapter 7) illustrates. Unlike the case for *W. auropunctata*, households in the Solomon Islands have not been found to be resilient to the impacts of *A. fulica*.

[280] Not her real name.

PART 2: DEVELOPMENT POLICY AND THE CHALLENGES OF INVASIVE ALIEN SPECIES

As outlined in the introduction to this chapter, this second part examines how the livelihood impacts of IAS may challenge contemporary development policy objectives in the Solomon Islands, and through this the livelihoods of rural Solomon Islanders. This part of the chapter seeks to show the wide ranging influence IAS can have across multiple sectors and highlight why IAS need to be considered a development issue. It illustrates McNeely's argument, first raised in Chapter 2, that IAS go "…to the very heart of problems policy-makers are spending much time debating, ironically usually without reference to IAS" (McNeely, 2006, p. 6).

The following section looks at an important high level development policy driver operating in the Solomon Islands - the Solomon Island National Development Strategy 2011-2020, - and uses the case studies to examine how IAS may influence the objectives of this policy. It can be argued that because this is a high level overarching policy document, specific details addressing the livelihood impacts of IAS are best addressed in the sector plans which typically sit under this document. However, as has been contended throughout this thesis, IAS issues transcend sectoral boundaries. Because they are a cross-cutting issue IAS should be addressed in overarching development documents to inform the different sectors of the issue and to ensure cohesion in their response. It is because they are not appropriately considered in these overarching documents that the problem largely continues to go unrecognised and unchallenged.

8.3 The Solomon Islands National Development Strategy 2011-2020

The Solomon Island National Development Strategy 2011-2020 (NDS) covers social, economic and environmental objectives geared towards building better lives for all people in the Solomon Islands (SIG, 2011, p. 4). Produced following a broad consultation process, including Government agencies, non-state actors, civil societies, private sectors, Provincial Governments and development partners (SIG, 2011), the NDS sets out the direction of the Solomon Islands Government's development agenda (SIG, 2011). Four major areas of focus are presented in the NDS. These areas,

considered to be reflective of the challenges facing the people of the Solomon Islands (ibid. , p. 4) are shown in Figure 8.2.

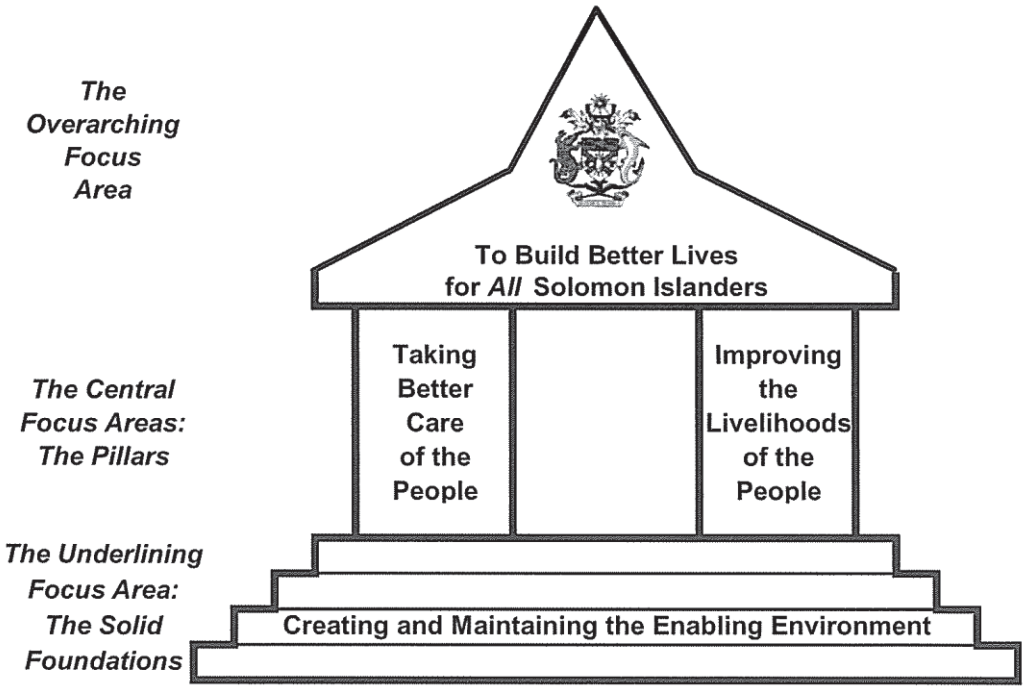

Figure 8.2: Structure of the Solomon Island National Development Strategy 2011-2020 (Source SIG, 2011, p. 5).

As Figure 8.2 shows, the overarching focus of the NDS is "To Build Better Lives for *All* Solomon Islanders" (SIG, 2011, p. 5 - emphasis in original). The NDS has a single objective for this focus area and that is:

> Objective 1: To alleviate poverty and provide greater benefits and opportunities to improve the lives of Solomon Islanders in a peaceful and stable society (ibid.).

Three challenges are identified in the NDS in meeting this objective, and these are discussed below. Although not raised in the NDS in relation to this objective, IAS, as the following discussion indicates, have an influence on the success or otherwise of achieving Objective 1.

The first challenge identified in the NDS to achieving Objective 1 is poverty. Reflecting the poverty figures for the Solomon Islands presented in Adelman et al.

(2015, p. 27)[281] the NDS notes that almost 23% of the population face difficulties in meeting basic food and non-food needs (SIG, 2011, p. 8). Importantly, the NDS (like Adelman et al., 2015, p. 28) recognises that many more households hover just above the poverty line and are vulnerable to falling into hardship (SIG, 2011, p. 8). The importance of the subsistence sector in maintaining the livelihoods of the majority of Solomon Islanders is recognised in the NDS (ibid., p. 10). Under Objective 1, the NDS proposes policies and strategies for strengthening the subsistence sector in order to meet the challenge poverty poses to the countries development. In doing so, it aims to

> …better achieve food security, reduce hunger, and facilitate marketing of surpluses from subsistence as well as income generation from smallholder cash production and commercial development (ibid.).

Critically, the NDS identifies poverty in the Solomon Islands as being income rather than asset poverty and therefore argues that the poverty challenge can "…be addressed by increasing employment and income-earning opportunities in urban and rural areas" (ibid., p. 9). However, as the *A. fulica* case study shows, households affected by this particular IAS are experiencing asset poverty, as land, an essential asset for the livelihoods of the majority of Solomon Islanders, is abandoned due to the presence of the snail. In those areas in which the snail is present, *A. fulica* are actively weakening the subsistence sector; reducing food security, increasing hunger and stymieing small-scale income-generating activities. Given the major role played by subsistence activities in the livelihoods of Solomon Islanders (ibid., p. 10), *A. fulica* pose a direct challenge to achieving this development outcome as they expand their distribution to other parts of the country.

Conversely, and reflecting the complexity of the IAS issue, *W. auropunctata* may be playing a role in poverty alleviation as they potentially protect the coconut plantations of small-holders, who are reliant on this crop for income and food, from the impacts of *Amblypelta* (see section 6.3.2.1). Kannan et al. (2014, p. 664) note that specific IAS can be an important resource for the rural poor, "…especially in the context of the limited livelihood opportunities available to them" (ibid.). While *W. auropunctata* appear to support this view[282], the reverse is equally true; specific IAS can be

[281] See discussion in section 8.1.
[282] At least for rural households reliant on coconut plantations for their livelihoods.

detrimental to the rural poor, as the *A. fulica* case study demonstrates. What the case studies presented here highlight is the varied role IAS can have on the livelihoods of the rural poor. The fact that IAS can either improve or impoverish livelihoods emphasises why they need to be considered when discussing development issues.

The second challenge to Objective 1, as identified in the NDS, is population growth and rural-urban migration. The strategy notes that the "Solomon Islands has serious problems with rapid ***unplanned*** urban expansion" (SIG, 2011, p. 9 – emphasis in original) due to internal migration. As noted in Chapter 5, migration has played a significant role in the livelihood strategies of many Solomon Island communities, particularly those from the eastern islands, where livelihood opportunities are limited due to a lack of development. Gough et al. (2010, p. 7) note that migration to other places within the Solomon Islands is an established process, especially for communities on the more isolated[283] islands. Many of these remote islands are almost completely self-sufficient, relying on agriculture and marine resources for their food supply (ibid., p. 4). Emigration helps maintain the populations on these islands at levels which can be supported by the existing agriculture and marine resource base[284] (Feinberg, 2010, p. 46; Mertz et al., 2010, p. 24). The arrival of an IAS like *A. fulica* to these islands has the potential to exacerbate the migration issue. On their own, IAS are not a driver of migration. Weber (2014, p. 121) notes that decisions to migrate are complex and diverse.

> Migration is often based on free and involuntary aspects, on opportunities and constraints, on hope and desperation at the same time (ibid.).

Nonetheless, Weber also argues that

> There is no doubt that the degradation of the natural environment can lead to huge pressures for individuals and communities. This even can result in people leaving their homes temporarily or for good (ibid., pp. 121-122).

[283] Island communities are rarely, if ever completely closed in on themselves. Mertz et al. (2010, p. 11) argue that "…historical practices of connectivity and current experiences with borderless capital and wireless communication weaken the metaphor of 'isolation' with which small islands are often associated. Nevertheless, it should be acknowledged that the combination of actual distances across vast expanses of water, limited government support and insufficient development of shipping does create situations in which small island populations are left to fend for themselves and live in relative isolation".

[284] And also provides remittances.

As the *A. fulica* case study shows, households on Guadalcanal have abandoned areas and suffered food shortages because of the snail. Based on the impact *A. fulica* has had on subsistence agriculture on Guadalcanal, its arrival on these remote islands could see a dramatic, sustained decrease[285] in agricultural food production to levels that may not support the current population. With agricultural land areas already fully utilised[286] (Feinberg, 2010, p. 44; Mertz et al., 2010, p. 14) and links to outside markets from which to purchase food "…sporadic at best" (Gough et al., 2010, p. 5), increased emigration is a probable scenario; fuelling the urban expansion issue that already exists within the country.

Closely coupled with the issue of migration is the third challenge to achieving Objective 1 of the NDS: social and communal stability. While significant progress has been made in promoting and maintaining stability after the civil unrest of 1998-2003, the root causes largely remain present. Population pressures due to the high levels of migration from the outer islands to Guadalcanal are one such cause (SITRC, 2012, p. 240). Stability is seen as a necessary condition for achieving a better future for all Solomon Islanders (SIG, 2011, p. 9), but as outlined in Chapter 5 there is still some underlying tension between the Guale and those from other provinces; particularly amongst the youth. Unless managed properly, uncontrolled and unplanned migration could contribute to new civil unrest (SITRC, 2012, p. 745). As noted above, specific IAS such as *A. fulica* have the potential to exacerbate migration issues, particularly from the outer islands where livelihoods are heavily reliant on agricultural production. While the extent to which IAS may induce migration is unknown, the pressures placed on individuals and communities from environmental degradation (Weber, 2014, pp. 121-122), such as that caused by (but not limited to) IAS, is a factor that could contribute to the migration issues faced by the country. The NDS notes that migration can be reduced by improving rural living standards (SIG, 2011, p. 9). Additionally, it could be reduced by preventing the deterioration, by IAS, of the environment on which so many current rural livelihoods depend.

[285] Unlike with most natural disasters, where crop losses are relatively short-term and can be re-established.

[286] Either under cultivation or in fallow. Figure 8.1 outlines the coping strategies undertaken by households following the arrival of *A. fulica*. Due to the limited land area available for cultivation on these islands there would be limited scope in which to move crops to *A. fulica* free areas.

In addition to the overarching focus area just discussed, the NDS has two central focus areas, or 'pillars' (see Figure 8.2). The first of these,

> 'Taking Better Care of all the People of the Solomon Islands', is concerned with fulfilling social needs of the people, including support for the vulnerable and better access to education and healthcare for all (ibid., p. 5).

Three objectives support this focus area;

> Objective 2: To provide support to the vulnerable,
>
> Objective 3: To ensure that all Solomon Islanders have access to quality healthcare and to combat malaria, HIV, non-communicable and other diseases, [and]
>
> Objective 4: To ensure that all Solomon Islanders have access to quality education and for the country to adequately and sustainably meet its manpower needs (ibid.).

Again, although IAS are not discussed in the NDS in relation to these objectives, IAS affect all three of these objectives in various and interrelated ways, as illustrated below.

One specific vulnerable group identified by the NDS are women[287] (ibid., p. 13). As outlined earlier in this chapter (and in Chapter 7), *A. fulica* is having a major impact on the livelihood opportunities of women in areas through which it has spread. The *A. fulica* case study found that the presence of the snail has resulted in reduced earnings from activities women in the Solomon Islands rely on for cash. These include such activities as the sale of surplus garden crops, cocoa production, and cut flowers. As noted in Part 1 of this chapter, *A. fulica* is directly contributing to the hardship of many rural households in the Solomon Islands. Particularly the poorest households, as they are the most reliant on subsistence agricultural activities for their livelihoods. Of concern is that female-headed households are disproportionately represented among the poor (ibid., p. 9). Given the key role women play, not only in food security, but as Okali (2006, p. 18) has noted, in rural economic growth, these impacts should be of considerable concern with regards to the country's development policies.

[287] Children are another.

Because the impacts of IAS can be felt differently between men and women (Fish et al., 2010, p. 52),

> …how they are managed is a matter of some consequence. …Invasive species have impacts on poverty and sustainable use of natural resources. In both of those areas taking a gender perspective has been shown to be important when assessing, designing and implementing interventions and monitoring and evaluating the outcomes (ibid., p. 8).

As noted above, the NDS is silent concerning the impacts of IAS on vulnerable groups such as women, and yet, IAS impacts can have a significant influence on the lives of women. This therefore needs to be taken into account when developing policies aimed at women. This is particularly the case for those policies with transformatory potential that seek to move beyond conventional social protection programmes and implement long-term sustainable change "…into arenas such as equality and economic, social and cultural rights" (Okali, 2006, p. 20).

As has been reported in the literature, IAS can also have detrimental human health impacts (see Fish et al., 2010, pp. 16-17; Maundu et al., 2009, p. 46; Reaser et al., 2007, p. 7 for example). The health impacts *A. fulica* has, such as its contribution to malnutrition from reduced food security, eosinophilic meningitis via the consumption of snail contaminated food, and its potential role in assisting the breeding of *Aedes* mosquitoes[288] is of concern, not only for vulnerable groups in the Solomon Islands, but for the wider community. Despite this, enquiries made with the Ministry of Health during the course of my fieldwork indicated that no work into the consequences or extent of these health impacts on the lives of Solomon Islanders was being undertaken (Field notes 29 and 30 August 2013). *Wasmannia auropunctata* also have health impacts, and vulnerable groups are of particular concern. As outlined in Chapter 6, infants are particularly susceptible to *W. auropunctata* when on the ground or sleeping. Being virtually defenceless, they are unable to prevent the ants from crawling over them and being stung. A number of interviewees raised this as being a serious health risk for babies. As the above discussion illustrates, IAS are having serious (and potentially life threatening) consequences in the Solomon Islands. Greater awareness

[288] A vector for both dengue and Zika virus.

of the issue, and better understanding of the extent of the problem is a missing component of Objective 3 of the NDS.

Education is a further concern. Objective 4 of the NDS seeks to ensure all Solomon Islanders have access to quality education, but this too has been affected by IAS. Chapter 7 demonstrated how children's education was directly and indirectly affected by *A. fulica*. While the indirect impacts on education caused by the financial constraints due to IAS was foreseeable, the direct destruction of schoolbooks and papers by *A. fulica* was unexpected. Other indirect impacts, such as poor nutritional intake[289], are also likely to be operating, given the impact *A. fulica* is having on food security in the areas it has invaded. While not the only factor determining whether children attend school or not, the presence of *A. fulica* was repeatedly raised by households as a significant factor for this.

In sum, although the NDS recognises that women, children and other vulnerable groups are affected by many cross-cutting issues, IAS are not included as one of these. As the above discussion highlights, IAS affect vulnerable groups "…in myriad, often unpredictable and at times contradictory ways" (Pfeiffer & Voeks, 2008, p. 281). Given that some of these ways can be dire (for example specific health and food security impacts), IAS are an additional issue that should be taken into consideration when developing policies aimed at these groups. For example, the 2013 SIG RAMSI People's Survey (ANU, 2013, pp. 48-50) found that only 11% of respondents received agricultural extension information services, with women being far less likely (less than half as often) to receive information than men. Given the key role women play in food security it is vital that agricultural extension services aimed at women are increased. Equally as vital, is that these services address IAS that are of concern to women.

The second central focus area of the NDS (see Figure 8.2) centres on

> 'Improving the livelihoods of all the people of the Solomon Islands' and is about improving the economic benefits to the people through higher growth, increased employment and the distribution of the benefits of development (SIG, 2011, p. 6).

[289] Which can affect learning ability (Stevenson, 2012, p. 28).

This focus area has two objectives;

> Objective 5: To increase the rate of economic growth and equitably distribute the benefits of employment and higher incomes amongst all provinces and people of the Solomon Islands, [and],
>
> Objective 6: To build and upgrade physical infrastructure and utilities to ensure that all Solomon Islanders have access to essential services and to markets (ibid.).

Again, IAS can affect both of these objectives in various and interrelated ways as demonstrated by the case studies.

As covered in Chapter 5, small-holder agriculture forms an important component in the livelihoods and food security of many rural households, not only in the Solomon Islands, but throughout the Pacific (Connell, 2010, p. 116; Kull et al., 2013, p. 7; W. Morgan, 2013, p. 1; Thaman, 2008, p. 103). The NDS recognises this view, arguing that agriculture is a major economic sector for the country and is the main source of rural employment and livelihoods (SIG, 2011, p. 23). Subsistence agriculture is practised by the vast majority of Solomon Islanders (Bourke et al., 2006, p. 1; SIG, 2011, p. 23), with the domestic marketing of surplus production playing an increasing role in the cash income for rural households (SIG, 2011, p. 23). As already noted under Objective 1 of the NDS, strengthening the subsistence sector is a main aim of the NDS. Objective 5 seeks to build on this by developing the natural resource based sectors, such as agriculture, through the promotion of agribusiness and value-added approaches in order to increase the country's economic development. Agriculture is seen as having a big role to play in the economic growth of PICs (W. Morgan, 2013, p. 3). For this to occur, it is argued that the focus needs to shift away from undifferentiated commodities to a focus on high-value, niche-marketed agricultural-based products (Connell, 2010, p. 117; W. Morgan, 2013, p. 3; SIG, 2011, p. 23). Value-added niche production, particularly in the Pacific agriculture sector, has been promoted as a tool for sustainable economic development by policy makers and aid donors (Coates, Clark, & Skeates, 2010, p. 19; Jones, Murray, & Overton, 2012, p. 14; MFAT, 2015, p. 12; W. Morgan, 2013, p. 3). As demonstrated by the case studies, IAS can have variable effects (both positive and negative) on agricultural production and therefore their presence will have an influence on the outcomes of Objective 5 as discussed below.

Like the migration issue raised above, IAS on their own will not determine the success or failure of this economic growth approach, or whether it will provide benefits to the people of the Solomon Islands. Research, looking largely at agricultural niche production case studies from the Pacific , found that while it has potential for economic development in the Pacific, the benefits were not broad-based (Coates et al., 2010; Jones et al., 2012), with Jones et al. (2012, p. 75) arguing that it was unlikely "…to result in large increases in material standard of living for substantial numbers of Pacific [Islanders]". Similarly, Connell (2010, p. 117) notes that agricultural niche production opportunities in the Pacific have often been transient, arguing that they are "…vulnerable to subtle global shifts in demand (and therefore prices) and intervening opportunities…" (ibid.). Additionally, many of the agribusinesses operating in the Pacific are micro-enterprises (Coates et al., 2010, pp. 9-12; Jones et al., 2012, p. 16). In the Solomon Islands, programmes to support micro-enterprises "…are ineffective at providing technical and entrepreneurial training, support for business planning and management and facilitating access to finance" (SIG, 2011, p. 23). So even without the influence of IAS, the hurdles facing the achievement of this objective of the NDS are considerable. IAS add a further complexity to the issue.

Consistency of raw product supply is one obstacle facing agribusinesses operating in the Pacific (Jones et al., 2012, p. 24; SPC, 2011, p. 1). Natural disasters, such as cyclones, are one recognised constraint on the supply chain, and as demonstrated by the case studies, IAS can be another. Products derived from cocoa, for example, provide niche marketing opportunities for Pacific nations[290]. As discussed in Chapter 7, in the areas in which it has become established, *A. fulica* is having a serious impact on cocoa production in the Solomon Islands, with some growers reporting losses in the vicinity of 80% (HH male: interview # 36; Garden visit: interview # 23). Such effects on the supply of raw materials will impact on the chances of agribusiness opportunities being successfully developed around commodities like this in the Solomon Islands. While *W. auropunctata*, as discussed in Chapter 6, appear to be benefitting the production of raw commodities such as coconut[291], it should be noted that in other parts of the world their presence in other specific niche crops (for example

[290] For example, chocolate bars (W. Morgan, 2013, p. 5) and organic cocoa (Coates et al., 2010, p. 12).
[291] From which a number of niche marketed products are produced in the Pacific (Coates et al., 2010, p. 10; SPC, 2011, p. 8).

citrus groves and coffee plantations) has affected the ability of producers to supply raw products (Fabres & Brown, 1978, pp. 139-140; Spencer, 1941, p. 6). This implies that the livelihood benefits being derived from *W. auropunctata* in the Solomon Islands are context specific and cannot be assumed to apply to other situations or crops. So while agricultural micro-enterprises, as covered by Objective 5 of the NDS, have a potential role to play in the economic development of the Solomon Islands, they face some significant hurdles. Invasive alien species, as the case studies have shown, will have an influence on this objective, raising or lowering the bar depending on the species concerned.

Closely related to Objective 5 of the NDS is Objective 6: "To build and upgrade physical infrastructure and utilities to ensure that all Solomon Islanders have access to essential services and to markets" (SIG, 2011, p. 6). Improving the physical infrastructure and access to services and markets goes hand in hand with increasing the opportunities and distribution of economic growth. Invasive alien species are also closely tied to this objective, as the case studies have demonstrated. As noted in Chapter 7, infrastructure development has directly led to the spread of *A. fulica* within the Solomon Islands. Machinery and gravel taken from Guadalcanal for the construction of telecommunication towers on other islands has led to the introduction of *A. fulica* into new areas (SIAQS: interview # 60). Likewise, residents from two Guadalcanal communities east of Honiara informed me that *A. fulica* arrived in their location with the machinery used to construct a nearby bridge (HH female: interview #56; HH male female: interview # 45). The way in which *A. fulica* has been unintentionally distributed around the country in the course of infrastructure development highlights the link between IAS and development issues. To illustrate, a key infrastructure challenge identified in the NDS is transport. The NDS notes that domestic shipping services and maritime infrastructure have deteriorated in the Solomon Islands and needs reviving (SIG, 2011, p. 32). Regular domestic shipping services, the NDS argues, increases domestic trade and economic activity (ibid.). However, as discussed in Chapter 2, more trade (be it international or domestic) means more IAS, which can potentially compromise the very livelihoods that better infrastructure and market access are trying to improve. As the *A. fulica* case study shows, having ready access to markets is of little consequence if you have nothing to sell due to the impacts of an IAS.

It should be noted that the above discussion is not an argument against economic and infrastructure development. These are important components in improving the livelihoods of Solomon Islanders. Rather, the above discussion is a reminder of the need for greater awareness of the full effects, both positive and negative, that economic growth and infrastructure development bring, including those associated with IAS. Lin et al. (2007, p. 1) have shown that in China economic development has accelerated biological invasions, with those provinces that are more economically developed having a higher abundance of IAS (ibid.). The authors argue that although

> …economic growth is welcomed and desirable to meet social requirements and to improve the quality of life of growing human populations,…more invasions cause more ecological and economic damage (ibid., p. 4).

Rather than advocating against economic growth, the authors argue for the incorporation of the goal of minimising biological invasions into the economic growth agenda (ibid.). This approach would see IAS issues become an integral part of the economic development process rather than an externalised, often overlooked cost, as is largely the case at present (McNeely, 2006, p. 9; Perrings, Mooney, et al., 2010, p. 12). The incorporation of such a goal into the Solomon Islands economic growth agenda, as outlined in the NDS, could ensure that those livelihoods which economic growth is intended to help are not burdened or compromised by the unintentional associated costs of an IAS like *A. fulica*.

IAS are not absent from the NDS, but just as the focus of IAS literature in general is on their ecological impacts (as outlined in Chapter 2), so too is their focus in the NDS. Invasive alien species are mentioned as one challenge facing the fourth focus area of the NDS: creating and maintaining the enabling environment (SIG, 2011, p. 6) (see Figure 8.2). This focus area includes

> …protecting the environment and managing natural resources, efficiently working with international partners and strengthening good governance with Solomon Islands national, provincial and community level governments (ibid.).

The NDS raises IAS as an issue in relation to Objective 7; namely, "…to effectively manage and protect the environment and ecosystems and protect Solomon Islanders from natural disasters" (ibid.). In particular, the NDS argues that IAS pose a threat to biodiversity and land degradation, stating that,

> Degradation of **land resources** is becoming a primary environmental concern, with significant implications for sustainable development and economic activity. Food security and quality is threatened and rural labour opportunities diminish. Where land degradation and structural decline occur or invasive species are prominent, land is often abandoned, triggering additional pressures. Abandoned lands are havens for invasive species, sources of sediment, and can lead to additional tenure disputes (SIG, 2011, p. 37 – emphasis in original).

As earlier discussions show, *A. fulica* has contributed to land degradation and increased marginalisation in the Solomon Islands (also see Figure 8.1). But, while there is a relationship connecting degradation (i.e. undesirable ecological transformations), marginalisation and IAS (Robbins, 2012, p. 170), "not all cases fit readily into the simple pattern of degradation and marginalisation" (ibid.). *Wasmannia auropunctata* illustrates this point[292]. Undoubtedly, *W. auropunctata* has contributed to some undesirable ecological transformations in the Solomon Islands. The biodiversity impacts described in Chapter 2 attest to this[293]. Although *W. auropunctata* has affected the livelihoods of agricultural producers in other parts of the world (Fabres & Brown, 1978, pp. 139-140; Spencer, 1941, p. 6), there was no evidence that *W. auropunctata* has contributed to the marginalisation of households in the Solomon Islands. If anything, they may be contributing to poverty alleviation for some households.

As indicated above, the effects of IAS are complex. What the *W. auropunctata* case study presented here, and other cases from the literature show (for example, see Kaufmann, 2004; C. Shackleton et al., 2007) is that the environmental impacts IAS may have do not automatically translate into livelihood impacts for all sectors of society. Granted, as Reaser et al. (2007, p. 4) note, the environmental impacts may be

[292] As do cases from the literature. For example, see C. Shackleton et al. (2007); Kannan et al. (2014); Shaanker et al. (2010).

[293] As noted earlier in Chapter 6, this research is not an ecological study. However, as part of this research I did ask interviewees whether they had observed any impacts that *W. auropunctata* had on wildlife, either in general or on those species that they may have harvested as wild foods. Many stated that they had not noticed either way. Members from one focus group noted that they had observed possums blinded by the ant (Focus group: interview # 64), whereas another interviewee reported that while his family's pig dogs had been blinded by the ant, he had never noticed it in the feral pigs they caught (NGO: interview # 63). Another interviewee noted that he had not noticed any decline in the abundance of possums he harvested as wild food, despite the widespread presence of *W. auropunctata* in the area (HH male female: interview # 53).

"…so subtle that they are not readily perceived, but be cumulative over time", thus manifesting their livelihood impacts at a later date. But equally true, as Kull et al. (2013, p. 8) point out, IAS related environmental impacts can reduce over time as the IAS become part of the local ecology. The point being, as Kull et al. (2013, p. 9) highlight, is that it:

> is next to impossible to assert at a general level whether the… [environmental changes due to IAS] …are good or bad, for the answer depends on the particular case (the species, the context, the scale), on interactions between different ecosystem services, and – most critically – on diverse human judgements.

Environmental concerns are an important issue in relation to IAS and their acknowledgement in the NDS is important for achieving a better life for all Solomon Islanders. But, while raised as a challenge to achieving Objective 7, the threat IAS pose does not extend into the policies and strategies aimed at supporting the achievement of this objective and the risk is that the issue may be lost and overlooked as an area of concern in the underlying sector plans.

As this section has attempted to demonstrate, environmental issues are not the sole area of concern when it comes to improving the livelihoods of Solomon Islanders. Economic and social aspects are equally important. Invasive alien species can have far reaching effects, influencing many different sectors (with social, economic, and/or environmental mandates), often in completely contradictory ways (Pfeiffer & Voeks, 2008, p. 289). Recognition of this could contribute to better development outcomes for the country.

The final objective of the NDS - Objective 8: To improve governance and order at national, provincial and community levels and strengthen links between them (SIG, 2011, p. 6) - also has an IAS element to it. It is under this objective that policies and strategies supporting border security and quarantine are proposed (ibid., pp. 46-47). The importance of good biosecurity in the prevention of IAS is undisputed (Keller & Lodge, 2010, p. 232; UNEP, 2014a, p. 14). As noted in Chapter 7, the IAS issue in the Solomon Islands exceeds current budget and resources of the SIAQS; a common problem experienced by government departments worldwide. While undoubtedly some efficiencies could be made in the use of resources, ultimately the SIAQS has to

work within its limited budget, which means prioritising its responses. Current priorities[294] mean that there is a significant gap around post-border control of IAS in the Solomon Islands. This is illustrated by the *A. fulica* case study. Although two-thirds of the SIAQS annual budget is directed at *A. fulica*, most of this goes towards internal border security and primary incursion control in an effort to limit the extent of the problem. This leaves many households in areas where *A. fulica* has become established, to manage the problem on their own, which is largely ineffective and detrimental to their livelihoods. Given the wide ranging influence IAS can have on the livelihoods of Solomon Islanders, there is a strong need for a greater emphasis on post-border control of IAS in the Solomon Islands, especially for those IAS identified as being detrimental to the development goals of the country.

This section has highlighted how IAS can challenge contemporary development policy objectives in the Solomon Islands. These government policies shape and influence the livelihood strategies that are available to Solomon Island households[295], and have the aim of providing a better life for all. As the above discussions show, IAS have an influence on each of the objectives geared towards this aim. Yet despite this, the Solomon Island NDS is largely silent on the role IAS play in the livelihoods of those it seeks to improve. This, as discussed in Chapter 2, is not unique to the Solomon Islands Government. Governments, industries and communities worldwide have failed to grasp the scale of the IAS issue (Barnard & Waage, 2004, p. 4; Browne et al., 2009, p. 8; Murphy, 2014, p. 4; Steiner, 2010; Thaman, 2013). Back in 2004, Barnard and Waage (2004, p. 5) were arguing that:

> IAS management in most areas has been relegated to a sectoral activity, especially for the protection of the environment, agriculture, or trade. …Many countries remain only dimly aware of the costly social, economic, and ecological disruption which inevitably arises from [such] narrow sectoral planning and management. …The challenge is to mainstream this management into national development planning, without delay.

[294] As noted in Chapter 7, the primary focus of SIAQS is on awareness within the high risk industries/pathways which are most likely to see *A. fulica* being transported to other provinces, and on the control of newly reported incursions.
[295] Through what sectors are promoted, where infrastructure is constructed, and what social services are available, for example.

Little has changed since then, which is why IAS are still considered to be "…one of the most serious but under-acknowledged threats to sustainable development …" (UNEP, 2014a, p. 13).

8.4 Conclusion

This chapter has sought to address two of the secondary research questions raised in Chapter 1. The first was how do IAS influence the vulnerability/resilience of Solomon Island livelihoods? As the chapter demonstrates, the livelihood impacts of IAS are complex and at times contradictory. How vulnerable or resilient a particular livelihood strategy is to IAS is dependent on the species, the context and the scale (Kull et al., 2013, p. 9). Contemporary rural livelihoods in the Solomon Islands are heavily reliant on subsistence/semi-subsistence agriculture. *Wasmannia auropunctata* for the most part is not negatively affecting this livelihood strategy. While there are some social impacts associated with *W. auropunctata* in the Solomon Islands, overall Solomon Island households can be considered resilient to this IAS. *Achatina fulica* on the other hand is a different story. This species is negatively affecting the subsistence/semi-subsistence agricultural sector on which so many rural Solomon Island households depend. This has resulted in households implementing negative livelihood diversification measures as they fail to cope or adapt to the snails' presence. Unlike for *W. auropunctata*, Solomon Island households have not demonstrated a great deal of resilience to *A. fulica*.

The other secondary research question addressed by this chapter concerned the extent to which IAS challenged current development policy in the Solomon Islands. The Solomon Island NDS mentions IAS as an issue in regards their environmental impacts. But as this chapter has demonstrated, IAS have a far greater influence on rural livelihoods than this. Invasive alien species touch each of the three sustainable development pillars: environmental, social and economic. With such a broad influence on many livelihood aspects, there is an urgent need to shift away from the narrow and limited sectoral approach currently taken with IAS, and fully recognise them as a significant development issue.

Chapter 9: Invasive Alien Species – A Blip on the Development Screen

9.0 Introduction

In line with the research aims outlined in Chapter 1, this thesis has explored the influence IAS have on contemporary rural Solomon Island livelihoods. Using two case studies, *Wasmannia auropunctata* and *Achatina fulica*, it has investigated the effects these species have had on rural livelihoods, how vulnerable/resilient these livelihoods are to IAS, and the implications IAS have for sustainable development in the Solomon Islands. As highlighted in Chapter 1, IAS issues have largely gone unrecognised in development circles; flying under the radar of many sectors and governments. This thesis has sought to illustrate the multiple effects IAS have on the livelihoods of those living with, and enduring the consequences of these invasive species. In doing so, it has attempted to go some way towards putting IAS issues firmly on the screens of development practitioners. In this chapter, concepts and theories from the literature and key findings from the research process are brought together to conclude the research.

9.1 Recognising Invasive Alien Species as a Development Issue

As outlined in Chapter 3, livelihoods comprise both the economic and non-economic attributes necessary for survival, and they are considered to be sustainable when they can cope with, and recover from, adverse events without undermining the natural resource base (DFID, 1999). In the Solomon Islands around 80% of the population live rurally and small-scale agricultural production is central to the livelihoods of many. Utilising long-standing traditional practices, such as diverse crops (agrobiodiversity) and landscape mosaics (fragmentation) (Campbell, 2009, p. 90; 2014; Kull et al., 2013, p. 8) agriculture has been central to the food security, income and livelihoods of many Solomon Islanders throughout the history of the country. While traditional agricultural practice has been modified over the course of time, it still remains the underlying activity that supports many Solomon Island households, with around 89% of all households growing some of their own food and the great majority also producing something for the cash sector (SIG, 2009b, p. 14). Although

the natural resource base supporting this dominant livelihood strategy is under some pressure, due for example to reductions in fallow periods and soil fertility (Bourke et al., 2006, p. 24); by and large, small-scale agricultural systems such as those practised in the Solomon Islands, are considered to be sustainable (Kull et al., 2013, p. 13). Nevertheless, despite this assertion, there are still areas of uncertainty regarding the sustainability of such livelihood strategies, particularly with regards issues such as IAS. Little is known about the specific impacts IAS have on rural livelihoods (Murphy, 2014, p. 4) and whether these impacts may affect the sustainability of those livelihoods.

While not a new phenomenon, the rate of dispersal of IAS around the world over the last fifty years is unprecedented (Hulme, 2009, p. 11). Invasive alien species are closely linked to trade, and trade is an integral part of contemporary neoliberal development policy[296]. As global trade increases, so too it is predicted, will invasion rates of IAS (Levine & D'Antonio, 2003, p. 325; Paini et al., 2016, p. 3). While this has been identified as a major threat to livelihoods across the Pacific region (Tye, 2009, p. 3), there is a lack of scientific research into the impacts IAS have on Pacific livelihoods, such as those described above for the Solomon Islands, to support this claim one way or the other.

This situation reflects the global trend with regards to IAS research. Invasive alien species have only been a relatively recent (1980s, 1990s) focus of the scientific literature (Simberloff, 2011, p. 14). Originating out of concerns IAS were having on biodiversity and ecosystems (McNeely, 2001a, p. 6), this aspect of research has come to dominate the approach taken with regards IAS. As a result, the environmental sector has largely been the main force championing the IAS cause (Murphy, 2014, p. 4). Consequently, little attention has been given to the specific influence IAS have on the day to day lives of those people living with invasions. Murphy (2014, p. 4) notes, that at the national level, governance of the natural environment usually falls to the Ministry of Environment (or the equivalent), whereas 'pest' issues often lie with the

[296] Which is strongly focused on economic growth. This for example, forms an important part of New Zealand's development agenda (MFAT, 2015, p. 3) and the international SDGs have specific goals (goal 8) and targets (target 17.10) associated with trade and economic growth (United Nations, n.d.). It is also part of the Solomon Islands development agenda (SIG, 2011, p. 5).

Ministry of Agriculture. Likewise, national development oversight usually falls to a separate ministry yet again[297]. This, Murphy (2014, p. 4) argues, frequently results in poor information flow within a country on issues such as IAS. This means that IAS issues are new or unknown to many sectors of government outside of the environmental sector, and largely go unseen and un-actioned. Browne et al. (2009, p. 13) support this view and note that in many parts of the world there is still a lack of scientific information on IAS, "…insufficient mechanisms for the dissemination of information to relevant decision makers, and a general lack of awareness about the issue" (ibid.). It is with good reason therefore that the UNEP (2014a, p. 13), when reviewing the major environmental and socio-economic issues deemed critical to the sustainable development of SIDS, identified IAS as a significant but under-acknowledged threat.

9.2 Key Findings - The Impacts of Invasive Alien Species on Rural Livelihoods in the Solomon Islands

This section provides an overview of the key findings of this research and addresses the primary research question; namely what implications do IAS have for sustainable livelihoods in the Solomon Islands? This study confirms that the livelihoods approach, with its holistic view of the realities people face and the range of approaches they take to achieve their livelihood goals, is an effective framework for assessing the effects IAS have on people's lives. As discussed further below, the holistic approach taken by the livelihoods framework enabled the cross-cutting effects that IAS have to emerge during this study. The single sector approach, to which IAS issues are often relegated (Barnard & Waage, 2004, p. 5) does not capture this aspect, which in part, contributes to their relatively low profile.

As the case studies presented in this thesis show, the effects of IAS on rural livelihoods are complex. One such complexity is the time an IAS has been in the country. C. Shackleton et al. (2007, p. 122) note that there is a temporal dimension to the study of IAS impacts on rural livelihoods, arguing that adaptions "…only evolve after a period

[297] In the Solomon Islands it is with the Ministry of Development Planning & Aid Coordination (MDPAC). 'Pest issues' are largely dealt with by the Ministry of Agriculture and Livestock, particularly through the SIAQS. Environmental issues generally fall under the mandate of the Ministry of Environment, Climate Change, Disaster Management and Meteorology (MECDM).

of time and exposure to the IAS" (ibid.). Similarly, Kull and Rangan (2015, p. 496) argue that:

> Most invasion biology and political ecology studies focus on immediate spatiotemporal consequences such as disruption to places, human communities or native biodiversity.

They contend that researchers should:

> Adopt scopes of analysis that encompass landscape and ecological change as an integral part of the human processes of regional transformation and evolution (ibid., p. 497).

Citing work conducted on plant invasions in Timor by McWilliam (2000), Kull and Rangan (2015, p. 497) note that long-term, the impacts of these invasions appear to resolve themselves as households adapt to the constraints and advantages the species offer (ibid.). Other studies (for example, Kannan et al., 2014; Shaanker et al., 2010; C. Shackleton et al., 2007) have made similar observations.

Wasmannia auropunctata appear to support this view. *Wasmannia auropunctata* have been in the Solomon Islands for almost 50 years now and households have become accustomed to their presence, considering them part of the landscape. Because of the length of time *W. auropunctata* have been in the country it was hard to establish with certainty a temporal dimension to the impacts *W. auropunctata* had on rural households in the Solomon Islands. In some cases, interviewees were born after the arrival of *W. auropunctata* so did not know any different. Others were unable to remember. Those that could recall the arrival of *W. auropunctata* into their location[298] stated that *W. auropunctata* had not required them to change to any great extent the way they went about their livelihood activities. While it is possible that this is because those households that were unable to cope with *W. auropunctata* are no longer present, this is considered unlikely because of the widespread nature of *W. auropunctata* and the continued widespread practice of semi-subsistence agriculture in the Solomon

[298] Or vice versa. For example, in 1977, following an earthquake which devastated communities on the weather coast of Guadalcanal, the Solomon Islands Government relocated some of the affected people to alienated lands on the northern coast of the island (HH male: interview # 4). Some of those households were interviewed as part of this study. These interviewees stated that *W. auropunctata* was not present on the weather coast at that time but many of those who remembered the move to the northern coast said it was present in their new location. Despite its presence, the interviewees reported that it had not changed their livelihood approach, with semi-subsistence agriculture forming the mainstay of their livelihoods.

Islands. While in the short-term the impacts of *W. auropunctata* may have required some adjustments, long-term, contemporary Solomon Island households have adapted to their presence. However, while households may adapt to the constraints and advantages of IAS over time (Kull & Rangan, 2015, p. 497), the short-term livelihood impacts of invasive species should not be so readily dismissed, as the *A. fulica* case study shows. As noted earlier in Chapter 2, the impacts of *A. fulica* can diminish over time as the population naturally declines (Mead, 1979, p. 83; Simberloff & Gibbons, 2004, p. 165). Similarly, newspaper articles from the Solomon Islands (Eremae, 2014; Piringi, 2015) report a reduction in *A. fulica* numbers and impacts due to the predatory flatworm *Platydemus manokwari*[299]. Therefore, a long-term look at *A. fulica* may not see this species as a particular problem. But as this research shows, what happens in the short-term can be devastating for local livelihoods, driving many households into hardship, from which some may not recover. As the case studies presented here demonstrate, both aspects need to be considered when looking at the livelihood impacts IAS have, and this needs to be taken into account when designing policies and interventions aimed at alleviating those impacts.

Another complexity is that "IAS are rarely uniformly problematic or uniformly beneficial to entire geographic communities" (C. Shackleton et al., 2007, p. 121), because of the heterogeneous nature of such communities. Both *W. auropunctata* and *A. fulica* illustrate this point, although *W. auropunctata* more so. For the majority of the population *W. auropunctata* is a nuisance, and while it does not have negative impacts on a household's income portfolio it does negatively impact on their general well-being (for example affecting their sleep). However, for those growing coconut (and even for some of those growing garden crops), *W. auropunctata* is regarded as potentially beneficial as they believe it controls pests which would otherwise impact on crop productivity (and subsequently income). "Good for plants, not good for people" is how one woman described *W. auropunctata* to me (Field notes 7 November 2013). This has led some sections of the community to deliberately move the ant onto crops, as noted by Bigger (1984, p. 32) and one of my focus groups (Focus group: interview # 42). Woodley (2002, p. 268), in her description of gardening practices on

[299] As noted in section 4.6, this event occurred after I completed my fieldwork and therefore the full effects of this event are unknown.

the island of Vella Lavella (in the Solomon Islands Western Province), also noted that people were deliberately moving red ants[300] into their gardens in an effort to control crop pests. Similarly, a NGO representative working with small-holder farmers in the Solomon Islands reported to me that on Makira people were putting empty tuna tins in their gardens in an effort to attract *W. auropunctata*; in the belief that the ants controlled pests that would otherwise damage their crops (NGO: interview # 54). As noted in Chapter 2, *W. auropunctata* has been deliberately spread to crops as a pest control agent in other locations around the world (Fabres & Brown, 1978, p. 140; Wetterer & Porter, 2003, pp. 22-23).

Even given the near universal negative experiences encountered by households affected by *A. fulica*, I still came across one person who thought that *A. fulica* was a benefit (due to it being a source of free food – Field notes 7 November 2013) as well as being informed by others that certain communities were utilising the species[301] (Field notes 11 November 2013). As C. Shackleton et al. (2007, p. 121) argue, how useful or problematic an IAS is, is a matter of perspective and scale.

Coupled with the points just raised is that different IAS species have different impacts, both in magnitude and in the range of activities they affect (either directly or indirectly). The case studies presented here illustrate this variability across a number of aspects. One of which is the gender impacts IAS have. Fish et al. (2010, p. 52) note that "…the immediate effects of species invasions can be experienced in different ways by men and women"[302]. But just as importantly, different species can be experienced in different ways by men or women, and the impacts that *W. auropunctata* and *A. fulica* have on women in the Solomon Islands demonstrates this. In Solomon Island society, the gendered division of labour means that women are largely responsible for keeping the house clean. Although both *W. auropunctata* and *A. fulica*

[300] Red ant was a term sometimes used by people I interviewed when discussing *W. auropunctata*. However, Woodley (2002) does not identify the ant so there is no certainty that she is describing *W. auropunctata*. While there are no reports of *W. auropunctata* on Vella Lavella, it was well established on other Western Province islands by this time (see Chapter 6).
[301] Two GPPOL staff members told me that their Indonesian workers regularly prepared dishes from *A. fulica* and as noted in Chapter 7 people deliberately moved *A. fulica* around in the belief that it was good for feeding to pigs.
[302] For example, this can be seen in section 6.2.1 where the men's and women's focus groups from one community had different perceptions on the abundance and effects of *W. auropunctata*.

frequently invaded homes, it was only *A. fulica* that generated additional workloads[303]. While women reported that keeping the house clean was also important in preventing *W. auropunctata* infesting the house, they stated that this was achieved as part of their normal cleaning routine. Likewise, the control of *A. fulica* from gardens and flower beds added additional workload for women, whereas there were no reported workload changes associated with *W. auropunctata*.

The variability in the magnitude of impacts that different IAS species can have also shows itself with the influence *W. auropunctata* and *A. fulica* have had on the economic opportunities of Solomon Island households following similar livelihood strategies. As noted in earlier discussions, *W. auropunctata* has not had much of an impact on the income portfolio of households in the Solomon Islands reliant on subsistence/semi-subsistence agriculture. These households have been able to maintain their livelihood portfolios and food security in the presence of *W. auropunctata*. *Achatina fulica*, on the other hand, has had a significant effect on this core livelihood strategy, causing considerable hardship for many households. Households in the Solomon Islands affected by *A. fulica* have employed negative livelihood diversification/substitution practices and have abandoned assets (the most critical being the use of the land) as they struggle to cope and adapt to the snails. Critically, *A. fulica* have affected both wealthy and poor households. The generic assumption that wealthy people have more assets and therefore a higher adaptive capacity (Djoudi, Brockhaus, & Locatelli, 2011; GISP, 2006, p. 8) needs reconsidering (Djoudi et al., 2011). Djoudi et al. (2011) raise this point in relation to climate change studies in Mali. However, the point is equally pertinent to IAS. As shown in Figure 8.1 (Chapter 8), having more assets (land access) did not prevent wealthier households from succumbing to the effects of *A. fulica*. Ellis (2000b) argues that vulnerable households are those

> …prone to adverse external events and lacking the assets or social support systems that might be able to carry them through *periods of adversity* (my emphasis).

Because IAS are a long-term slow-wave driver of change, the 'period of adversity' many households face when confronted with an IAS like *A. fulica*, extends well

[303] Due to the work to clean up their slime trails, faeces, and removal of the snails themselves.

beyond their usual ability to cope; even for the wealthy. As one traditional landowner told me:

> Disasters… come and go, but the snail it stays. You do not know for how many years you will continue to feel the effects (HH male: interview # 67).

The two case studies have demonstrated the variable impacts that different IAS have, and this means that how households cope and adapt to different IAS will also be highly variable. While poor households, with their limited assets, may succumb more quickly than the wealthier, the long-term nature of IAS means that all are susceptible if a particular IAS affects a livelihood strategy being followed by that household.

Furthermore, IAS can affect a range of activities. Fish et al. (2010, p. 52) note that the "…impacts of invasive species are often multiple, interact, and lead to a series of other …impacts". This too however is variable between species. Both *W. auropunctata* and *A. fulica* had cross-cutting impacts, but they were most pronounced with *A. fulica*. The snails' impact on garden productivity not only had financial implications, but also health implications (malnutrition concerns). Financial impacts also flowed through into education as parents were unable to meet the costs of keeping their children in school. Health concerns, such as the empty shells providing potential breeding sites for disease-transmitting mosquitoes, also have flow on effects as illness from these vectors affect children and adults alike. While *W. auropunctata* also affected a range of interrelated activities in the Solomon Islands, the extent and the flow-on effects this had, did not match those caused by *A. fulica*.

The above discussion not only emphasises the need to look at IAS on a case by case basis, but it also emphasises the cross-cutting, interrelated impacts IAS are having. As argued throughout this thesis, IAS transcend sectoral boundaries. A sole focus on only one sector would, in some cases, underestimate the implications certain IAS can have on the livelihoods of those living with invasions. Solely focusing on the economic impacts households face, for instance, would completely miss the main effects *W. auropunctata* has on households in the Solomon Islands, as they largely affect the non-financial aspects of people's lives. Although such a focus would identify *A. fulica* as being a significant issue for those households dependent on subsistence/semi-subsistence agriculture, it would miss the wider health risks to which the entire community is susceptible. Touching on all three of the sustainable development pillars

(social, economic, environmental), IAS exert a broad influence on the livelihoods and well-being of rural people, not only in the Solomon Islands, but across the globe. However, as illustrated in Chapter 8[304] (and the literature – Barnard & Waage, 2004, p. 4; Browne et al., 2009, p. 8; Murphy, 2014, p. 4; Steiner, 2010; Thaman, 2013), this influence still continues to go largely unrecognised by many governments. Allison and Horemans (2006, p. 759) argue that

> Understanding how people succeed or fail in sustaining their livelihoods in the face of shocks [and] trends… can help to design policies and interventions to assist people's existing coping and adaptive strategies.

This can only occur, however, if the full range of shocks and trends are recognised. To date, this has not been the case for IAS, and as such, they remain a significant missing component of development policy.

9.3 Lessons for the Future

This research supports the view held by the literature that IAS are an important development issue (Barnard & Waage, 2004, p. 5; GISP, 2006, p. 11; Thaman, 2013; UNEP, 2014a, p. 13), which is still being largely overlooked (Thaman, 2013, p. 13; UNEP, 2014a). Trade and IAS are linked (Paini et al., 2016, p. 3), and the importance of trade and economic growth to the contemporary neo-liberal economic development agenda is not going to abate any time soon. This means that IAS issues are only going to increase, so the problems they cause need to be more widely acknowledged and solutions more widely instigated. Particularly in developing countries, where the risk and frequency of entry and spread of IAS has increased significantly (UNEP, 2014a, p. 13).

Just as IAS are not a new issue, neither are many of the solutions to the problem. Barnard and Waage (2004, p. 17), Murphy (2014, p. 5), and the UNEP (2014a, p. 14) for example, all broadly outlined actions that should be taken, or gaps that needed addressing, to move this issue forward. These included (but are not limited to): preventing new introductions, inventories of current introductions, risk assessments of pathways and spread, coordinated action and investment between sectors, raising the

[304] See the section on the Solomon Islands NDS and the largely silent approach it takes to the role of IAS in the country.

awareness of IAS – especially at the political level, and increasing research into IAS. However, while these actions are undeniably important, and are being instigated by some governments to various degrees, more needs to be done to advance the issue (Murphy, 2014, p. 5). Critically, as Allison and Horemans (2006, p. 759), Murphy (2014, p. 5) and Djoudi et al. (2011) argue, there is a need to learn from national and local examples and use those experiences to inform future plans. This is particularly so for the impacts IAS have on rural livelihoods, of which so little is still relatively known. With this in mind, the remainder of this section looks at some of the main over-arching lessons from this study and how these can inform future decisions and approaches to IAS.

First and foremost, there need to be more local examples to draw experiences from. As noted in Chapter 2, the livelihood impacts of IAS are one of the least explored aspects of IAS research. More local case studies are needed to ensure informed and appropriate policies and interventions are developed to address this critical issue. That said, this area is receiving more consideration in recent times. For example, CABI UK has recently (2016) launched a website[305] profiling the livelihood threats of IAS. However, the website's focus on Africa and Asia further illustrates the point made in Chapter 2, that there is a paucity of research into the livelihood impacts of IAS in the Pacific region. While these African and Asian examples provide valuable general learnings, Pacific solutions by and large require Pacific case studies to draw from.

One reason more local case studies are required is because different IAS, as outlined earlier in this chapter, can have different effects on very similar livelihoods. The impacts of *W. auropunctata* and *A. fulica*, on the dominant livelihood strategy practised in the Solomon Islands, varied considerably, as did households' ability to cope and adapt to the different species. Other IAS are likely to have different effects yet again. Similarly, because communities are heterogeneous, specific IAS are rarely problematic to everyone (C. Shackleton et al., 2007, p. 121). This, as Murphy (2014, p. 4) notes, means that in some situations certain IAS can be a livelihood for some (or improve some livelihoods - as *W. auropunctata* in the Solomon Islands illustrates), yet at the same time cause misery and cost to others. While the case studies presented in

[305] See http://www.invasive-species.org/

this thesis largely highlight the negative effects IAS can have on rural livelihoods, it would be incorrect to assume this is universally so for all IAS (see Kaufmann (2004), C. Shackleton et al. (2007), S. Shackleton et al (2011) and Kull et al. (2013) for examples of the positive effects IAS can have on rural livelihoods). Furthermore, the cross-cutting effects IAS have mean that for every IAS there are many local facets that need exploring. This thesis has raised a number of further research areas for the two species investigated[306]; the role that *A. fulica* shells play in the prevalence of mosquito borne diseases in the Solomon Islands being a prime example. All these points emphasise the need for more local case studies to inform local solutions. They reiterate the point made by Kull et al. (2013, p. 9) that it

> is next to impossible to assert at a general level whether [IAS] …are good or bad, for the answer depends on the particular case (the species, the context, the scale).

As noted previously, raising the awareness of the IAS issue amongst decision makers, across sectors, and amongst the public, has been identified as an important requirement to move this issue forward. Development agencies in particular need to engage in this issue. However, before doing so, it is vital that they understand IAS concepts. The management of IAS is a technical issue and therefore requires a sound technical knowledge of the subject to ensure that inappropriate practices are avoided. For example, as discussed in Chapter 7, the SIAQS contracted a local development NGO to assist with *A. fulica* awareness programmes in the Solomon Islands. While the mode of delivery was good, some of the messages being delivered were not. A lack of understanding of some of the basic technical principles of pest control[307] meant that false expectations[308] were created by the NGO within the communities it talked to. Coupled with this was a lack of technical capacity within SIAQS to maintain a liaison and presence with the communities visited by the NGO. This meant that technical questions arising from the awareness programme were left to non-technical people to address. Not only did this lead to false expectations being created, but it also led to a feeling of being abandoned by the Government when these expectations were not met. Low (2012) notes other examples from around the world where inappropriate use or

[306] As raised in Chapters 6 and 7.
[307] See Holloway (1993, pp. 287-289) for an outline of these.
[308] For example, the promise of a bounty system as a control technique.

management of IAS by development agencies has placed additional hardships on local livelihoods. What this highlights, is the need to expand IAS technical capacity across all sectors. As noted earlier in this chapter, the main force championing IAS issues has been the environmental sector (Murphy, 2014, p. 4). But as illustrated throughout this thesis, IAS also have a social and economic impact. One reason for the poor information flow on IAS issues between these sectors (ibid.) is the lack of technical knowledge of the subject outside of the environmental sector. Coupled with this is that the environmental sector is largely focused on the removal of IAS due to their negative impacts on ecosystem services (S. Shackleton et al., 2011, p. 190). As S. Shackleton et al. (2011, p. 190) remind us, IAS can also be a valuable resource and play a role in reducing the vulnerability of the world's poorest households. Mainstreaming IAS technical capacity into the social, economic and environmental sectors would provide a much needed impetus in raising the awareness of this complex issue and ensure appropriate policies and interventions are developed that provide a balance between the benefits and disadvantages of IAS (ibid.).

9.4 Final Word – Donald's Story

Situated just metres off the highway in a rural area east of Honiara, sits a group of three small houses. The homes belong to Donald[309] and the other nine members of his extended family. Donald moved here with his family in 2001 and established gardens in which they grew a wide range of crops, which they used to feed the household and to sell in the central market in Honiara. Donald also obtained a labouring job which provided additional income for the family. All that changed however in 2007 when *A. fulica* arrived in their area.

Since *A. fulica* arrived they no longer make gardens and grow their own food, because the snails eat all the crops. Although they tried to control it initially, snail numbers just kept on increasing and the problem became too hard for them. Now, according to Donald, every evening the snails cover the area around their houses like stones. They go into the houses and eat any food stored there, such as bananas and sweet potato. The snails also foul the houses with their droppings and slime trails, creating more work for his daughters who are responsible for keeping the houses clean.

[309] Not his real name.

With no food or income from the garden the family has set up a roadside stall from which they sell betel nut that they buy from others and on sell. On a good day they make around SBD$100 which they use to buy food to feed the entire family. The money Donald earns from his job helps but it is mainly used to cover other expenses like school fees. While it is a struggle, he has been able to keep the one school-aged child in school. What will happen when the others reach school age, he does not know.

The widespread distribution of the snails also means that Donald is unable to call on wantok for support. They all face the same problem, he tells me. No one has enough to share.

As we wrap up our interview, Donald reflects that what they have experienced with *A. fulica* has been really challenging for them; that his family has fallen on hard times because of it. He admits that sometimes he just wants to give up; but knows that he has to struggle on to survive and to support the family (HH male: interview # 28).

As this thesis has demonstrated, the threat IAS pose to sustainable rural livelihoods, like Donald's, can be very real. But while households like Donald's (and Mary's - section 1.0, Chapter1) struggle to endure the best they can in these invaded spaces (Rogers, 2015, p. 38), many governments, decision makers, and development agencies blindly continue to debate development issues in the absence of IAS (McNeely, 2006, p. 6). Failure to make IAS a priority and incorporate them into the development agenda will see many livelihoods continue to fall short of their full potential. Invasive alien species are a development issue, and for Donald, Mary, and the many others whose voices adorn these pages, they are an issue that needs to be addressed as a matter of urgency.

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Appendices

Appendix 1: Massey University Ethics Approval

MASSEY UNIVERSITY
TE KUNENGA KI PŪREHUROA

1st May 2013

Dean Stronge
178 Karaka Street
WHANGANUI

Dear Dean

Re: Invasive Alien Species: A Threat to Sustainable Livelihoods in the Pacific? A Study of the Livelihood Impacts of Little Fire Ants (*Wasmannia auropunctata*) in the Solomon Islands

Thank you for your Low Risk Notification which was received on 1 May 2013.

Your project has been recorded on the Low Risk Database which is reported in the Annual Report of the Massey University Human Ethics Committees.

The low risk notification for this project is valid for a maximum of three years.

Please notify me if situations subsequently occur which cause you to reconsider your initial ethical analysis that it is safe to proceed without approval by one of the University's Human Ethics Committees.

Please note that travel undertaken by students must be approved by the supervisor and the relevant Pro Vice-Chancellor and be in accordance with the Policy and Procedures for Course-Related Student Travel Overseas. In addition, the supervisor must advise the University's Insurance Officer.

A reminder to include the following statement on all public documents:

> *"This project has been evaluated by peer review and judged to be low risk. Consequently, it has not been reviewed by one of the University's Human Ethics Committees. The researcher(s) named above are responsible for the ethical conduct of this research.*
>
> *If you have any concerns about the conduct of this research that you wish to raise with someone other than the researcher(s), please contact Professor John O'Neill, Director (Research Ethics), telephone 06 350 5249, e-mail humanethics@massey.ac.nz".*

Please note that if a sponsoring organisation, funding authority or a journal in which you wish to publish requires evidence of committee approval (with an approval number), you will have to provide a full application to one of the University's Human Ethics Committees. You should also note that such an approval can only be provided prior to the commencement of the research.

Yours sincerely

J. O'Neill

John G O'Neill (Professor)
Chair, Human Ethics Chairs' Committee and
Director (Research Ethics)

cc A/Prof Glenn Banks
School of People, Environment & Planning
PN331

Dr Rochelle Stewart-Withers
School of People, Environment & Planning
PN 331

Dr Allanah Ryan, HoS
School of People, Environment & Planning
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Massey University Human Ethics Committee
Accredited by the Health Research Council

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E humanethics@massey.ac.nz animalethics@massey.ac.nz gtc@massey.ac.nz **www.massey.ac.nz**

Appendix 2: Information Sheet and Informed Consent

PhD Research into Invasive Species and Livelihoods in Guadalcanal
Individual/Household Information Sheet

My name is Dean Stronge. I am a PhD student at the Institute of Development Studies, Massey University, New Zealand.

I am here to conduct research into the impacts that invasive species have on the livelihoods of Solomon Islanders. In particular I am interested in how little fire ants and the giant African snail affect people's lives.

The research will involve interviews and discussions with individuals, households, non-government and government organisations during which my aim is to collect information on how these species affect different aspects of people's lives.

Participation in this research is voluntary. If you are interested in taking part in this study you are welcome to ask any questions about your participation in the research now or at any point in time during the study. If you agree to participate you will be asked to sign a consent form. You have the right withdraw from the study at any time and the right to refuse to answer any particular question if you take part in the research.

Interviews will be audio recorded and written notes taken, unless otherwise requested. You have the right to have any information provided by you erased or destroyed at any point.

All information provided will be treated confidentially and will only be used for this research. Research assistants have been required to sign a confidentiality form. Your

name will not be used in any reports or publications unless you agree for your name to be used. All data will be stored securely and all recorded interviews will be erased after analysis of the data.

This project has been evaluated by peer review and judged to be low risk. Consequently, it has not been reviewed by one of the University's Human Ethics Committees. The researcher named above is responsible for the ethical conduct of this research. If you have any concerns about the conduct of this research that you wish to raise with someone other than the researcher, please contact Professor John O'Neill, Director, Research Ethics, telephone 06 350 5249, email: humanethics@massey.ac.nz.

Thank you for your time and consideration.

PhD Research into Invasive Species and Livelihoods in Guadalcanal

Informed Consent

I have read and understood the information sheet provided and have had the details of the study explained to me to my satisfaction. I have been given the opportunity to ask questions regarding any concerns I may have and understand that I may ask further questions at any point of the study.

My consent is given voluntarily with the understanding that I am free to withdraw it at any time without prejudice.

I understand that I can decline to answer any question and that I can, at any time during the study, request that any information provided is not used.

I agree to provide information on the basis outlined in the information sheet.

I agree to the interview being audio recorded.

Name: _____

Signed: _____

Dated: _____

Where required, the contents of this document have been explained in SI Pijin by:

Name:

_____

Contact:

_____

Appendix 3: Interview Schedules

These questions formed the basis of the semi-structured interviews. Additional probing questions were used, depending on the response.

Household Interviews

Knowledge of IAS

- How long have you lived here?
- How long have LFA/ GAS been here?
- Has their abundance changed over the last 5-10 years, if so how? Why do think it has changed?
- How did the LFA/GAS get here?
- How does it get spread?
- Have attempts been made by the HH to control them?
    - If yes;
        - Who does the control (Men, Women, Children)?
        - What times – How many hours a day?
        - How big is the garden?
        - Are the numbers being reduced?
    - If no; why not?

Natural Capital

- What land types does your HH have access to (crops/farm, gardens, plantation, natural forest, other)?
- What are they used for?
- What are the terms of access - is it customary land or settlers (terms – rent, wantok connections – reasons for being allowed to stay)
- Does LFA/GAS cause any problems with regards your HH use of this land? if yes, what problems do they cause?
- Does the presence of LFA/GAS reduce the amount of time you spend in the garden/plantation?
- What affect has it had on your work output?
- What affect has it had on the size of your garden/plantation?
- What affect has it had on your income?

- What affect has it had on the productivity of the garden?
- Does this species have any benefits for your HH?
- Has your HH food production been affected by LFA/GAS? Explain.
- Are you still able to provide enough food for the HH to eat?
- If you cannot meet the HH food needs, what do you do?
- What livestock do the household own?
- Have livestock numbers changed in the last 10 years?
- Have livestock been impacted by LFA/GAS/?
- Have you noted any changes in wildlife/wild foods due to the presence of LFA/GAS/? Explain.

Financial Capital

- How does the household earn income (include cash and non-cash activities)?
- What is the main activity – by whom (describe for all members)
- What other activities do you undertake – by whom?
- Which is the most important?
- [For sellers at market – how many hrs/day selling?
    - How many days/week?
    - How much do you make in 1 day (average/estimate)?
    - Cost of transport to/from market?
    - Do you pay a stall fee/ taxed licence fee?
- Has your income been affected by GAS/LFA (increased, decreased, stayed the same over time (describe))?
    - If decreased – what is given up (school fees, church fees, food items)?
- Have you had to change what activity you earn income from because of IAS?
- Describe pre IAS activities.
- Describe post IAS activities.
- Is there any particular time when you are more vulnerable to IAS?
- Do you grow your own food for the HH or buy?
- What crops are grown in the garden and why?
    - Taro and LFA – is crop productivity increasing, decreasing, same in the presence of LFA?

- Are gardening practices changing? Why? [location of gardens in relation to HH]
- What wild foods are harvested? When? Has this changed? Why? [any IAS impacts]
- Has the size of your garden increased, decreased, same – why?
- Size now?
- Size then?
- How much labour is required to work this land – has this changed as a result of IAS?

Physical Capital

- Housing, markets, transport, water supplies, sanitation? Are these compromised in any way by IAS? How so?
    - Prompt house invasions by LFA
    - GAS
        - Do they go into the house?
        - What impacts does it cause?
        - Eat paper?
        - Leave mess/slime?
        - Who cleans this up?
        - How often?
- Are you able to move your garden location if GAS/LFA numbers get to high?

Social Capital

- Do you have relatives in the community/ other communities on Guadalcanal / other Provinces?
    - Do you give/receive help from them (labour/ food/ money, goods etc.)? Explain.
    - Have these forms of mutual aid increased, decreased or stayed the same over time? Explain.
- Have IAS affected your ability to meet wantok obligations – in what way?
- Has it increased your need to call on these obligations in any way?

- Have any social (recreational/sports events) or cultural (religious) activities been limited due to LFA/GAS? Explain.
- Does the community work together to address the problems GAS/LFA are causing or is it an individual HH approach?
- Have GAS/LFA been the cause of any conflict in the community?

Vulnerability /Resilience

- What strategies do you use to cope with GAS/LFA?
- What have been the main changes in living conditions because of the IAS?

Policies/Institutions etc.

- What organisations, institutions, associations dealing with IAS work/or have worked in the community?
- What assistance do they provide/what programmes have they undertaken?
    - Who benefits, who does not and why?
- What rules, regulations and customs are in place regarding IAS that affect people's livelihoods?
    - Who makes those rules etc.?
    - Who is affected by them and how?

Human Capital

Name	Relation to HH head	Age	Sleep at home	Eat at home
1.				
2.				
3.				
4.				
etc				

- How many people in the HH have been stung by LFA? How often does this occur? Consequences? Any health impacts from other IAS?
    - What treatment is sought? (Medical centre/traditional)
- GAS - What health impacts are occurring due to the snail's effects on food security?
- Do men and women have different roles in the HH/garden/plantation – how do LFA/GAS affect men and women as they undertake these roles?
- Is there active interest amongst the children of the HH in learning gardening/other livelihood skills? [are kids not going to gardens due to LFA or is it just a lack of interest in traditional practices? – re Woodley (2002) and the overall reduction in traditional knowledge and practice with subsequent generations]

<u>For LFA only communities</u>

- If GAS gets here – what do you see as your prospects for the future?
- How do you think it will impact on you?
- What will you have to change in the way you do things to cope with this?

Stakeholder Interviews

<u>NGOs/Commercial</u>

- How are IAS affecting the communities you deal with? (prompt for LFA/GAS specifically)
- Are there particular sectors of the community affected more than others (e.g. particular livelihoods, genders, ages etc.)?
- What is being done to manage this issue? - by whom?
- What should be done? – by whom?

<u>SI Government</u>

- Knowledge of IAS and their impacts within the country (in particular LFA/GAS).
- Description of the programmes undertaken for these species.
- Progress, barriers and issues.

- Process for deciding which species to work on.
- Resources available to Departments – how has this changed over time?
- Exploration of development agenda /trade policies and awareness/knowledge of IAS issues pertaining to these.
- Available documents.

Appendix 4: Focus Group Composition

Focus Group	IAS Discussed	Group Composition
FG1	GAS	Five male village leaders and around as many young men (young men from the community came and went throughout the discussions. They did not participate in the discussions).
FG2	GAS	Five staff from a rural primary school (three men, two women) plus one male from a HH near the road who introduced me to the staff at the school.
FG3	LFA + GAS	Four male farmer representatives from a local NGO. Two from Western Province, two from Malaita. One female staff member from the NGO was also present.
FG4	LFA + GAS	Seven women and two men from a rural community. The women did most of the talking.
FG5	LFA + GAS	Four male and three female adult agricultural students from a rural training centre.
FG6	LFA + GAS	Four female staff members from a rural training centre.
FG7	LFA + GAS	Four men and two women from a rural community.

Appendix 5: Focus Group Pairwise Ranking Results

Focus Group 4

	GAS	**LFA**	**PM**	**BB**	**WF**
GAS		GAS	GAS	GAS	GAS
LFA			LFA	LFA	WF
PM				BB	WF
BB					WF
WF					

GAS (giant African snail) = 4

WF (unidentified white fly scale insect) = 3

LFA (little fire ant) = 2

BB (unidentified black beetle) = 1

PM (paper mulberry) = 0

Focus Group 7

	LFA	**PM**	**Rat**	**BA**
LFA		LFA	Rat	LFA
PM			Rat	PM
Rat				Rat
BA				

Rat (unidentified rat species) = 3

LFA (little fire ant) = 2

PM (paper mulberry) = 1

BA (unidentified black ant) = 0

Appendix 6: Sample Locations for *Wasmannia auropunctata*

Location	1:50,000 Map Series	Grid Reference
Foxwood/Red Beach	Burns Creek, Solomon Islands 0916005 X715 Edition 1-SI50K	219574
Henderson Airport	Burns Creek, Solomon Islands 0916005 X715 Edition 1-SI50K	169578
St Martins Rural Training Centre, Tenaru	Burns Creek, Solomon Islands 0916005 X715 Edition 1-SI50K	177552
Tomboko	Honiara, Solomon Islands 0915908 X715 Edition 1-SI50K	908675
Pao	Burns Creek, Solomon Islands 0916005 X715 Edition 1-SI50K	154523
Toghusai	Burns Creek, Solomon Islands 0916005 X715 Edition 1-SI50K	255547
Poha	Honiara, Solomon Islands 0915908 X715 Edition 1-SI50K	976591