Developing A Systems Understanding of Rural Water Supply in Timor-Leste

by

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Submitted in fulfilment of the requirements for the degree of

Doctor of Philosophy

Deakin University

May, 2015
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submitted for the degree of Doctor of Philosophy

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Date: 01/05/2015
Acknowledgements

For ethical reasons I cannot name the participants of my research and so I will refrain from naming any of the myriad people who deserve to be acknowledged here.

I would like to extend my thanks to the residents of the aldeias in Timor-Leste who answered my endless questions with patience, tolerance and good humour and who made me feel welcome in their homes. Staff members from NGOs facilitated my visits and also answered questions; my thanks go to them as well. I wish to extend my appreciation to the staff of government departments and elected officials in Timor-Leste who were both forthright and generous with their time.

Others who have helped me along the way for reasons of professionalism or collegiality, I thank you for your time, your patience and your thoughtful critiques of my work.

New friends I have made along the way, family and old friends have provided support, inspiration and fair amount of proof reading. Thanks heaps!

Chapter 4 starts with a quote from author Sir Terry Pratchett who wrote amazing books and who passed away on March 12th, 2015. If you are reading this thesis and you have never read a Discworld novel, I recommend that you read one.
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1 Introduction

1.1 Abstract

This thesis presents an original articulation of the links between sociology, development and complex adaptive systems (CAS) theory that highlights the significance of user choice in international community development. The research has explicitly applied systems thinking techniques to the water sector of international community development in an attempt to explicate the connections within and between rural communities, non-government organisations, policy environments and technology. In doing this the applicability of CAS theory for informing both policy and implementation in WASH programs is queried and found to provide a useful framework for conceptualising the drivers of beneficial outcomes in WASH programs.

Methodologically this research is founded in a transformative paradigm (Mertens 2007) that highlights the voices of the residents of rural villages and their perceptions of WASH programs as applied in their situations. It provides a multilayered perspective of the strengths and issues involved in the implementation of robust water systems through the lens of a CAS framework and systems thinking tools.

This thesis is based on research conducted between 2011 and 2015 in Australia and Timor-Leste. Data collection was primarily via semi-structured interviews, conversational surveys and participative observation. Semi-structured interviews were conducted with staff from NGOs based in Australia and Timor-Leste and included diagramming of professional ego networks (Wasserman & Faust 1994). Conversational surveys and participative observation were undertaken as part of case studies in five villages in rural areas of Timor-Leste.

Results are presented in graphical and narrative formats that make visible the interconnected realities of rural residents with WASH technologies and the NGOs that provide them. The ensuing discussion locates the research results within a CAS framework.

At a theoretical level this thesis concludes that development occurs as a result of processes which also cause increases in complexity. Applying complex adaptive systems theory as a framework for international community development activities opens up a new set of questions for development practitioners and academics. In the end these questions ask us to interrogate the process of development in order to ensure the positive gains of development outcomes, such as the provision of water, are not counteracted by processes that neglect the diversity and agency of individuals in a community.
Acknowledging development as a complex adaptive system leads to a further conclusion that the use of systems thinking tools is an appropriate approach to intractable development issues. Systems thinking tools including system dynamics, social network analysis and common pool resource management are applied, within a framework of complex adaptive systems theory and development sociology, to create a unique picture of the drivers of robust water supply systems and services.

Utilising the CAS framework, I concluded that community managed water systems can be classified as common pool resources (CPR). From common pool resource theory it became clear that the installation of water level indicators on community tanks could create significant opportunities for water user groups to enhance their management of water systems and services. Also arising from CPR theory is the conclusion that variable fee structures related to variable service levels would provide a ‘user choice’ arrangement. A variable fee structure would need to reflect the amenity of the water service in terms of tap locations, reliability, volume delivered and quality of water. The consequence of providing users the option to pay for higher amenity should be felt in the increased opportunity for individual agency and increased diversity. These increases, according to the theoretical results, can lead to increased complexity and increased development outcomes.

Other conclusions that arise from the application of systems thinking include the need for development agencies to create or extend networks of WASH stakeholders in rural areas. In the context of Timor-Leste, creating extended WASH networks would include ensuring that government officials, retailers, rural residents (in particular water management committees) and service providers are introduced personally to each other. The creation of informal networks like this provides scope for the emergence of locally appropriate and locally directed support structures for WASH services.

The insights gained from exploring WASH programs implemented in Timor-Leste from within a complex adaptive systems perspective indicate that there may be usefulness in a broader application of this perspective. For international community development program staff, a CAS framework can be used to question assumptions and model solutions alongside ‘experts’ and communities. It is compatible with theory of change practices and highlights feedback loops that act both for and against development objectives. For managers and donors of programs it highlights that, in the face of local government capacity shortfalls, there is a need for flexible programs that allow for locally emergent solutions to be implemented.
1.2 Introduction

Access to water that is both plentiful and safe is considered by the UN to be a human right (UNHRC 2010) yet there are over 748 million people globally who don’t have access to water that is potable, accessible and plentiful (WHO & UNICEF 2014).

Development agencies alone spend over $8 billion a year on the implementation of water systems across the majority world (WHO 2012). Despite this, it seems that many water systems implemented by NGOs are not robust. Given the importance of water for development in general, it is appropriate that this lack of robustness of water systems is a cause for concern.

Over the 70 years since the end of World War 2, development organisations have evolved a range of strategies for improved localised supply of water to communities. Variations of technology, education, skills training, community engagement, government engagement, standards, participation, ownership and community management have been implemented in different combinations all over the world (Cairncross & Valdmanis 2006) and still there are 748 million people without access to improved drinking water sources (WHO & UNICEF 2014).

Intuition alone will tell us that international community development is a complex situation. International community development involves a range of actors with different motivations; it also involves problems that seem intractable. It is clear that different aspects of any development situation will influence other aspects in ways that are sometimes predictable, but which are more likely to catch us by surprise (Rihani 2002a). These are all classic hallmarks of a complex adaptive system (CAS).

This thesis argues that development is a CAS. Building from the argument CAS theory is applied as an overarching framework to investigate the long term sustainability of water systems in rural areas of Timor-Leste. Systems thinking tools such as system dynamics (SD) and social network analysis (SNA) are applied to case studies of five villages in Timor-Leste.

Quantitative techniques are coupled with a rigorous analysis of qualitative data, in mind of Bourdieu’s (1977, 1986) insights to practise, habitus, capital and field, as well as Max-Neef’s (1991) work on human scale development. The theories of both Bourdieu and Max-Neef lend themselves to understanding the world as being complex and interrelated, hence there is value in applying sociological theory within a complex adaptive systems framework.

It is recognised throughout this work that the people of Timor-Leste (Timorese) are capable, resilient and resourceful, both individually and collectively. They have managed to maintain lives and livelihoods, family, culture and community despite 25 years of overwhelming aggression perpetrated upon the country and in the wake of hundreds of years of disinterested colonial rule. As Bourdieu and Max-Neef both maintain a respectful acknowledgement of individual agency
throughout their theories, this sits well with the strengths generally acknowledged of Timorese people, hence is an appropriate starting point for understanding community actions within Timorese villages.

In any consideration of any CAS, boundaries are a key idea. The scope of the system under analysis necessitates a broad boundary – so as to include as many influencing factors as possible. The inclusion of government and non-government organisations, communities, individuals, environment, technology and policy provide the broad boundary for this thesis leading to a multilayered and comprehensive final analysis.
### 1.3 Abbreviations, Acronyms & Definitions

<table>
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<th>Term</th>
<th>Description</th>
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<tr>
<td>AusAid</td>
<td>Australian Government Aid Agency: now subsumed by the Australian Government Department of Foreign Affairs and Trade (DFAT).</td>
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<tr>
<td>BESIK</td>
<td>Bee, Saneamentu no Ijene iha Komunidade (Water, Sanitation and Hygiene in Communities): An AusAid program supporting GoTL goals in WASH. BESIK is currently in its third iteration having previously been known as RWSSP and then BESIK and now BESIK 2.</td>
</tr>
<tr>
<td>CAP</td>
<td>Community Action Planning: Participatory process for planning development interventions</td>
</tr>
<tr>
<td>CAS</td>
<td>Complex Adaptive System(s): see chapter 4</td>
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<tr>
<td>CLTS</td>
<td>Community Led Total Sanitation: a participatory development program that uses peer pressure and the disgust factor of faeces transmission to encourage latrine building and hand washing</td>
</tr>
<tr>
<td>DNSAS</td>
<td>National Directorate of Water and Sanitation Services</td>
</tr>
<tr>
<td>DNSB</td>
<td>National Directorate of Sanitation</td>
</tr>
<tr>
<td>DSAS</td>
<td>District Water and Sanitation Services</td>
</tr>
<tr>
<td>FCSD</td>
<td>Sub-district Community Facilitator (also SDF)</td>
</tr>
<tr>
<td>GMF</td>
<td>Grupo Manajemento Facilidade (Community Water Management Group)</td>
</tr>
<tr>
<td>GoTL</td>
<td>Government of the Democratic Republic of Timor-Leste</td>
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<td>INGO</td>
<td>International NGO</td>
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<tr>
<td>JMP</td>
<td>WHO/UNICEF Joint Monitoring Program for Water Supply and Sanitation</td>
</tr>
<tr>
<td>LNGO</td>
<td>Local NGO (i.e. an NGO that is specific to Timor-Leste and is not a sub-group of a larger INGO)</td>
</tr>
<tr>
<td>MDGs</td>
<td>Millennium Development Goals</td>
</tr>
<tr>
<td>Abbreviation</td>
<td>Description</td>
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<tr>
<td>NGO</td>
<td>Non-Government Organisation</td>
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<tr>
<td>O&amp;M</td>
<td>Operation and Maintenance</td>
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<td>ODA</td>
<td>Official Development Assistance</td>
</tr>
<tr>
<td>PSF</td>
<td>Environmental Health Promoter</td>
</tr>
<tr>
<td>SAS</td>
<td>Water and Sanitation Services department of the GoTL</td>
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<tr>
<td>SD</td>
<td>Sub-district</td>
</tr>
<tr>
<td>SDF</td>
<td>Sub-district Facilitator (also FCSD)</td>
</tr>
<tr>
<td>SDGs</td>
<td>Sustainable Development Goals</td>
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<tr>
<td>SIBS</td>
<td>Sistema Informasaun Bee no Saneamentu Water Asset Information System, GoTL</td>
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<tr>
<td>SNA</td>
<td>Social Network Analysis</td>
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<tr>
<td>SPHERE</td>
<td>The Sphere Project is a working group of humanitarian agencies who aim to improve the quality and accountability of humanitarian assistance. They produce technical guidelines for humanitarian action.</td>
</tr>
<tr>
<td>WASH</td>
<td>Water Sanitation and Hygiene</td>
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<tr>
<td>WHO</td>
<td>World Health Organisation</td>
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1.4 Tetun, Indonesian and Portuguese terms used in the text:

<table>
<thead>
<tr>
<th>Term</th>
<th>Description</th>
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<tbody>
<tr>
<td>Aldeia</td>
<td>Village</td>
</tr>
<tr>
<td>Angunna</td>
<td>Truck used for passenger transport to remote villages</td>
</tr>
<tr>
<td>Bairo</td>
<td>Sub village</td>
</tr>
<tr>
<td>Barlake</td>
<td>Traditional marriage rituals</td>
</tr>
<tr>
<td>Chefe</td>
<td>Leader/chief/head</td>
</tr>
<tr>
<td>Chefe Aldeia</td>
<td>Elected head of village</td>
</tr>
<tr>
<td>Chefe Suco</td>
<td>Elected head of group of villages</td>
</tr>
<tr>
<td>Ema Timor</td>
<td>Person or people of Timor-Leste</td>
</tr>
<tr>
<td>Folin</td>
<td>Bride price paid as part of barlake</td>
</tr>
<tr>
<td>Grupo</td>
<td>A group of between three and ten houses clustered together</td>
</tr>
<tr>
<td>Malae</td>
<td>White foreigner</td>
</tr>
<tr>
<td>Mandi</td>
<td>Small tank that stores water for washing</td>
</tr>
<tr>
<td>Suco</td>
<td>Group of villages</td>
</tr>
<tr>
<td>Tara Bandu</td>
<td>A system of designating particular natural resources as sacred or taboo (Escollano Brandao ~2011)</td>
</tr>
<tr>
<td>Tetun</td>
<td>One of the official languages of Timor-Leste</td>
</tr>
<tr>
<td>Timor-Leste</td>
<td>East Timor (Portuguese)</td>
</tr>
<tr>
<td>Timor Lorosa’e</td>
<td>East Timor (Tetun)</td>
</tr>
<tr>
<td>Topasses</td>
<td>Multilingual, ethnically diverse group claiming Portuguese ancestry.</td>
</tr>
<tr>
<td></td>
<td>(<a href="http://en.wikipedia.org/wiki/Topasses">http://en.wikipedia.org/wiki/Topasses</a>)</td>
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The use of some words from Tetun or Portuguese that are in common use in Timor-Leste but given a plural or ownership “s” as per English is not linguistically correct but was also observed to be used by Tetun speakers. One Timorese man shouted hello to a group of women that I was out walking with, as “bondia manas” where bondia is good morning and mana is older sister, but manas is hot (in terms of temperature or sexiness). The obvious translation within the context was “good morning older sister”.

1.5 Other specific terminology

**Majority world/Minority world.** In this thesis I choose to use the terms majority world and minority world to denote the broad dichotomy of areas and people discussed within development theory. The options of third world/first world, developing countries/developed countries, impoverished/wealthy and global south/north all denote to me a form of denigration and implication that the minority of people in this world have the right to label and inflict their way of life, both economically and culturally, on the majority world. I find these other labels useful only in that they are broadly understood. In choosing the terms ‘majority world’ and ‘minority world’ I am explicitly recognising that the majority of global citizens live in conditions that constrain their capacity to achieve abundant social, economic and cultural capital. While there appears to be no widely agreed academic use of these terms it follows a tradition of literature that seeks to highlight the imbalanced perceptions and unequal relations that currently exist between these demographic sectors (Chambers 1997; Grech 2009; Punch 2003).

**Water system.** Throughout this thesis reference to a water system implies the physical infrastructure of water delivery, in particular spring protection, pipes, tanks, taps and valves and where appropriate pumps, wells and solar panels. While this thesis premises that the robustness of the physical infrastructure is subject to certain social aspects of the users, it is easier to discuss these separately from the outset.

**Water service.** Encompasses both the physical infrastructure (water system) and the social and bureaucratic enterprise of water supply.

**East Timor/Timor-Leste/Timor Lorosae.** East Timor is the English term for the country known in Portuguese (its official language) as Timor-Leste and in Tetun as Timor Lorosae. While Tetun is also an official language, the language of government is Portuguese and so I use the same terminology herein as the Government of Timor-Leste uses.

**Residents/Communities/Participants** I find the language of development and the language of research to be both problematic and unavoidable. In referring to those people who have answered my questions in a long interview format, I use the terms participant or key informant or informant. In discussing the geographical communities who allowed me to stay and to observe and question
their practises, I use the terms participant or resident or community. In discussing more generalised concepts I use the term communities. I use the Tetun words aldeia, grupo or bairo when the specific meanings are intended. I use the term village to denote the areas that are identified to me by residents for inclusion in the study as part of their community.

**Village** Clamagirand (1980) indicates that the term village has no particular meaning within Timorese society. The geo-political structural distinctions currently used by the Timorese, in decreasing size, are district, sub-district, suco, aldeia and, bairo or grupo. The aldeia is the smallest recognised administrative unit and may encompass several geographically distinct groupings of houses (bairo/groupo) or it may encompass just one. Within this thesis, I use the term village to describe the areas that local people considered as their community and which they have indicated through mapping and walking these areas with me.

1.6 Research Purpose and Scope

*Why do ~70%¹ of rural water systems implemented by development agencies in Timor-Leste have at least partial breakage within one year of implementation?*

This deceptively simple question is disturbing because development agencies, governments and the UN have been implementing water systems across the majority world for many years. It has become apparent that the failure of waterpoints is a globally intractable issue. In one district of Zimbabwe, Dube (2012) found that around 60% of water points were non-functional. A more generalized lack of robustness of waterpoints was evidenced in a webinar series conducted by the Rural Water and Sanitation Network (RWSN) in 2014 that reported waterpoint failures across Sierra Leone, Mozambique, Tanzania, Kenya, Ethiopia, Ghana, Bolivia, Afghanistan, Nicaragua, Honduras and Malawi (RWSN 2014). This thesis seeks to explore the causes of recurrent issues around the robustness of water points in rural villages of Timor-Leste. The aim is then to understand more generalizable principles for the implementation of water systems appropriate for community managed water supply.

While the main focus of this thesis is water supply, it is inevitable and desirable that any discussion of water supply also includes sanitation and hygiene as these are closely associated with water supply. Sanitation and hygiene are issues that, as a researcher using homestays and observation within my research methodology, I gathered a quite intimate knowledge of. Activities included washing at springs, carrying water and toileting in the dark. This type of experience reinforced for me the importance of working with Timorese people in understanding how to improve access to plentiful clean water within their specific contexts.

¹ The figure of 70% breakdown in the first year of system implementation is based on data collected and reported by government officers over the years from 2001 to 2013 and recorded in the SIBS database.
This thesis is not intended as a critique of development, development theory or development agencies. Rather it is intended to explore a specific issue in development, within a specific context using a novel framework - complex adaptive systems theory (CAS) - that is not mainstream in current development thought and practise. The aim is to apply this framework as a method of gaining insight into the causes for some of the counterintuitive outcomes of development activities. The hope is that this can open up ways for NGOs and water users to achieve more lasting benefits from water, sanitation and hygiene programs. It is perhaps inevitable that some criticism is a part of any analysis of WASH programs. Where there is criticism within this thesis I hope that it is taken in the spirit in which it is intended, to create ideas and conversations about strengthening programs and extending the duration of beneficial outcomes. Certainly staff at the NGOs, government and other individuals whom I met in the course of this research are engaged in making the world a better place for their fellow beings. My respect and admiration for their ethics, determination and abiding love for humanity is unwavering.

1.6.1 Why the outcomes of water, sanitation and hygiene programs in small remote villages in Timor-Leste are important.

It may seem that the daily struggle for survival by residents of poor and remote villages in Timor-Leste is not of great import in a world that is focussed on issues of climate change, global economics and internecine wars. This thesis is grounded in the ideas of social justice and human rights. It recognises that

"The failure to actively pursue justice is not without consequences. From the comprehensive global perspective shaped by the United Nations Charter and the Universal Declaration of Human Rights, neglect of the pursuit of social justice in all its dimensions translates into de facto acceptance of a future marred by violence, repression and chaos. (UN Dept of Economic and Social Affairs 2006)"

If the struggle of residents of small rural villages in Timor-Leste are ignored in the pursuit of “greater good”, if the death of a toddler from a preventable disease is not mourned by many and if we do not stand up and defend the rights of indigenous peoples to a life of their own choosing on their own lands, then we accept a cultural hegemony that represses, kills and undervalues the lives of the many.

Of the 748 million people in the world who do not have access to safe water around 300,000 live in Timor-Leste (WaterAid 2015). The conduct of this research in Timor-Leste does not imply that the people of Timor-Leste are more important than those who live in the slums of Calcutta, the villages of countries in Africa or the Indigenous homeland communities of Australia.

Timor-Leste presents a good case study for WASH as there is a well-developed
set of collaborations around WASH between the government and local and international NGOs. The lessons learned here might be applied to other places where the need for robust water systems and WASH programs is just as urgent. There is no single global statistic that tells us how many small water systems fail each year but the available evidence would suggest that failure rates are at least 20% per year across the countries where community managed water supply is implemented. Timor-Leste, even with its committed government sector and NGOs is no exception to this.

When WASH programs fail to achieve robust delivery of safe water systems and improved sanitation and hygiene, it is not just unfortunate, in many cases it will contribute to the death of a child. Lack of safe water, sanitation and hygiene kills 500,000 children every year (UNICEF 2014, p. 20). Safe water is a human right and good sanitation is required to meet the social justice objectives of access to good health, education and economic prosperity.

The daily struggle of women and children in the remote villages of Timor-Leste is important. John F Kennedy said

“Freedom is indivisible, and when one man is enslaved, all are not free”

The freedom of these children and their families to create the life they want requires a foundation of good health, and that requires access to safe water and good sanitation and hygiene. To pursue these goals is to acknowledge that social justice and human rights must be foundational to all that we do when faced with economic, environmental or humanitarian disasters.

1.6.2 Research Objectives and Research Questions

The research objectives within this thesis are centred on exploring the usefulness of systems thinking in development contexts, they are:

• From a theoretical basis, to determine whether CAS theory is commensurate with development theory and sociology.

• From a practical perspective, to apply the analysis tools of systems thinking to the WASH development environment.

• To review these results for valid new perspectives and strategies arising from the application and analysis of systems thinking tools.

From the research objectives this thesis looks to answer the following research questions:

• Why do water systems fail?

• What factors appear to contribute to robust water systems?
Do systems thinking tools and techniques have useful application within the international community development WASH sector?

1.7 The structure of this document

“there is a problem in discussing systems only with words. Words and sentences must, by necessity, come only one at a time in linear, logical order. Systems happen all at once. They are connected not just in one direction, but in many directions simultaneously. To discuss them properly, it is necessary somehow to use a language that shares some of the same properties as the phenomena under discussion. Pictures work for this language better than words, because you can see all the parts of a picture at once.” (Meadows 2008, p. 5)

This thesis deals with complex adaptive systems in all their interconnectedness. There is a tension in attempting to explain a system using the linear techniques that are the current norm for a doctoral dissertation. While I have attempted to make sense of this by building up concepts iteratively throughout the thesis I apologise that at times there will be ‘disconnects’ where topics of importance sit side by side and only with further reading does their connection become apparent. In the tradition indicated by Meadows (above) Figure 1 may assist the reader to see the significant conceptual interlinkages that arise in this thesis.

Figure 1: Conceptual connections within the thesis

Chapter 2 introduces Timor-Leste and the ema Timor through a first person narrative of my experiences there both prior to and during fieldwork. Having located myself as part of the research scenario I use the first person personal in various sections of this thesis in order to strongly signify the use of participative research. The rest of chapter 2 goes on to give a brief overview of the current state of Timor-Leste and the history that led it to this point including a glimpse of
the nature of traditional networks of sacred observances. Chapter 2 concludes by noting the influence that NGOs have had over the last fifteen years of rebuilding and development in Timor-Leste.

Chapter 3 outlines the nature of Water Sanitation and Hygiene (WASH) programs within the development field. Section 3.1 specifically describes the needs and expectations for WASH programs to deliver water that is potable (safe to drink), plentiful (adequate volume for needs), close to houses and accessible both physically and financially. In section 3.2 there is an overview of the processes of WASH programs. On a local scale, section 3.3 looks to the specific legislations and guidelines for WASH programs in Timor-Leste, including a review of some of the literature critiquing community management. This section concludes by introducing the novel concept of spring fed water supply management as a common pool resource issue.

Chapter 4 introduces Systems Thinking as a way of understanding the world as a Complex Adaptive System (CAS). This begins the argument for the applicability of CAS theory as a framework for understanding development activities. Section 4.1 is designed to introduce the reader to CAS theory. Sections 4.2 and 4.3 respectively look at Social Network Analysis and System Dynamics as methods from the systems thinking toolbox. These sections review the use of these methods within specific sociological contexts and note the constraints in putting together disparate methods and methodologies.

Chapter 5 brings to the fore theories from international and community development and sociology in order to highlight those that fit with an integrated understanding of human and community development. The final section of the chapter (section 5.4) looks at how CAS theory and systems thinking have previously been applied within development literature and practise in both implicitly and explicitly.

Chapter 6 articulates a synthesis of complex adaptive systems theory with existing development theories including ‘development as freedom’ and ‘human scale development’ as well as sociological understandings of ‘habitus’ and ‘resilience’. It concludes by noting that the integration of these congruent theoretical perspectives provides a novel understanding of the place of emergence and complexity in development. The rest of this thesis explores the application of this novel framework to the specific development context of water services in Timor-Leste.

Chapter 7 presents the methodology and methods that are applied to this research. Coming from a social justice perspective the research looks to acknowledge the relationships and voices of the residents of rural villages in Timor-Leste within the context of WASH programs. The data collection and analysis methods applied are a mixture of qualitative and quantitative methods that work to provide insight into the actual experiences of individuals as well as aggregated data from village WASH programs.

Chapter 8 presents results of case studies in a range of formats distinctively
including social network maps and system dynamics style causal loop diagrams. Interviews formed a significant part of data collection and hence results are presented as case study narratives that include social network maps and statistical tables and graphs.

**Chapter 9** locates the research results in a systems thinking framework that looks at the roles of NGOs and water user/management groups in the provision of robust rural water services within a CAS framework.

**Chapter 10** highlights the contributions that this research has made possible within academic, practitioner and community fields of endeavour. The research is then summarised in the conclusion.
2 Timor-Leste

This chapter introduces Timor-Leste as the site of the case studies for the research. The recent history of Timor-Leste is well documented so in this chapter I begin with my own reflections of the feel and sense of Dili just two years after the withdrawal of the Indonesian military, and the again 10 years later when I returned to begin field work. The use of the first person narrative here intentionally introduces Timor-Leste and the *ema* Timor from my own perspective in order to reinforce the location of the researcher as part of the researched environment rather than as a neutral observer. Section 2.2. and 2.3 then briefly introduce the current situation in Timor-Leste and contextualise this in terms of previous conflicts as described by Durand (2006). Timor-Leste society has sacred traditions that are still adhered to in some areas, these traditions have an impact on power and influence in rural villages and so they are also introduced herein. This chapter concludes with an overview of the commentary on international development in Timor-Leste since 2000.

2.1 My Introduction to Timor-Leste

I first visited Timor-Leste in 2002. I was inspired by the idea that as a newly independent nation, Timor needed tourists. One of Timor’s greatest natural assets was, and still is, the large number of diverse types of easily accessible dive sites. So I went to Timor as a dive tourist. My memories of Timor then, are of heat, light and amazing natural beauty under the water, in the mountains and along the coastal cliffs.

In 2002 there was a lot of evidence of the Indonesian withdrawal; burnt buildings and bullet holed walls, and a quiet sort of nervousness about the people. Amongst that there were enterprises emerging; coconuts for sale, rooms for rent, small tin shacks serving food and beer. One particularly enterprising group were charging entrance to “dollar beach” a popular diving and picnicking spot for foreigners. On a dive there, aside from paying our one dollar entrance fee, we were joined by a group of UN peacekeepers. They piled out of their 4WD dropped a bunch of guns on the ground and all but one of them stripped off for the dive. I found the guns confronting. The UN had guns, the police carried guns, the army carried guns and groups of young men drove around town waving guns in the air. I found myself wondering if the people of Timor-Leste could ever live a peaceful, secure life and what it would take for them to turn around the aggression of the past and to flourish into the future. What would it take to turn that quiet nervousness into confidence and optimism?

Twelve years later, I returned to Dili to find exactly that; a town less dominated by foreigners and guns. There is a burgeoning local middle class and an enthusiasm to share Timor’s past experiences through museums, art galleries, stories and film. It appeared that Timor-Leste had found catharsis in
documenting the invasion, and had found peace in forgiving the perpetrators.

Dili, with its new buildings, shops, hotels and a befuddling public transport system was a stark contrast to what I found in the rural districts. Visiting villages high in the hills of Liquica and in the remotest parts of Viqueque, I found myself in places where there was no electricity or water pipes. People were resiliently eking out their existence in arid soils and paying homage to their ancestors in the way of many generations before them.

Travelling to Dili from these villages often involved several hours walk to the nearest big town followed by a lengthy angunna ride to be dropped at the outskirts of Dili. An angunna is a small truck with seats facing each other in the back and metal cage for a roof to carry extras such as giant baskets of tobacco, bananas, coffee and woven goods being taken to market. Passing through tiny villages on the angunnas incited a lot of pointing and waving. On checking if this was just a normal level of excitement I was told that seeing a white foreigner (malae) on an angunna was pretty rare. It wasn’t the only time that I would feel like a rarity, small children were often terrified by my appearance and I was invited to hand out certificates at a school graduation.

Generally there was much concern shown for my comfort. My interpreter did a wonderful job of allaying peoples’ fears about what to feed me (I would eat anything), whether I would be ok to walk between houses (I had proved that I could walk for hours on our first visit) and I suspect a whole lot of other issues that she didn’t make me aware of. I shared photos of my family, having a husband was seen as good but having no children was seen as cause for sympathy or surprise, moderated somewhat by my twenty-four nieces and nephews, all proudly displayed on request. The technology that I carried with me was limited to a smartphone which was great for showing photos and swapping music but limited in its other functions by the erratic coverage of the telecommunications network. Lack of power made carrying a computer seem silly, and I am glad that I didn’t. For each household that agreed to have me stay with them I brought with me some food, usually rice, salt, sugar and vegetables, provided some cash and gave them a “d-light”, a neat weatherproof solar powered torch and phone charger in one. Some households had solar panels and so the technology was familiar, but the ease of charging a phone and the ability to move the torch around to where light was needed seemed to be useful innovations in those remote hills.
2.2 Current Situation

Timor-Leste makes up the eastern half of the island of Timor, and includes an exclave (Oecussi) in the Indonesian western half of the island, and the smaller islands of Atauro and Jaco, both easily accessible from the mainland. With a population of approximately 1 million people and a total land mass of 14,874 square kilometres, it is the 160th largest nation by both land mass and population (CIA 2014).

In 2012, Timor-Leste conducted peaceful elections and the general stability of the nation has seen the withdrawal of UN Peacekeeping forces. Economic progress, as measured by GDP, and excluding oil and gas production, in 2009, 2010 and 2011 was, respectively 12.8%, 9.5% and 10% (amongst the highest in the world). Oil and gas exports account for 90% of government income. This income provides the government with a means to invest in public services including water, sanitation, education and health (Santos & Florindo 2013).

While anecdotally the Timorese middle class is growing and the “ema Timor” (people of Timor-Leste) are becoming noticeably more educated and more cosmopolitan (Whalen 2014), Santos and Florindo (2013) note that 41% of the population still live on less than $1 a day with many (up to 70%) relying on subsistence agriculture for survival. There is a distinct urban/rural divide in terms of services and opportunities, with rural areas suffering from increasing income inequality and underinvestment in education and agricultural services (Leach 2013).
In terms of water supply, improved sources in urban areas are almost ubiquitous with 93% of the urban population having access to an improved source. In rural areas slightly less than 60% of the population have access to improved water sources. “Improved” sources are defined in terms of the availability of water via a protected spring and tap, or a well, close to dwellings (CIA 2014). In both urban areas and rural areas, water from improved sources is still treated (usually by boiling) at point of use, before consumption. In urban areas there appears to be a high demand for 20L bottles of sanitised water as well as the smaller disposable bottled waters. In rural areas water is collected and stored in 5L repurposed plastic cooking oil bottles. Where water points are close enough for hoses and pipes to be used, water is collected in 44gal drums or directly into a concrete mandi.

2.3 A History of Conflict

In a nutshell:

“On 20 May 2002, rising out of a history fraught with tragedy, East Timor acceded to independence under the name of Timor-Leste or Timor Lorosa’e: Sunrise Timor. This insular ethno-linguistic mosaic wedged between Southeast Asia and Oceania had been a colony of Portugal for four centuries before it was invaded by Indonesian forces in December 1975. It was not until 30 August 1999, however, that more than 78% of the population voted for independence, thus ending twenty-five years of Indonesian occupation.” (Durand 2006, p. back cover)

Based on the Durand’s (2006) “Chronology of International Relations” the history of Timor-Leste has been a history largely of trade in naturally occurring resources, and of conflict created by external actors:

In the early 13th century the Chinese identified the island of Timor as an abundant source of sandalwood. Three centuries later, the Portuguese opened trading posts on the island and in the 1600s they conquered the western part of the island. During this period the administration of the island was mainly by religious orders (Dominicans and Jesuits) who communicated with local chieftains primarily through the Topasses (native interpreters with Portuguese cultural background). Early in the 18th century Portugal appointed a governor. The following period included various conflicts between the Timorese, the Topasses, the Dutch and the Portuguese in Timor. In 1914 the boundary between Timor-Leste and West Timor was decreed by the International Court of Justice.

During World War Two, Timor-Leste was invaded by Japan, and used by Australia as a line of defence to stop the Japanese reaching Australia. This conflict resulted in the deaths of many Timorese with fatalities caused by both sides.

The process of Portuguese decolonization began in the 1960s and culminated in a declaration of East Timorese independence on 28th November, 1975. Independence was short lived, as the Indonesian army invaded Timor-Leste on the 7th December 1975. This led to 25 years of brutal warfare as the Timorese resisted the Indonesian occupation.
In 1999, under UN supervision, a referendum resulted in Timor-Leste’s independence from Indonesia. The exit of Indonesian military and militias from the country was accompanied by horrific levels of violence and destruction. The first government elections for Timor-Leste were held in 2001, again under UN supervision. The ensuing years have included periods of peaceful nation building as well as periods of internal strife. The UN and many international NGOs have since been ensconced in Timor-Leste in an effort to assist with nation building projects.

2.4 The Sacred in Timor-Leste

Society in Timor-Leste has been studied and written about for many years. Much historical anthropological work has been undertaken by Portuguese speakers during the colonial period, and since then. Anthropologists have noted that Timor-Leste is not a homogenous society, the cultural groups vary across the country and in fact some internal strife has had its basis in cultural differences across the country.

Traditionally, one of the most important community structures was the “sacred house” – this refers to both a physical structure (uma lulik) and the social organisation (uma lisan). While recognising that Timor-Leste is made up of many different ethno-cultural groups, it seems reasonable to extrapolate some of the most common observations about uma lisan from observers of regions other than that under study, for which there appears to be no observations in English translation. The system of sacred houses in most areas of Timor-Leste is a hereditary, patrilineal system, with a few notable exceptions of matrilineal tradition. Generally though, the tradition is that wives move to the village of their husband and take on the same uma lisan as their husband. The leaders of the uma lisan are the liurai and this position is generally passed down the male line, defaulting to the brothers/uncles if a male heir is not available. This system of sacred tradition would have been particularly valuable in maintaining reciprocal trust and cooperation in small community groups with no written language (Mullins, Whitehouse & Atkinson 2013).

In the process of modernisation of the country, there are changes to the way that tradition is observed within communities. For example, while the liurai are still respected, the head of the most powerful uma lisan in the village is no longer automatically the Chefe Aldeia. The position of Chefe Aldeia is now a democratically elected position, and while many Chefe Aldeia are, in fact, also liurai, there are examples where this is not the case. The changing role of the chefe’s is explained by Pereira and Lete Koten (2012) as a move “from authority over the community, to representative of the community”. Clamagirand (1980) indicates that changes to traditional hierarchy based on sacred houses had begun with the Portuguese instigation of ‘Dato Kase’ as administrators of villages. Displacement, forced relocations, youth migration to major towns for jobs and education, and increasing recognition of the rights of women, are all factors that are creating changes to how uma lisan are viewed within the sphere of obligations of individuals. Tilman (2012) also indicates that attitudes towards
uma lisan and the liurai are changing in the face of new democratic institutions and urban living but that the changes are not consistent between villages and therefore the role and respect afforded to the liurai and the uma lisan varies from place to place across Timor-Leste. The idea of the sacred and the taboo also extends beyond animals and places to include sources of water.

2.5 International Development in Timor-Leste

As a newly independent country, at the end of 2002 Timor-Leste was dealing with a lack of infrastructure (destroyed by the withdrawing Indonesian army), a traumatised population, a high number of displaced persons and returnees, a lack of professional and skilled workers and influx of foreign aid. Traub (2000) goes as far as to say that between the independence vote (1999) and the first democratic election (2002) “Dili appeared to be a wholly owned subsidiary of the international development community.” At the time of writing Dili still hosts a remarkable number of development NGOs who are working across many sectors.

Since 1999 Timor-Leste has consistently been in the top 25 countries for development aid received, per head of population (World Bank 2015). Timor-Leste is a small country, with a small population, some natural resources and a lot of political will towards positive development outcomes for all citizens. Shepherd (2009) indicates that Timor-Leste was likely to serve as a model for state building. Effectively there are no excuses for development failure in this situation hence development organisations and agencies have an almost perfect test case and a lot to lose if they can’t assist Timor-Leste to become a “successful” country. Failure here would imply a global inability for development to ever succeed. Molnar (2010) agrees with Hughes’ observation regarding the “branding” of Timor-Leste as a capable performer and reliable partner of international aid donors” which she cites in building the case that there is an “unequal power relation” between Timor-Leste and its donor countries. Molnar (2010) goes further than this, and in fact claims that donor countries have an interest in maintaining Timor-Leste as an aid dependent country in order to benefit themselves through continuing natural resource concessions and trade exports. This is not an uncommon perception of the motivations for the provision of development aid from external governments (van der Veen 2011). However, whilst the aims of individual development volunteers may be varied, they are dominated by altruism (Rehberg 2005). Shepherd (2009) looks to the post-development critique by Escobar and Ferguson to explain the shaping of political and civil life by development agencies. There is undoubtedly a continuing influence of the development sector in government policy and practise, which can be inferred from the words of Xanana Gusmao, the Prime Minister of Timor-Leste in addressing a Development Partners Meeting in 2011:

“...we have managed to link the vision of the Timorese People with the vision of our international friends and partners, so as to enable the successful development of Timor-Leste.”

(Gusmao 2012)
3 Water Sanitation and Hygiene (WASH)

There is a conversation in the development literature about specific impacts of water quality, water quantity, sanitation and hygiene in reducing health problems (Bartram & Cairncross 2010; Sobsey 2002). This debate which attempts to separate the different factors that contribute to improved health is counterproductive, as it is not possible to create a hygienic, sanitary environment without access to clean fresh water (Hunter, MacDonald & Carter 2010). Hence this research focuses on water supply whilst acknowledging that significant beneficial health outcomes require good sanitation and hygiene environments.

This chapter begins by defining the rationale and the issues around WASH programs globally. The second part of the chapter focuses on WASH programs in Timor-Leste pointing out the legislative requirements and government guidelines that are in place. In rural areas of Timor-Leste water systems are generally managed and maintained through community water management groups so the following section of this chapter looks at the demands that this places on a community. Finally it is suggested that community managed water supplies could be considered and managed as common pool resources.

3.1 WASH in development

In 2010 the UN General Assembly passed a motion recognising access to safe drinking water and sanitation as a human right (UNHRC 2010). More recently the thirteenth open working group for sustainable development goals (SDGs) which are due to replace the millennium development goals (MDGs) from 2015 have included:

“achieve the human right to water and sanitation by providing universal access to safe, sufficient, affordable, acceptable and accessible potable water” (Open Working Group on Sustainable Development Goals 2014)

Water has long been recognised as a vital factor for development. Sanitation and hygiene have also been identified as co-factors for successful development outcomes (Bartram & Cairncross 2010). The yearly contributions from Organisation for Economic Co-operation and Development (OECD) countries towards WASH programs worldwide is in the order of US$8 billion dollars (WHO 2012). It is widely accepted that the effort represented by this expenditure is necessary and that the outcomes are essential to global development objectives such as the MDGs and now the SDGs.

Water supply is important in its own right as clean and plentiful water is
essential to life. Water is also significant for the ongoing impacts it has towards health, schooling, farming, work and manufacturing. Easy access to clean water reduces disease and increases health (Howard & Bartram 2003). Plentiful water increases sanitation options, expands food growing options and has the potential to be useful in emerging industries. Having water supply close to households reduces the effort that needs to be made for basic survival activities such as collecting water.

In a move that was pre-emptive of the sustainable development goals, several organisations have begun work on “Sustainable Water Services at Scale” or “Triple-S”. This work is predominantly sponsored by the International Red Cross (IRC) as part of a coordinated attempt to shift the water sector to a sustainable water service model in preference to the current “building systems” model (Water Services That Last 2015). The service delivery approach identifies the need for country specific solutions but notes the limitations of community management models (Lockwood et al. 2010). This will be discussed further in Section 5.4.

3.2 Standards for Water Supply

When looking to standards for water supply there appear to be four significant considerations that arise from the 2010 declaration of the human right to water and sanitation (De Albuquerque 2012; Gleick 1998; UNHRC 2010; UNICEF 1999; WHO 2003):

- Potability – is it safe to drink?
- Quantity – how much water is reasonably needed per person?
- Distance – how much travel to collect water is reasonable?
- Accessibility – who has access to or control over the water, is it culturally acceptable and physically safe to access? Is the cost reasonable?

These areas of water security are presented in various ways depending on the author of a particular work. Notably, the idea of safety is often presented as both safety in terms of safe water quality and safety in terms of safe access to the water source, as in De Albuquerque (2012). This document explicitly separates the two types of safety into potability and accessibility. Separating potability from accessibility allows for clarity in the discussion of safe water points as being geographically and socially safe but not necessarily providing potable water. Distance is also treated as a separate issue to accessibility or availability in this thesis as the evidence around the impact of distance is quite compelling as will be discussed in section 3.2.3. In another diversion from the normative criteria, as defined by De Albuquerque (2012), I treat cultural acceptability and cost as a part of accessibility of water supply as both of these can be seen as structural factors which can block access to water.
3.2.1 Potability

Is water safe to drink? Potability requires the physical, chemical and biological safety of drinking water. The criterion applied in the MDGs is ‘improved water source’. An improved water source is defined by the JMP (JMP) as any of the following:

- Piped water into dwelling
- Piped water to yard/plot
- Public tap or standpipe
- Tubewell or borehole
- Protected dug well
- Protected spring
- Rainwater

In the case of a protected spring, the spring it is generally capped, filtered and fenced in order to reduce the chances of animals or animal faeces contaminating the spring. The water is then piped through a system of covered pipes, either directly to a tap stand or into a storage tank (UNICEF 1999).

Spring protection is not guaranteed to ensure that water is clear of chemical pollutants, protozoan, bacteriological or viral pathogens at the tap stand, but it does help (Kremer et al. 2009). If the system loses its integrity though, the benefits of spring protection can be lost – either through practises such as bucketing water from tanks with non-hygienic equipment or through lack of repair and maintenance to the capping, fences, filters or pipes that serve to protect water from environmental contamination.

Transport and storage between the tap and the point of use can also introduce pathogens to the water supply if containers and practices are not hygienic. Palit et al (2012) indicate that there is contention over the impact of spring protection in improving health, possibly because some springs are isolated enough that there is not much initial need for the protection, or sometimes because the contamination originates in the ground water.

3.2.2 Quantity

What is reasonable? WHO standards recommend 20L of water for drinking and cooking per person per day as a minimum basic standard (WHO 2011). Cairncross and Valdmanis (2006) state that “most of the benefit [of improved water supply] is attributable to improved convenience of access to water in quantity”. Reducing disease - particularly diarrhoeal diseases - requires good hygiene and sanitation practises, particularly focussed on ensuring that food is not contaminated with faecal matter. Good hygiene practise requires plentiful water and soap to be available at the points when faecal matter may be contacted (going to the toilet, changing nappies, gardening or farming for example) or when food is being prepared (Cairncross & Valdmanis 2006).

According to the Centre for Disease Control and Prevention (CDC 2013) hand
wiping is most effective when using running water rather a bucket or bowl of water. This indicates a need for extra water to be available within the household just for hand washing. Experimental observations by Hoque (2003) concluded that there was a statistically significant reduction in the bacteria remaining when hands are washed in 1L of water rather than 500mL. In fact it has been suggested that for effective sanitation, a secure supply of 100L per person per day of clean, though not necessarily disinfected, water is required (Gleick 1998; Palit et al. 2012).

On this basis of 20L of water for cooking and drinking and 50 - 100L for sanitation, a secure supply of at least 100L of water per person per day is required to be confident of a beneficial impact on health. Of this 100L per day, approximately 20L needs to be potable at point of use which means that disinfection techniques are critical even for improved water sources.

### 3.2.3 Distance

What is reasonable? As above, one of the reasons to supply water to households is to improve their capacity for sanitation and hygiene. There is some evidence that unless water is delivered directly to the household there is little increase in the amount of water that is used for sanitation and hygiene. In a review of evidence of health impacts of improved WASH, Cairncross and Valdmanis (2006) assert that “moving the […] tap from the street corner to the yard produces a substantial reduction in diarrheal morbidity”. DeVoto et al. (2011) found that private water pipe connections are associated with significant increases in quantity of water used at the household level. Water that is piped directly to the house was also associated with increased free time, increased wellbeing and reduced household and neighbourhood conflicts. The significant increase in quantity of water used where a household connection was available was attributed to increased frequency of baths, showers and hand cleaning which constitute improved sanitation practises (Cairncross & Valdmanis 2006; Devoto et al. 2011). The World Health Organisation (WHO) recommends that water should be available within 500m of any residence but state that a pipe to the household is preferable (WHO 2003). Howard and Bartram (2003) point out that the significantly reduced quantity of water collected by residents who live more than 5mins or 100m from a water point has been known since at least 1987. Despite this knowledge, water points are still installed at non-optimal distances from dwellings.

### 3.2.4 Accessibility

Who has access to improved water supply? Getting access to a water source can be difficult, natural sources can be hard to get to as they require walking up or down steep hills, in slippery or rocky terrains. Access points are often unstable and there is a possibility of coming across wild animals, snakes, centipedes and spiders. This has a disproportionate impact on the very young, the very old, pregnant women and the physically disabled (Mengistu 2012). In the case of improved water supply the issues with terrain are reduced, though
my personal observations of water points indicates that taps are often still located in difficult to reach positions. Environmental access is not the only concern in majority countries. Social acceptability, safety and cost are also access issues that might impact on individuals. In particular cost can be an issue in the case of privatised water supply, as can gaining access from someone who “owns” the water source or the land where it is located (WaterAid 2011).

From the above discussion an ideal WASH program would provide a consistent water supply that is potable, delivers at least 100L of water per person per day, is piped to the household and is affordable relative to income.

3.3 WASH in Timor-Leste

World Bank data indicates that in 2012 only 61% of the rural population of Timor-Leste had access to improved water sources (The World Bank 2015) and according the JMP this figure has remained static into 2015 (JMP 2015) leaving 307,000 rural residents currently reliant on unimproved water sources compared with 323,000 residents in 2000. Water sources that are considered to be improved include piped water on premises or public taps or standpipes, tube wells or boreholes, protected dug wells, protected springs, or rainwater tanks. WASH programs include implementation of improved water sources, encouragement for the building of toilets and education about hand washing. The overall aim of WASH programs is to improve access to water, sanitation and hygiene. Through achieving better WASH outcomes it is expected that residents will incur improved health outcomes as well as flow on benefits for access to education and livelihoods (Sobsey 2002).

The Government of Timor-Leste (GoTL) is determined to improve water and sanitation conditions for rural citizens. To this end, it has established goals and strategies within the Timor-Leste Strategic Development Plan 2011-2030 (GoTL ND-b). The development plan includes employing water and sanitation facilitators (SDFs) for each sub-district, to oversee infrastructure and community development projects in rural areas. This includes liaising with NGOs and bilateral organisations who are delivering WASH programs.

Currently, the most significant organisation in the WASH sector in Timor-Leste, aside from the Government of Timor-Leste, is BESIK (Be’e Saneamentu no Ijine iha Komunidade – Water, Sanitation and Hygiene in Communities). BESIK is the WASH sector program of the AusAid (Australian Government) effort in Timor-Leste. BESIK focuses on rural WASH programs and has a mission to “support Timor-Leste’s target of providing 75 per cent of the rural population with access to a safe water supply by 2015” (DFAT 2014). The BESIK program and the GoTL link to other NGO WASH programs through the WASH forum, as well as coordinating and combining reports to ensure that the state of water and sanitation across the country is captured and understood.

Sub-district facilitators (SDFs) also report on access to water systems to the
SIBS (Sistema Informasaun Bee no Saneamentu – Water Asset Information System) database program. This program records access to improved water sources at the aldeia level and hence includes water systems implemented by the GoTL, NGOs, “friends of” groups and service clubs like Rotary or Lions.

Problematically, WASH programs appear to have a poor track record in terms of the length of time that improved water supplies to villages are adequately maintained. In a report on Timor-Leste for the Asian Development Bank, Schoeffel (2006) found that water systems less than four years old were broken or functioning sub-optimally in relation to their design. None of the nine fully implemented systems reported on had a functioning water management groups (GMFs). Schoeffel noted that NGOs tended to believe that problems are caused by lack of community capacity to manage water systems and that better training and support practises would lead to longer term beneficial outcomes. The report indicated that there is little evidence for this as a successful strategy and concluded that implementing WASH programs, then signing them off to GMFs to manage, is not an appropriate approach to long term water delivery. It suggests that water supply needs to be managed, policed and maintained through institutional means. This recommendation runs counter to evidence presented by Schoeffel (2006) in the same document implying that there is a lack of institutional capacity to manage and maintain the water systems within GoTL sub-district offices.

This leaves a quandary as to who should be responsible for the ongoing management and maintenance of water systems – if communities and the government both lack capacity to maintain and manage water systems, then perhaps NGOs should be responsible for management and maintenance over extended periods.

3.3.1 Guidelines

The Timor-Leste Rural Water Supply Guidelines provide guidance for the implementation of water systems in rural areas of Timor-Leste. The guidelines have been agreed and published by the Government of Timor-Leste in conjunction with BESIK and in collaboration with other NGOs involved in delivery of water (GoTL 2010b). The guidelines are based on RDTL Decree-Law No. 4/2004 “Water Supply for Public Consumption”.

Table 1 gives a comparison of these guidelines against SPHERE minimum standards for emergencies, and WHO service level descriptors. It can be seen that the GoTL guidelines provide for a higher service level for access, than emergency or basic services would demand, but they leave a lot of scope for services to be below ‘intermediate access’ levels and have lower quality standards than those described for emergency situations.
Table 1: Comparison of water standards guidelines. (GoTL 2010b; The Sphere Project 2011; WHO 2003, 2011)

<table>
<thead>
<tr>
<th>GoTL Guidelines</th>
<th>WHO descriptors</th>
<th>SPHERE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minimum</td>
<td>Basic access</td>
<td>Emergency access</td>
</tr>
<tr>
<td>Recommended</td>
<td>Intermediate access</td>
<td></td>
</tr>
<tr>
<td>Quantity per person per day</td>
<td></td>
<td></td>
</tr>
<tr>
<td>30L</td>
<td>60L</td>
<td>20L</td>
</tr>
<tr>
<td>100m</td>
<td>50L</td>
<td>15L</td>
</tr>
<tr>
<td>Distance (one way) time to walk (round trip)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>200m</td>
<td>100m</td>
<td>&lt;1000m</td>
</tr>
<tr>
<td>5min</td>
<td>Tap in yard</td>
<td>500m</td>
</tr>
<tr>
<td>Quality</td>
<td>Quality</td>
<td>Waiting time</td>
</tr>
<tr>
<td>Will require boiling prior to drinking</td>
<td>No significant risk to human health</td>
<td>30min</td>
</tr>
<tr>
<td>Flow</td>
<td>Flow</td>
<td>0.25L/sec</td>
</tr>
<tr>
<td>0.2L/sec</td>
<td>0.25L/sec</td>
<td></td>
</tr>
</tbody>
</table>

All NGOs, BESIK and GoTL projects are required to meet these standards wherever possible, although there is a disclaimer that; “Non-compliance with these recommended standards will have to be justified and approved by local District SAS representatives”(GoTL 2010b). These levels are in stark contrast with the service levels of a city like Melbourne where the average water use in 2012-2013 was 161L/person/day (Melbourne Water 2013). There is an expectation within the minority world of multiple taps available within and around a house and that all water is uncontaminated and continuously available without undue limitation. Compared to this expectation it is notable that WASH implementations in Timor-Leste are often focussed on a very basic service level, with little consideration for the provision of more than the minimum nor for multiple use water systems. The minimum quantity for supply of water recommended in the GoTL guidelines is 30L, this is enough to cook with and drink. The higher ‘recommended’ quantity of 60L would provide enough additional water for some hygiene purposes. Even the ‘recommended’ quantity of water is barely half of the 120L considered adequate for enabling significant improvements in health from section 3.2.2.
3.3.2 The official role of community water management groups

In Timor-Leste, the government encourages the formation of community water management groups (Grupo Manajemento Facilidade – GMFs). The Timor-Leste Rural Water Supply Guidelines (GoTL 2010b) include a section that describes GMF composition and responsibilities, including gender balance both across the committee and in management and technical roles. The key responsibilities of the GMF are listed as:

- Operation and maintenance of the system
- Collection and management of funds in a transparent manner
- Monitoring proper use of the water resources and facilities
- Preventing erosion, protecting watershed area and annual tree planting
- Helping to prevent and/or resolve conflicts relating to water
- Organizing regular meetings among members and non-members to share information and to receive feedback
- Linking with other GMF (for example through a forum or/and cross visits)
- Working together with the PSF to promote good hygiene and sanitation practises
- Liaising with the District SAS
- Linking with other community groups such as livelihood and income generating activities (e.g. village savings/loans group)
- Monitoring and managing WASH services along with other actors
- Linking closely with the FCSD to strengthen coordination with DSAS

(GoTL 2010b)

This list of responsibilities implies a heavy burden on a voluntary committee. It is revisited in section 8.12.2 in order to illuminate the implicit and explicit objectives in light of observations of GMFs in the field.

Harvey and Reed (2007) indicate that there are three fundamental reasons for the rise of implementation of community water user/management groups since the 1980s. The first reason is a lack of government capacity, secondly it suits NGOs to be able to divest responsibility and exit a community quickly and lastly, communities are ‘idealised’ as being cooperative with each other and therefore able to manage. Despite the rise of community water management, reports and citations of small water system failure rates are between 30% and 60% globally (Harvey & Reed 2007; Lockwood & Smits 2011).

In contrast Bakalian and Wakeman (2009) found that the functionality of community managed water systems in areas of Ghana, Bolivia and Peru were around 90%. Looking for positive deviance, as per Mesa et al (2014), is a strengths based approach to identifying processes that lead to successful WASH implementation. Having identified these processes does not imply that there is a “silver bullet” that can be scaled up and used across other contexts. It
does mean that there is information worth sharing and/or a process worth modelling to other communities so that they can choose the methods and models that might work for them. Mesa et al (2014) concluded that while a minimum level of socio-economic wealth is essential to the functioning of community managed water supply, there are also combinations of other internal and external factors that are essential to sustained function and these cannot be easily defined for any single context.

### 3.3.3 Demands on community resources during WASH project cycle.

Many of the NGOs working on water projects in Timor-Leste have initiated community water management groups as part of their participatory practices. The NGOs aim to “hand over” the water systems that they build to GMFs who would ideally be supported by government agencies. Ostensibly NGOs are involved in WASH activities because there is a perception that the government doesn’t have the capacity to implement or maintain a functioning water supply sector. This begs the question of responsibility and ownership post-implementation:

“One big question that arises is what organizations in the water sector should do about these failures: haven’t donors and implementers done enough by trying to provide access? If it is truly believed that safe water access is a human right, then the answer is a resounding “no.” To save lives and change lives, implementing organizations and donors must take responsibility beyond the project.” (Davis 2014, p. 6)

The requirements in terms of skills, money and time for a GMF as well as the community that they serve, is quite demanding. The structures imposed by the implementing partners require a high level of adjustment by the community as they challenge the existing hierarchies of power among residents as well as the status of women. This is specifically contrary to advice regarding the building of social capital by Portes and Landolt:

“For the most part, the research literature has not been supportive of attempts at ‘social engineering’ that seek to build solidarity networks when few or none exist. More often than not, such attempts end in failure, either because of free riding by some participants or because the communitarian structures weaken readily after outside supports are removed. Instead, it is advisable to build on whatever exists, that is to reinforce existing social ties and work alongside the definitions of the situation of community members rather than seeking to impose them from the outside” (Portes & Landolt 2000, p. 546)

There are also demands on the community to change their behaviours in terms
of sanitation and hygiene and to facilitate this through building toilet and hand
wash structures for themselves and other community members. Able bodied
men who would be otherwise be occupied in farming or other livelihood related
work, are required to donate their time and energy for the good of the
community. Women, who would also be involved in farming or other livelihood
work as well as childcare, are expected to collaborate to produce a community
meal each day that work is ongoing on the implementation of the system. It
seems likely that for many community managed water systems that the
demands on the community and in particular the demands on the GMF are
unsustainable, even if the GMF in fact has the technical and social capacity to
function effectively to start with.

Post Construction Support

It has been noted that for community management of water systems to be
effective there is some need for post-construction support for management
groups and technicians (Bakalian & Wakeman 2009; Kayser et al. 2014;
Prokopy et al. 2007). There are several ways to support a community
management group after construction. A report by Davis (2014) for Improve
International states that:

“Most development organizations monitor and evaluate during
their programs, but this is not enough to ensure that water and
sanitation interventions lead to sustainable services. Post-
implementation monitoring, whether by the implementing
organization or by another entity, is necessary to ensure that
services continue, and post-implementation evaluation can help
to understand why systems are working or not” (Davis 2014)

Davis continues on to indicate that successful post-construction support
requires more than monitoring, it also requires:

- External support like mechanics associations and circuit riders
- Networks of water committees
- Supportive local governments

One of the techniques of post construction support is the “circuit rider” who
attends communities on a regular basis to conduct monitoring and provide
support advice and training (Lockwood & Smits 2011). Good evidence for the
effectiveness of the circuit rider comes from research in El Salvador by Kayser
et al (2014). The ways in which the circuit rider appears to have a positive
influence on water outcomes in El Salvador are specifically around the
enhanced technical disinfection of water and better use of financial services.
Lockwood and Smits (2011) also identified technical advice, water quality
monitoring, administrative assistance, organisational assistance, networking
and auditing advice as beneficial forms of support.
3.3.4 Water supply as a common pool resource

Common pool resources are resources that are shared by groups of people, none of whom can be easily excluded from using the resource, and for which the use of the resource by one person makes that resource less available for others (Steins & Edwards 1999). This definition of common pool resources originated from systems thinking traditions, specifically Ostrom’s theory of common pool resources. Ostrom’s response to Garrett Hardin’s bleak predictions in “Tragedy of the Commons” indicated ways in which ‘the commons’ can in fact be managed sustainably over time for the common good (Ramalingam 2013).

Community management of water systems is a reasonably common approach to the maintenance of small scale water systems (Harvey & Reed 2007). It is clear from the definition above that water supply and infrastructure managed by a community are common pool resources. Water systems management is therefore subject to both the strengths and weaknesses of managing many other common pool resources (Neely In Press-b). While GMFs in Timor-Leste are responsible for managing a common pool resource, they may lack the tools to do this appropriately.

As discussed by Neely (In Press-b), when communities share a common resource such as grazing lands, forest or water, there is a need to make decisions about how much of the resource each user can access. Brucks and Mosler (2011) show that in order to make decisions about resource use, two types of information are considered. The first is the status of the resource; the second is the current social norm around resource use in a community. As the amount of available resource decreases, community members will adjust their use depending on their beliefs about the reason for the decreased resource availability. According to Brucks and Mosler (2011) community members will act to conserve resources when they believe that the limitations are caused by environmental effects, but if they believe that limitations are caused by overuse by others they are more likely to set their use in line with the community “norm”. In Timor-Leste communities may benefit from specific information about local environmental variability of water flows from springs.

Irrigation schemes seem to provide the basis of research on water as a common pool resource, with a distinct bias towards the natural resource (water) rather than the irrigation infrastructure Sarker and Itoh (2001). Despite a body of literature that critiques community management of water systems (Harvey & Reed 2007), academic interest in the maintenance of small spring fed water systems appears to be constrained to engineering disciplines (Eade & Williams 1995; Steele 2010; UNICEF 1999).

Community management of small water systems as a common pool resource issue, based in systems thinking, is therefore a relatively novel approach that is worth considering from both a theoretical and practical perspective. This thesis takes Ostrom’s design principles (Table 2) and considers them in respect to field observations of spring fed water systems in Timor-Leste. See Section
8.12.1 for a contextualised discussion on community management of water as a common pool resource.

Table 2: Design Principles Derived from Studies of Long-Enduring Institutions for Governing Sustainable Resources (Ostrom 2008). Source: Neely (In Press-b)

<table>
<thead>
<tr>
<th>1. Clearly Defined Boundaries</th>
<th>The boundaries of the resource system (e.g., irrigation system or fishery) and the individuals or households with rights to harvest resource units are clearly defined.</th>
</tr>
</thead>
<tbody>
<tr>
<td>2. Proportional Equivalence between Benefits and Costs</td>
<td>Rules specifying the amount of resource products that a user is allocated are related to local conditions and to rules requiring labour, materials, and/or money inputs.</td>
</tr>
<tr>
<td>3. Collective-Choice Arrangements</td>
<td>Most individuals affected by harvesting and protection rules are included in the group who can modify these rules.</td>
</tr>
<tr>
<td>4. Monitoring</td>
<td>Monitors, who actively audit biophysical conditions and user behaviour, are at least partially accountable to the users and/or are the users themselves.</td>
</tr>
<tr>
<td>5. Graduated Sanctions</td>
<td>Users who violate rules-in-use are likely to receive graduated sanctions (depending on the seriousness and context of the offense) from other users, from officials accountable to these users, or from both.</td>
</tr>
<tr>
<td>6. Conflict-Resolution Mechanisms</td>
<td>Users and their officials have rapid access to low-cost, local arenas to resolve conflict among users or between users and officials.</td>
</tr>
<tr>
<td>7. Minimal Recognition of Rights to Organize</td>
<td>The rights of users to devise their own institutions are not challenged by external governmental authorities, and users have long-term tenure rights to the resource.</td>
</tr>
<tr>
<td>For resources that are parts of larger systems:</td>
<td></td>
</tr>
<tr>
<td>8. Nested Enterprises</td>
<td>Appropriation, provision, monitoring, enforcement, conflict resolution, and governance activities are organized in multiple layers of nested enterprises</td>
</tr>
</tbody>
</table>
This chapter has identified some of the significant areas of concern to the WASH sector of development and looked at how these are approached within the sector in Timor-Leste. The role of communities in maintaining systems, along with the support provided post-implementation, was considered. NGOs were found to practise some dissonant logic whereby development interventions such as WASH programs are predicated on lack of government capacity but the ownership and maintenance of systems is handed over to the same government within months of program completion. The concept of envisioning community managed water supply as a common pool resource (CPR) was introduced. CPRs arise from a systems thinking tradition, the following chapter will look at systems thinking as a tool for understanding complex adaptive systems which are described in section 4.1.
4 Systems Thinking

“The difference is between hammers and levers. Witches generally tried to find the small point where a little change made a lot of result. To make an avalanche you can either shake the mountain, or maybe you can just find exactly the right place to drop a snowflake.” (Pratchett 1998).

Popular author Terry Pratchett was an inventor of worlds. The worlds he invented are full of people and magic and science, and he understood systems because worlds cannot work without them. Systems thinking is one way to understand where to place the witches’ snowflake. In development, the avalanche that we look to create is an avalanche of freedoms: freedom from poor health, freedom from hunger, freedom from illiteracy, freedom from authoritarianism, freedom from violence, freedom to choose, freedom from poverty (Sen 1999). I will argue in this thesis that increasing individual freedoms also increases the complexity of society and creates conditions for the emergence of higher levels of organisation. Taking the analogy of the avalanche one step further it should be noted that just as a lot of snowflakes have to fall before the single well placed snowflake can cause an avalanche, it is possible that a lot of incremental changes have to happen in a community/society before we notice the tipping point of freedoms that would signify development outcomes.

This chapter serves as an introduction to Complex Adaptive Systems (CAS) theory and the systems thinking tools Social Network Analysis (SNA) and System Dynamics (SD). These sections serve as a foundation for understanding the framework used later to analyse data and to bring sociology and development theory together in a fashion that acknowledges that the topics of research in both of these disciplines are themselves complex adaptive systems. The final section of this chapter looks at previous work recognising system dynamics and sociological frameworks as being commensurate with one another.

Systems thinking isn’t a single method, tool or discipline. It comes from a variety of traditions (see Figure 3) and is applied broadly in multi- and trans-disciplinary studies. Donella Meadows (2008) ‘Thinking in Systems’ introduces systems as “a set of things—people, cells, molecules, or whatever—interconnected in such a way that they produce their own pattern of behaviour over time” (p2). Systems thinking isn’t just one nice neat way of doing things and practitioners have approached this area from many perspectives and with a multitude of purposes as illustrated by Ison in Figure 3. With this in mind, I use the term ‘systems thinking’ throughout this thesis to describe a purposeful awareness of interconnected, interdependent systems with self-generated behaviours.
Systems thinking approaches have developed from a multitude of fields including sociology, anthropology and engineering. The commonality between the different approaches is that they all strive to find a way to deal with complexity, to understand, manage or simply navigate the interconnected world around us. The interconnectedness and interdependence that we observe as complexity within the natural and social world is described by Complex Adaptive Systems Theory.

4.1 Complex Adaptive Systems Theory

Complex Adaptive Systems (CAS) theory as an identifiable field of study and research has developed over a relatively recent timeframe. The perceived need to use transdisciplinary methods to comprehend the wicked problems facing society lead to the founding of the Santa Fe Institute in 1984 as a place to

“bring the tools of physics, computation, and biology to bear on the social sciences, reject departmental and disciplinary stovepipes, attract top intellects from many fields, and seek insights that were useful for both science and society”

(German 2015)

Currently CAS theory is being applied within the social sciences, business, marketing and economics to enable a non-linear understanding of social and ecological phenomena (Byrne 1998). The ideas within complex adaptive systems theory point us towards developing a network understanding of our
world. This varies greatly from traditional views in many fields where the assumptions of linearity and divisibility are at odds with the reality of an intricate connectedness within and between social, biological and ecological worlds (Gell-Mann 1996).

Walter Buckley was an early proponent of sociocultural systems as non-linear, non-homeostatic and non-equilibrium systems. He identified that our understanding of individuals and society would be enhanced by an ability to incorporate systems thinking across fields that remained traditionally separate, particularly anthropology, sociology and psychology ((Buckley 1968) republished in (Schwandt & Goldstein 2008)). In tracing the history of “feedback” thinking in the social sciences, Richardson (1999) acknowledges that “the loop concept underlying feedback and circular causality is one of the most profound and most penetrating fundamentals in all social science”. This implies that whilst sociologists may not all recognise systems thinking and complex adaptive systems theory as a part of the sociology toolbox, it does in fact constitute an historical and current framework within sociology.

4.1.1 Foundations of complex adaptive systems theory

Linear and Non-Linear Systems

In general, we have an intuitive understanding of a system as being a collection of parts that work together as a whole. The parts here may be mechanical, social groups, individuals (people or other organisms) or they could be sub-systems constituting parts of larger systems that are also their own system.

Because we are constantly surrounded by systems, and we are part of systems, it would seem logical that we would have a mental model of the world that depicts it in a systemic way but this is not necessarily the case. Historically, the success of the sciences in understanding our world using linear models based on positivist, reductionist paradigms, has led us to thinking that it is possible to understand the world as a series of linear processes (Meadows 2008). At some scales this is a reasonable assumption, but it is important to recognise that in many cases the simplification of complex, non-linear phenomenon to linear models will not serve us well (Espinosa & Walker 2011). As our knowledge and computing power increases we are becoming more aware that climate, weather, society, ecology, economics and many other fields of human interest are subject to non-linear change and fluctuation.

Complexity

In order to understand complex adaptive systems theory it is useful to first understand how the word complexity is used and not used. The Oxford Dictionary (online version) defines ‘complex’ as “The state or quality of being intricate or complicated”. In common use the word ‘complex’ is equivalent to using the word ‘complicated’.
Within the scope of complex adaptive systems theory, the words ‘complex’ and ‘complexity’ are used to denote a very specific state of being. The best way to understand this state is by comparing it with the alternative possible states of being. If we consider that a system may be ordered, complex or disordered (chaotic) then we would define complexity as a state that is not entirely ordered and predictable but which has some pattern to it. In Figure 4 it can be seen that an ordered system is quite predictable and very stable, whereas a disordered or chaotic system is entirely unpredictable and unpatterned. The peak of complexity is found between these extremes.

![Figure 4: Relationship between complexity and order.](source: Parrott (2012))

Systems composed of elements that are interrelated and which show interdependencies that have broad patterns but limited specific predictabilities are complex adaptive systems.

For example, let’s consider the state of various ecosystems. An intensively farmed field of wheat may be considered to be very ordered and predictable since we know from one row to the next what we will find (more wheat). Now imagine a field where the farmer has randomly introduced new and exotic plants each year, and randomly dug up sections over several years. If we walk through the field we will find mature plants and young plants, lots of different types of plants and weeds and all in a quite unpredictable fashion. This field would be chaotic as the constant random perturbation by the farmer does not allow for a level of stability or iteration to occur within the system.

In contrast to these two examples, a rainforest ecosystem is complex. We can predict the growth of canopy trees and undergrowth, we can understand the pattern of sizes and shapes of plants that occur and their response to changes in weather, but we can’t predict when a tree will fall, or precisely what will replace it. Some of these factors depend on chance occurrences, wind-blown seeds, weather etc… so there are patterns but we need to look at several levels
of the landscape and ecosystem to identify and understand them. This means that we can model how a rainforest works in general but we can’t predict with any long-term accuracy what will occur at a specific time or place.

Complexity is a state where there are patterns that are not immediately obvious, because their iteration is not exact. Even if we struggle to define complexity we do tend to recognise it when we see it. Rainforest ecosystems, coral reefs, planetary movement, human societies and organisations within societies are all complex systems that we would recognise as such (Parrott 2012).

**Adaptive Systems**

When we consider ‘adaptation’ we tend to think about the suitability of an element for its environment or purpose in that environment. In terms of complex adaptive systems the interdependency of element and environment mean that rather than adapting to its environment a system is adapting with its environment (Levin 1998). The interconnectedness of systems means that co-evolution of this type is not confined to the elements of one system or environment but also to related systems and their elements (Walby 2007). It is possible to imagine chains and loops of adaptive change continuing in this fashion *ad nauseam*.

**4.1.2 Descriptions of complex adaptive systems (CAS)**

Complex adaptive systems (CAS) are defined as systems that co-evolve with their environment, show self-organisation and emergent properties, are non-linear in their dynamics, are sensitive to initial conditions and show a certain level of “stability” due to feedback processes that create homeostasis (Lyons 2004). CAS can be understood in terms of both complexity and responsiveness. Definitions of CAS revolve around several key concepts. Ramalingam et al. (2008) define several concepts crucial to CAS theory that they then demonstrate with examples from relief and development environments. The following concepts are often used to describe complex adaptive systems behaviours (Bar-Yam 2002; Bossel 2001; Ramalingam et al. 2008; Urry 2003):

*Agents are a heterogeneous group of individuals*

CAS are made up of individual agents or elements, whether these are bacteria, people, atoms, schools, fish or any number of other identifiable individuals. Each of the agents or elements in a system is in some way different to the others. Living organisms show dramatic diversity due to the well-known mechanisms of evolution, natural selection and environmental influence. Human social organisations are always different from each other – the personalities and skills of the individuals who constitute them ensure that this is the case. Although we can determine an average behaviour or general pattern of the elements or people in a system, it is impossible to make long term precise predictions of the actual behaviour of individual agents (Page 2011).
Each agent acts within its own freedom to make decisions, interact and adapt to its environment

Individual agents within a CAS interact with various degrees of freedom within, and externally to, the system. Freedom of interaction is a good determinant of the complexity of a system e.g., in a very repressive regime with strict governmental control of resources there is little opportunity for individuals to explore or innovate in businesses by creating new products or strategies, so in this respect the society is more ordered than complex. When law and order break down in a society then anarchy ensues, at least temporarily the society is more disordered than complex. Eventually, the anarchic society might find itself with leaders who form coalitions who form a government. We would recognise a complex social order that has emerged from the previous anarchy. So complexity arises when there is significant freedom, limited by some rules (Bar-Yam 2002). Within any complex adaptive system it is important to note that an individual agent may “break the rules” effectively innovating or adapting to changes in their environment.

The actions of the agents result in the emergence of new levels of organisation

If agents are free to interact and participate within a simple set of rules then the result is the emergence of higher levels of organisation. Individuals form groups, clusters, communities and so forth. These may be human, plant, fish, bacteria etc…. the scientific language used to describe them may vary, but the hierarchy of organisations is remarkably similar (Page 2011). For humanity some of the outward signs of emergence across history are visible in our different institutions for the governing of countries.

Understanding CAS means looking at their different levels

CAS are often contained within one another, a common analogy for this is a set of Russian matryoshka dolls but this is quite an unsatisfactory comparison as it doesn’t account for the links between and within levels. Figure 5 is taken directly from Parrott (2002) and gives a succinct diagrammatic description of the interactions between organisational levels of complexity.
Figure 5: Hierarchy of organizational levels in a complex system. Locally interacting components give rise to emergent, higher-level entities, whose existence, in turn, affects the behaviour of the lower-level entities. Source: Parrott (2002)

Interconnections exist within and between groups at the same level of organisation as well as between levels of organisation. An individual may be part of several groups and several levels of organisation. Understanding a CAS requires an understanding of the different levels of organisation that relate to it (Bar-Yam 2004). For example, understanding why bee colonies appear to be dying requires an understanding of agricultural practices, ecology of disease organisms (like the Varroa mite), nesting sites, bee anatomy, social structure within hives, and more. It cannot be assumed that there is a linear cause and effect that can be discovered and lead to a cure (Sumpter & Martin 2004). From a WASH perspective this interconnectedness requires development staff to be aware of social, policy and physical environments that may affect their efforts in implementing a technical solution to water accessibility.

Each level of organisation responds to feedback processes that act either to reduce change or to exacerbate change

Another notable characteristic of CAS is that they may stay apparently stable through many external changes and inputs and then change relatively rapidly. This is frequently described in popular and scientific literature as a tipping point or threshold effect (Page 2011). Agents in a system, and the system itself, are subject to feedback loops.
System dynamics deals extensively with feedback loops, which can be either reinforcing or stabilising (balancing) (Sterman 2000). A reinforcing feedback loop will drive change in a system while a stabilising, or balancing, feedback loop reacts against the direction of change of a system to prevent change in a system. (Sterman 2000). Change that is driven by reinforcing feedback loops often catches people by surprise because the process is not linear and there is a widespread tendency to underestimate exponential growth or decay. In a system which also includes delays in feedback the surprise factor can be quite large (Sterman 1994). Feedback process and system dynamics are explained further in section 4.3.

Change drives the process of co-evolution

Systems do not exist by themselves (Figure 5). It can be seen that each agent within a system, could potentially be a system of its own, or it could be a component of many different systems. Agents and systems can adapt to changes in their environment. As one system changes this will drive change in associated, underlying and umbrella systems. This process of change creating further change elsewhere is co-evolution (Byrne 1998). One example of this is disease-causing pathogens and humans co-evolving. For example each year “the flu” has cycles when it infects a lot of people and some people seem to be immune to it one year but will catch it another year. This is because the virus that causes the flu virus is constantly evolving which allows it to overcome human immune system resistance (Clark 2001). So as human immune systems adapt to recognise the flu virus, the virus evolves to become less easily recognised and then immune systems adapt again to recognise the virus and this process is iterated each year, so that each year there is a new flu virus (Clark 2001).

CAS are very sensitive to initial conditions

Edward Lorenz is credited with giving the example of the “butterfly effect” to demonstrate how sensitivity to initial conditions works in complexity theory. The idea says that a very small impact such as a butterfly flapping its wings in a certain place and time, could determine the characteristics of a cyclone in a different place, several days or weeks later (De Bot, Lowie & Verspoor 2007). This example is intended to highlight the fact that in a CAS it is possible for a very small initial difference in conditions to have a very large impact on the end result (Capra 2007). Our atmosphere and our weather are CAS, the butterfly may not create the cyclone, but its flapping wings (at a specific time and place) could cause a chain of disturbances large enough to effect the course or size of the cyclone. The settling of a snowflake in the right place, under the right conditions, could cause an avalanche.

The concept of ‘path dependence’ arises from the sensitivity of CAS to their initial conditions. Path dependence indicates that as CAS move away from a particular position the next step is determined somewhat by the previous steps. So the history of a community can often play a part in determining its response
to development interventions. For example, in a year when diarrhoea has been particularly prevalent in a community residents may be more receptive to messages about hand washing with soap.

**CAS resist change (are resilient)**

CAS can be seen to evolve. This means that their existence is based on a long period of growth and change. One result of evolutionary processes is built-in redundancy, so if one part of a system fails, another one will fill the niche. For example, if a program manager in a medium sized NGO leaves the organisation, the whole organisation doesn’t stop functioning. The duties are passed to others and the organisation continues to work with only a little adjustment required. This resistance to change in a system is also conceptualised as resilience in the sense of ‘bouncing back’ to a previous state or adapting to change.

“The adaptive capacity of all levels of society is constrained by the resilience of their institutions and the natural systems on which they depend. The greater their resilience, the greater is their ability to absorb shocks and perturbations and adapt to change.” (Berkes, Colding & Folke 2003, p. p14)

From the development perspective resilience as the ability to adapt to change rather than simply “bouncing back” to the previous state is important as this indicates that shocks can also be opportunities for beneficial change. In terms of individual human psychology, Fredrickson & Losada (2005) maintain that, within an upper limit, increased complexity (as measured by positive affect) leads to enhanced resilience of the individual. The merging of concepts around resilience across human development, social wellbeing and the environment is supported by Brown and Westaway (2011).

The evolutionary nature of CAS also creates a phenomenon known as ‘lock-ins’. A lock-in is a situation where a system has evolved around a particular structure or social norm and despite the fact that the structure or norm may no longer be useful, it is difficult for the system to change away from it. A familiar example is the QWERTY keyboard. When typewriters were invented the QWERTY keyboard was designed so that typists couldn’t type faster than the mechanical keys could shift. Despite this no longer being an issue, the inefficient QWERTY keyboard is still used by most people because changing is perceived to be too difficult.

In a cultural sense the idea of lock-ins helps to explain why traditions that are either harmful or apparently unnecessary continue in communities. For Timor-Leste one of these traditions is the payment of a bride-price or folin, also known as barlake (Hicks 2012). Hicks (2012) indicates that there is much criticism of the payment of folin but that its history and symbolism within communities means that while the costs and artefacts of the folin is likely to change over time, the sentiment and the symbolism will remain a part of the cultural landscape of Timor-Leste.
From a complexity perspective both ecological and social resilience are related to a system’s position within its fitness landscape or phase space as explained in the next section.

**CAS are constrained by Basins of Attraction and Phase Space**

CAS can be described in terms of their position in phase space. Phase space is a description of all the possible states of a system at all possible times. For most real systems this is impossible to show in a diagram as each possible state has its own dimension and it is difficult to create or to understand diagrammatic representations of more than 3 dimensions. CAS in their phase space are constrained to a basin of attraction and they will move in a specific space around the attractor without ever returning to the same place (Capra 2007). It is possible to predict that a system will be in a particular phase space but not where in that phase space it will be. Figure 6 is a diagram of a Lorenz attractor, named after Edward Lorenz whose investigations into weather scenarios led to the previously discussed “butterfly effect”. The diagram is a computer generated plot of the movement of a system within an n-dimensional space. Note that the system is never in the same place twice (it does come very close), even though it follows an almost repetitive path.

![Figure 6: Standard Lorenz Attractor. Source: Shil’nikov, Shil’nikov and Turaev (1993)](image)

The phase space for any CAS may contain multiple basins of attraction scattered throughout a fitness landscape. This is shown in Figure 7 where the phase space can be thought of as the entire sheet and the fitness landscape is the ‘geography’ of the sheet. While a system exists within any single basin of attraction (stable point in the fitness landscape) it has the potential to move to a different basin of attraction. Movement from one basin of attraction to another is noticed as a threshold effect or tipping point (Urry 2003). These tipping points tend to come as a surprise to even the most experienced observers (Sterman 1994). While it is possible for CAS to move between basins of attraction the tendency is to stay within the same basin of attraction. Movement between basins of attraction may be caused by large exogenous forces, small but
significant exogenous forces (snowflake or butterfly) or through the effect of a changing fitness landscape.

To explain this further if you imagine a ball rolling around the fitness landscape shown in Figure 7 and imagine the ball is a small community (a CAS). That community (ball/CAS) will get stuck in certain patterns of behaviour which would correlate to the valleys (basin of attraction) in the diagram. It is difficult to change those patterns of behaviour, so the community can be said to be constrained by the basin of attraction. With critical resistance, an exogenous impact or a change to the fitness landscape (e.g. government policy) the community might find itself moving either quite quickly or quite slowly out of a valley and towards a peak from where it is bound to fall towards another basin of attraction (pattern of behaviour).

At the point where a community (ball) is in a particular basin of attraction but appears to be moving away from it, it is useful to consider that the community isn’t able to predict what the fitness landscape looks like or the pathway that will be taken. The view of the community is similar to that in Figure 8 where only a fraction of the landscape is known. The community might recognise that they
are moving away from a basin of attraction but they cannot know exactly where they are moving to. Over-planning or over-engineering a development intervention can be caused by the assumption that fitness landscape in a known entity, as shown in Figure 9. Or it can be caused by the belief that with enough planning the direction that the community takes through the fitness landscape can be controlled.

![Figure 9: Cross-section of a fitness landscape. Source: Everett (2011) used with permission](image)

In summary, Complex Adaptive Systems can be recognised by their limited predictability, significant interdependent links with other systems and internally, a diversity of forms, built in redundancy, feedback loops, emergent behaviour and responsiveness to changes in their environment. The uncertainty that characterises complex adaptive systems is a result of the interconnected nature of the elements of the systems and the co-evolution of nested and interdependent systems to form an indecomposable whole that is robust, resilient and adaptable.

4.2 Social Network Analysis (SNA)

Social networks are apparent to us through the mediated lens of technologies such as Facebook, LinkedIn, Instagram, Pinterest, Twitter or whatever your favourite social media site is. But social networks are more than just the groups of friends, colleagues and followers found on these sites. Social networks exist anywhere that people are able to communicate with each other. Every interaction forms a bond between people and those bonds make up a social network. The nature of the bonds in a social network may be based on a wide variety of links including families, friendships, location, likes, dislikes and business dealings. Social networks may be formed through emergent process of community interaction or through much more externally structured interactions such as in schools and jails. Bonds between people in these networks can vary in strength depending on the relationship and they may or may not be reciprocal.
Social network analysis allows us to describe the links within a social network. This includes meta-networks where various aspects of social networks can be overlaid, for example people, knowledge, world-view, skills and resources.

Wasserman and Faust (1994) describe social network analysis at length but it defies easy definition. Their description “social network analysis is based on an assumption of the importance of relationships among interacting units” is consistent with CAS theory. Along with this relational concept, descriptions of SNA consistently include ideas around:

- Interdependence (compared to independence) of actors
- Resource (material, knowledge, status) flow through linkages
- Network structures providing constraints and opportunities to individuals
- Social network structures as longer term, rather than ephemeral, patterns of interaction
- SNA can include and involve different levels (individuals, organisations) of network agents

Wasserman and Faust (1994) highlight the usefulness of SNA as a means to bring objective definition to social concepts and also as a means of moving away from the conception of individuals as “islands” which are not influenced by the individuals around them. The use of statistical frameworks within SNA creates scope for explanatory theories, testing and analysis in a way that is not possible when relying on metaphoric frameworks.

International development research so far makes little use of social network analysis. There is significant potential for SNA to highlight the structure of small communities and the differences between formal and informal, or traditional and new networks. The mapping of networks within development spheres can open up new levels of understanding of influence within and exogenous to a community. This thesis will apply social network analysis methods to NGOs and rural communities in East Timor to investigate the relationships between these social structures and the implementation of rural water systems.

The few current examples of the use of social network analysis in international development studies tend to focus on collective action in community natural resource management (Alexander & Armitage 2014; Sutton & Rudd 2014) or on large water catchment communities (Stein, Ernston & Barron 2011).

SNA has gained greater traction within community development as an evaluation (Abel & Gillespie 2014) and explanatory tool. It has also been used to facilitate community analysis of internal networks looking to the strengths and vulnerabilities of specific communities (Ennis & West 2013).

The visual basis of social network analysis is social network maps that show connections between nodes. Connections are often called edges and nodes may be called vertices. Edges are generally indicative of a relationship through which there is a flow of resources, knowledge, ideas or other intangible goods.
Nodes are entities that may exist at a variety of levels. They can be individuals, organisations or even nations depending on the relationships observed by the map. Specific structures can be observed within social network maps and can be used to identify significant social positions including gatekeepers and knowledge brokers, isolates and cliques.

Measures of centrality indicate positions of leadership and overall structure may indicate the resilience of a social network to specific changes. Ego networks are the social network of an individual. Understanding social network maps requires both an analyses of the structure and a qualitative understanding of the social network under examination (Wasserman & Faust 1994). There is no such thing as an “average relationship” and so without contextual understanding SNA is not a useful tool. The following diagram and description (Figure 10) from Alexander and Armitage (2014) is useful in understanding the structure of social network maps:

![Figure 10: Conceptualizing social networks](image)

(a) composed of actors represented by the open circles, connected via particular relational ties (e.g., knowledge exchange; represented by the lines); (b) social networks can be fragmented with the potential that two actors are connected via one relational tie yet not connected to the other actors or a single actor can lack any relational ties (i.e., an isolate); (c) the significance of the tie between the two solid colour actors (i.e., connecting two otherwise unconnected subgroups) is only realized when placed in the larger context of relational ties. Source: Alexander and Armitage (2014).

4.3 System Dynamics

System dynamics is a mathematical approach to complex systems science, it enables predictions of what will happen to certain parts of systems under certain conditions of change. System dynamics uses stock and flow and influence diagrams as tools to understand and depict systems and their behaviour. System dynamics allow for a thorough understanding of the quantitative changes, delays and leverage points in a system (Sterman 2000). System dynamics have been used as a tool to discover feedback loops and leverage points in aid (Howe 2010). Being quantitative in nature, system dynamics is most commonly applied in business, engineering, manufacturing and ecology studies. Within this thesis the more descriptive aspects of system dynamics, in particular the influence diagram and causal loop, are used to describe and understand counter intuitive development scenarios (Luna-Reyes
Boyd, Brown and Midgley (2004) indicate that systemic problems can be modelled using a variety of techniques including rich pictures, signed diagraphs, influence diagrams, qualitative system dynamics models and problem mapping. They identify that rich pictures hold significant visual appeal but are complicated and highly individual while signed diagraphs, influence diagrams and qualitative system dynamics models are all good for making feedback loops visible but require some training to achieve transparency. Given the focus of this research on the counter-intuitive outcomes of WASH, the technique of influence diagrams seems the most promising. El Halabi, Doolan and Cardew-Hall (2012) have noted that there has been some dissent regarding the validity of the application of system dynamics to highly complex problems that involve qualitative data sources. Whilst acknowledging that other systems thinking tools – Soft Systems Methodology, Viable Systems Methodology, or Operational Research - are available to the qualitative researcher they conclude that system dynamics is also a useful tool for analysing qualitative research (El Halabi, Doolan & Cardew-Hall 2012).

4.3.1 Influence diagrams

This section explains the key features of an influence/causal loop diagram through presentation of an example. The example is an influence diagram drawn early in the research process to identify possible impacts of lack of access to potable water (Figure 11). Looking at the example, the notation used is consistent with Sterman (2000) and the diagram was created using Vensim PLE software. Each factor in the diagram is described as a measurable entity. The arrows in the diagram indicate that one factor will affect another factor, the symbol at the head of the arrow (+/-) indicates whether the effect drives the factor in the same direction or the opposite direction. So for example the diagram indicates that nutrition affects wellness, the positive sign indicates that increasing nutrition will increase wellness. The other way to state this would be that decreasing nutrition would decrease wellness – the positive arrow doesn’t indicate a positive change, it indicates that change is in the same direction. The negative symbol indicates that change is in a different direction, so if the time that a girl requires to collect and manage water is increased then her opportunities to access education or employment are decreased. And the opposite is also true, if the time that a girl requires to collect and manage water is decreased then her opportunities to access education or employment are increased. The arrow between access to education or employment and income has a positive symbol indicating the increased access to education or employment should create increased income but you will note that there is a double line across the arrow, this double line indicates that there is a delay in the effect – increasing a young girl’s access to education today won’t have a beneficial impact on her income for some years, hence there is a delay in effect.
In the centre of the diagram are two curly arrows with an R in each. These indicate that there is a reinforcing feedback loop in play. Colloquially a reinforcing feedback loop is known as a virtuous or vicious cycle – once a dynamic has begun, it reinforces itself – so in this case, if a woman’s income is increased this would create increased nutrition which would create increased wellness which would create increased access to employment which would create more income – so there is a circle that comes back to the start and reinforces the original increasing (or decreasing) factor. The second reinforcing feedback loop increases the consistent use of safe drinking water instead of increased nutrition, the impact on wellness and income though are both in the same direction. Obviously this influence diagram makes a considerable number of assumptions, part of the application of systems thinking in this manner is to raise and to question assumptions. One example in this case is that there is an assumption that any increase in income is put towards nutrition or potable water supply, which may not be the case, extra income could be put towards myriad other things. One aspect of influence that is not shown here is the balancing feedback loop – balancing loops, when they exist, stop reinforcing loops from rapidly overshooting, they cause a dynamic system to maintain its status quo. A balancing feedback loop that might act on the situation shown in Figure 11 would be if there is an overshoot, then increased nutrition may cause health problems such as diabetes and obesity so the feedback loop would change to the one shown in Figure 12 where increases in nutrition result in decreases in wellness, resulting in decreases in access to education or employment and therefore also decreased income which would result in decreased nutrition –
hence eventually balancing out the initial action.

**Figure 12: Overshoot of nutrition**

4.3.2 System dynamics and sociology

Richardson (1999) explores the history of feedback loops applied to the social sciences and determines that although feedback loops (a central tenet of system dynamics) have been acknowledged within the social sciences since the 1940s, they have been poorly integrated and applied in a diversity of ways and with no single unifying perspective.

Lane (2001a, 2001b) in a series of papers that attempt to locate system dynamics within sociology, investigates several sociological frameworks and contends that while there is no “best fit” for system dynamics in the voluntarism – determinism dichotomy, there is space in the structure-agency continuum that finds the right balance between the search for a universal pattern or truth (nomothetic approach) and the detailed case study (ideographic approach) in understanding sociological phenomena. Whilst Lane (2001b) references Bourdieu, his preferred integrative sociology for system dynamics is that of Anthony Giddens' Structuration Theory. Lane’s assertion that sociological theory appeals because it presents “plausible and insightful accounts of very subtle social phenomena” is more acceptable than his claim that integrative theories are the “poor relations” of economics because they lack grounding in quantitative empirical data. This thesis in fact attempts to use both Bourdieu’s integrative sociological theory, and system dynamics, in order to understand the sustainability of water systems as part of a complex adaptive system.

Bourdieu’s insight into habitus as unconscious action and patterns of relationships correlates with the CAS concept of phase space. Therefore Bourdieu’s ‘theory of practise’ is used in this thesis as a sociological basis for
understanding development phenomena. In particular I look to the implications of habitus and field as explanations of the behavioural patterns and interactions of development staff and the individuals and communities of the majority world with whom they interact.
5 Theoretical backgrounds

This chapter introduces theories from community development, international development and sociology that are useful in developing an understanding of what Shepherd (2009) refers to as the anthropology of development. It then looks to examples of previous explicit uses of systems thinking in international development areas.

Development research is an ill-defined area that has been described by Habermann and Langthaler (2010) as including the areas of research for development, research on development and development policy research. Habermann and Langthaler (2010) include natural, technical, social and socio-economic sciences along with the explicit use of the terms ‘multi-disciplinary’, ‘inter-disciplinary’ and ‘complex’ to describe development research. The use of this terminology locates Habermann and Langthaler’s (2010) paper as a call to cross boundaries to “build disciplinary bridges” between theory and practise and policy. They claim that “[research for development] is deemed to neglect the social and historical context as well as the societal and structural causes of those phenomena that it is trying to help overcome.”(Habermann & Langthaler 2010, p. 781)

This thesis, in taking complex adaptive system theory as a framework for research both for and on development brings together these disparate contextualisations into an integrated comprehensive view of the social and technical factors that influence the success of rural water systems in Timor-Leste.

5.1 International Development

International aid seems to be a necessary part of current global systems. The willingness and ability of countries and NGOs to provide aid to those in need has evolved rapidly over the 20th century. International aid comes in many different guises, in response to very different perceived needs; from helping the war wounded to feeding the destitute. Aid is provided to a range of emergency and development causes by organisations from diverse geopolitical, religious and cultural traditions; from puritan Christian England, to tribal Islamic Persia to polytheist India and socialist France (Walker & Maxwell 2009). The last 150 years has seen a proliferation of relief and development agencies working in majority world countries. It has seen multiple “global” governance agencies such as the League of Nations, the International Refugee Organisation and the United Nations, come into, and (in some cases) cease, existence (Walker & Maxwell 2009). The rationale behind all of this activity is grounded in an almost universal concept of “charity”. The desire to assist “those less fortunate” has been a strong driver of an amazing variety of well-intentioned interventions.

Modern aid is considered to have begun with the Marshall plan after World War 2 (Dabelstein & Patton 2012). Analysis and critique of the aid sector since the
1960s tends to see the sector in a less than utopian manner. Martens (2005) posits that almost all types of aid organisations including non-government organisations (NGOs) and multilateral development banks (MDBs) have come about in order to trade off transaction costs against certainty and negotiated aims and outcomes. He states that “the feedback loop between recipients and decision-makers is broken” meaning that recipients of aid (individuals or countries) have little say in the application or timing of aid. This view is strongly supported in a recent populist text by Easterly (2006). It is clear that in the continuum between direct aid, bilateral aid and multilateral aid there is an increase in conditionality that tends to follow a similar trend of increases in preference misalignment between donor and recipient. Noting that aid as a form of foreign policy has many rationales and drivers Van der Veen (2011) provides an analysis of rationales given for provision of foreign aid (Table 3).

<table>
<thead>
<tr>
<th>Frame</th>
<th>Goals for Aid</th>
</tr>
</thead>
<tbody>
<tr>
<td>Security</td>
<td>Increase donor’s physical security: support allies, oppose Communism, etc.</td>
</tr>
<tr>
<td>Power/influence</td>
<td>Pursue power: increase leverage over others, win allies and positions of influence in international fora</td>
</tr>
<tr>
<td>Wealth/economic self-interest</td>
<td>Further economic interests of donor economy; support export industries</td>
</tr>
<tr>
<td>Enlightened self-interest</td>
<td>Pursue global public goods: peace, stability, environmental health, population control, etc.</td>
</tr>
<tr>
<td>Reputation/self-affirmation</td>
<td>Establish and express a certain identity in international status and reputation</td>
</tr>
<tr>
<td>Obligation/duty</td>
<td>Fulfil obligations, whether historical or associated with position in international system</td>
</tr>
<tr>
<td>Humanitarianism</td>
<td>Promote the well-being of the poorest groups world-wide; provide humanitarian relief</td>
</tr>
</tbody>
</table>
This list makes it clear that while the origins of aid may have been altruistic, the current provision of aid by governments and corporations is often about gain in other areas. Hence validating view that aid is sometimes used more for the benefit of the country of origin than for the benefit of the billions of people living below the poverty line in majority world countries. Private contributions are still likely driven by altruism, although one critique would suggest that cognitive dissonance is a more compelling rationale (Martens 2005). De Cordier (2009) notes that other than these actual rationales for the provision of aid, there is a recent perception, within affected communities, of aid being confounded with armed conflict, local security and geopolitical control agendas along with the actuality of increasingly non-secular, non-neutral aid provision.

The academic discourse regarding aid and development has ranged across the broader discipline for many years now and, according to Kothari (2005) has included literature aimed directly at influencing policy and practice as well as analyses and critique of these. The multiple discourses of aid and development come from a multitude of critical perspectives and occur within various fields including development studies, area studies, economics, engineering and politics. Recent discourse has included contention about the millennium development goals (MDGs) and “the big push” including critique from left, right, centrist, neo-liberal and globalist perspectives (Habermann & Langthaler 2010). Critique from the different perspectives has a tendency to focus on the same issues with aid – lack of economic development as measured by gross domestic product (GDP), support for corrupt regimes, the onerous impact of reporting to, and hosting of, aid agency staff on small government departments. More recent critique has noted the complexity of trying to achieve “development” for billions of the world’s poor in an environmentally sustainable way (Easterly 2006; Kenny 2011) as idealised within the Sustainable Development Goals (SDGs).

Since 1960 the minority world had donated more than $2trillion in aid across the globe (Kenny 2011). This equates to less than 1% of GDP from most donor countries and up to 15% of the GDP of some recipient countries at various times. The OECD (2011) report that net Official Development Assistance (ODA) in 2010 reached USD $127.8 billion. Based on current trajectories we can expect that ensuring the survival of the world’s one billion poorest people will continue to require aid inputs in the form of both relief and development programs for some time to come.

The academic literature regarding development is broad, based in many different fields of enquiry, and valid support and criticism for many positions can be found. The term development covers a wide range of activities and a large number of organisations who are involved in development activities – these include single objective organisations, for example Cambodian Kids Can, a small Australian based charity running a girl’s orphanage and school in Cambodia (CKC 2014), through to large globally identifiable NGOs such as Oxfam and Save the Children. Activities cover provision of education, health care, shelter, infrastructure, logistics, capability support, livelihoods support,
fiscal services and more. Almost all of these activities have an overarching aim of creating an environment where individuals have the “basic necessities” and communities are resilient and adaptable and require no exogenous intervention. The success of development activities since the end of World War 2 is questioned, critiqued and assessed regularly. The focus of much of this assessment has been around economic development (growth in GDP) and taken on this basis alone it would appear that the provision of aid over the last 50 years has failed in many cases to produce the expected economic growth. GDP, however, is not the only measurement of development.

The best known or acknowledged combined measure of development is probably the Human Development Index (HDI) published regularly by the UNDP (UNDP n.d.). This index combines measures of life expectancy, education and income for all countries in order to assess “quality of life”. Kenny (2011) provides significant evidence that despite a lack of economic and income growth many populations have seen quantifiable increases in quality of life based on health, longevity, education, gender equality and political freedom indices. Kenny also cites cases such as the USSR where increased GDP was not associated with improvements in quality of life.

In Collier’s (2007) book The Bottom Billion and Jackson’s (2009) manifesto Prosperity Without Growth both author’s identify growth of GDP as a necessary ingredient for majority world countries to ensure the wellbeing of their citizens. Both authors also indicate that structural changes in minority world countries are needed to support economic growth in the majority world – these changes include reducing or halting economic growth as well as changing trade (and other) policies that work against development policies. These views are supported by The Royal Society (2012) in their report People and the Planet with the recommendation that there is a global need to “develop socio-economic systems and institutions that are not dependent on continued material consumption growth” (The Royal Society 2012, p. 9) while admonishing that the poorest of countries still need assistance to be able to increase consumption at the least to the point of meeting basic health and nutritional needs.

A global program to meet the basic needs of the world’s poorest people, the Millennium Development Goals, was adopted in September 2000 by the UN and has created a focus on particular areas of importance to development - education, poverty reduction, water, sanitation, hygiene, food security, livelihoods, health, child mortality, gender equality and environment (UN 2000). Whilst still controversial, there is evidence that this strong focus on particular outcomes is having a positive impact and despite some issues around the ability to measure some goals on a global scale (Dabelstein & Patton 2012) it appears that the target to reduce by half the number of people who don’t have access to an improved (safe) water source has been met (United Nations 2014).

From the field of international development I have been significantly inspired by Amartya Sen’s (1999) “Development as Freedom” and Martha Nussbaum’s
(2003) extension of Sen’s capability approach to social justice. While Sen’s conception of development as freedom is formative in my understanding of development activities as complex adaptive systems, it was Nussbaum’s list of capabilities that closed the circle of my understanding of the links between needs, emergence, freedoms and capabilities. The capabilities that Nussbaum describes as being essential to social justice also correlate with the needs and satisfiers that Max-Neef (1991) identified as constituting limits to development opportunities, these are discussed in section 5.2.1.

International development deals with humankind both as individuals and within social groupings at a whole range of different levels from family groups, to small villages, large towns, cities and nation states, as well as considering the effects of globalisation and global organisations at each of these levels (Bennett 1996). Development workers are attempting to bring beneficial changes to the lives of individuals and societies. In doing this, it is incumbent upon the sector to understand, as deeply as possible, the basis for actions and their possible impacts.

Theories of change are used within the development sector to apply a critical lens to the whole program cycle (Vogel 2012). The influence diagram as used in system dynamics has some parallel with theories of change as described by Morra Imas & Rist (2009). Theories of change are explained in terms of complexity, assumptions, logic chains and feedback loops.

“A good theory of change does not assume simple linear cause-and-effect relationships; it shows complex relationships by using boxes and arrows that link back to earlier- or ahead to later – parts of the theory of change. They also detail key assumptions underlying the model, including the major contextual or environmental factors or events that will likely influence the intervention.” (Morra Imas & Rist 2009, p. 157)

Despite the similarity of description between theory of change and influence diagrams, the examples of theory of change templates and diagrams given in the text by Morra Imas and Rist (2009) don’t include feedback loops and rely heavily on linear and parallel chains of input, action and output as per the more traditional logical frameworks. Vogel (2012) reviews the use of theory of change and identifies a range of philosophical positions and related intervention methods that apply theory of change in different ways including linear models (log frames), reflexive methods and complexity based methods. The surfacing of assumptions in a theory of change process is highlighted by Vogel (2012) as being both crucial and difficult. The group creation/checking of influence diagrams in a system dynamics process specifically brings out the assumptions made by stakeholders from differing perspectives (Newell et al. 2011).

System dynamics techniques may be useful when changes wrought through international development programs are not those that are intended. When Bennett (1996) states that “Planned change rarely works the way it is supposed
to; simple drift, or muddle, is the usual course” this implies an understanding that development projects are dynamic environments subject to changes in personalities, environment, funding, direction and other factors. Bennett (1996) stresses the point that outcomes that are not planned or measured may still nevertheless be beneficial outcomes. ‘Failed’ development, therefore, is not necessarily a waste of resources. There is an anecdote that demonstrates this:

A village was issued with mosquito nets through an NGO program designed to reduce malarial infections. Rather than use the nets as intended the villagers used the nets as fishing nets. This resulted in an improvement in the overall catch of fish for the village and was certainly considered beneficial by the residents of village, if not the NGO whose aims were not met.

This story demonstrates a level of self-determination in utilising the available resources strategically to affect a beneficial result for the village. Self-determination (or empowerment) is identified by Knox et al (2007) as being an important factor in the creation of human CAS and critical to the emergence of social structures. Chambers (2008b) also indicates that self-organisation and social emergence are critical aspects of development. This concurs with Sen’s theories of development being represented by increased freedoms. Further to this, work by Seitanidi (2008) suggests that the real failures in development may be the missed opportunities to create genuine partnerships that go beyond strategic intent and uni-directional reporting to allow for authentically emergent communication, interaction and change for all stakeholders.

5.2 Community Development

As an education student I was introduced to Abraham Maslow’s ‘hierarchy of needs’ and I felt an intuitive rightness about the theory. It made sense and it gave me, as a novice teacher some ideas of how to understand what was happening in my classroom. It helped me to justify the instigation of a ‘breakfast program’ at the secondary school where I worked and it gave me the tools to elucidate my empathy for people whose lives lack the basic securities of water, food, safety and shelter.

In the context of community development, I revisited Maslow but also came across Manfred Max-Neef’s (1991)“Human Scale Development” and Jim Ife’s “Community Development in an Uncertain World” (2013) and “Human Rights from Below” (Ife 2009). Max-Neef’s schema showed all of the interdependence that could be expected from a complex adaptive system. Ife’s conception of development work resonates with deep respect for the agency of individuals and communities. A part of respecting the strengths, knowledge and rights of the ‘subject’ of development is found in providing options. This chapter concludes by arguing the importance of individuals being free to make decisions founded in their own lived experience, rather than being coerced to agree with actions that are deemed to be ‘best for them’ by an external agent. Coercion in this case includes the willingness of outside agencies to support a
specific set of actions or decisions but not being open to supporting alternative forms of development as generated by residents of majority world communities.

5.2.1 Human needs

Max-Neef’s theory of human scale development looks to avoid many of the pitfalls of both modernization theory and dependency theories, as described by Foster-Carter (1985), through a framework for development practise which reflects an implicit parallel with CAS theory:

“Such development is focussed and based on the satisfaction of fundamental human needs, on the generation of growing levels of self-reliance, and on the construction of organic articulations [the construction of coherent and consistent relations of balanced interdependence among given elements] of people with nature and technology, of global processes with local activity, of the personal with the social, of planning with autonomy and of civil society with the state.”
(Max-Neef 1991, p. 8)

Unpacking this statement gives an insight into human scale development as a construct that fits neatly within the umbrella of CAS theory:

- “satisfaction of fundamental human needs” - as the basis of any other development, the importance of consistently and reliably good nutrition, water and shelter is a solid foundation.
- “generation of growing levels of self-reliance” – increased self-reliance in this sense would indicate increased freedoms, the ability to plan for the predictable future, and to accumulate capital (in all its forms) to ensure resilience. From a CAS perspective this implies a change from the orderliness that is imposed by poverty (lack of choice) to the complexity that is inherent in freedom from poverty.
- “organic articulations of people with nature and technology” – implies that there are links between the different systems, and that these systems are, ultimately, interdependent.
- “organic articulations of global processes with local activity” – implies interdependence between different levels of organisation; that local activity results in emergent global activity and where global activity affects local activity.
- “organic articulations of the personal with the social” – implies that the individual is not isolated, and is in fact part of multiple social networks, whilst being able to maintain an individual identity within those networks.
- “organic articulations of planning with autonomy” – implies that agency can be applied within a transparent framework of governance. Complexity is inherent in the freedom to make decisions within a set of socially agreed constraints.
- “organic articulations of civil society with the state” – implies that the state is responsive to the will of the people, and the people have, in full critical awareness devolved some responsibilities of society to
the state. This indicates the emergence of higher levels of organisation that are intrinsic to CAS theory.

The schema identified by Max-Neef is, in his own words ‘neither normative nor conclusive’ (Max-Neef 1991, p. 30). While the specific satisfiers of the schema may be relevant or irrelevant to East Timorese cultures, the axiological categories provide a good reflection of the aims of development as a minority world construct. The axiological categories identified are: subsistence, protection, affection, understanding, participation, idleness, creation, identity and freedom (Max-Neef 1991). Across the range of development organisations and projects each of these needs is in some ways to be found as an objective for community development. For Max-Neef the question that must be asked once a need is identified, is whether or not the proposed satisfier will impair the satisfaction of other needs. In this regard there is an explicit focus brought to bear on the interdependence of the different needs and satisfiers. Answering this question requires a broad understanding of the context in which the needs and satisfiers exist.

5.2.2 Power, Conflict and Community Participation

‘Community’ as defined by the Oxford online dictionary can denote a “group of people living in the same place or having a particular characteristic in common”. For (Ife 2013) membership of a community implies belonging and acceptance and a sense of being valued within a group. None of this implies that communities are necessarily egalitarian or without struggle or conflict.

Community development as a process implies changes that may challenge existing power structures. In Timor-Leste this process has begun with the democratisation of the governance of sucos and aldeias where the position of chefe is changing from a traditionally inherited position of “power over” a community, to a position where the chefe is an elected “representative of” a community (Pereira & Lete Koten 2012). The traditional source of power, which was based on ancestral lineage and the resources that can be commanded, has been transmuted to a representative power based on a democratic voting system. Regardless of whether this move to a democratic system of governance is perceived as good or bad, it is a significant change, not necessarily of individual leaders, but of the rationale of leadership and the choices available to communities.

Change and diversity is essential to a community and while diversity does not necessitate conflict it makes it more likely that not all interactions will result in consensus. Conflict occurs at multitude levels and can be seen as a constructive part of dynamic community relationships

“conflict has a positive role to play in sustainable community processes: it is both an undeniably inherent element of participation and a democratic imperative” (Holman 2014)
“This is also a world that is temporal and networked: where networks overlap and individual autonomy fluctuates, and where dissensus, consensus and indifference mutually inhabit layers of human interaction. From this ontological starting point the norm of community as a unified geographical entity which is harmonious (or aspiring to be) has to be supplanted with a more contingent understanding where diverse and open-ended expressions of participation in ‘real world’ locations are inflected by multiple conflictive, co-operative and contradictory processes. Specifically, conflict in communities has to be accorded equal consideration to consensus and co-operation. From this perspective, then, ‘community’ and ‘participation’ look far more complex, presenting both a theoretical and analytical challenge to the researcher, and raising questions […] about how these processes can be better understood.” (Holman 2014, pp. 7-8)

Community development in Timor-Leste is described by Shepherd (2009) as: “not a simple entity but a broad constellation of technologies, activities, stories, categories, idea(l)s, distributions, and power relationships” which “inevitably forms a local negotiating space”. Recognition of power and conflict that either exists in communities, or which may be introduced or exacerbated by development interventions, is an important aspect of community level development. The requirement for “participation” within this non-egalitarian space is often presented as a non-negotiable aspect of development, whereas it is “best viewed as emergent, contested, fractured, and negotiated rather than stable or given” (Shepherd 2009). McGregor (2007) notes that participation of communities in WASH programs tends to be bounded by the expectations of the NGO who has designed both the project and the participation with relatively little flexibility. These characteristics of some WASH programs could be seen to contribute to coercive development practices. Genuine participation according to Ife (2013) starts with community selected issues and is not imposed by external agents. It recognises different ways to participate and enables access to participation through skills development and structural accommodations for marginalised groups.

Pogodda (2014) suggests that intervention by NGOs may also reinforce power imbalances and distributive inequality through acceptance of existing cultural norms and beliefs. On the other hand Lenneberg (2010, p. 193) states that “development practitioners (as opposed to charity workers) also set out with a social change agenda – to change the power dynamics within communities”. Hence it seems that NGOs tend to pick and choose between acceptable local beliefs to incorporate in their work and the social norms that they wish to change. As an example Tara bandu is a system of designating particular natural resources as sacred or taboo in Timor-Leste (Escollano Brandao ~2011). Tara bandu is used by NGOs to assist with creating protection for certain areas of land or infrastructure (Shepherd 2009), whereas other cultural norms around the role of women in society are openly challenged by NGOs.
Power and Gender

There is a concern with gender rights linked to water availability. It is generally acknowledged that women and girls are most likely to collect and carry water for the home and are also least likely to have power or voice in the community. NGOs acknowledge this, and community level interventions often seek to create change in relationships, particularly around gender and power (Jupp & Ibn Ali 2013; Mengistu 2012). The government of Timor-Leste also acknowledge that gender equity is an issue and their water supply guidelines indicate a requirement for women to be represented on GMFs. This is a positive step but risks becoming an act of tokenism for women if they have numbers but no voice in committee meetings and across the broader community. In the South African context it has been noted that:

*While there has been a slight shift in gender composition over the past decades, technical experts are still predominantly men; although more gender representative, women still comprise the majority of social experts. This can thus create the appearance of women pleading for social issues to men who are preoccupied with the technical and do not listen well.* (Galvin 2011)

Gender is part of the intersectional vulnerability of individuals living in communities enduring water stress. WASH programs can and do aim to benefit women and girls both through the provision of water and sanitation as well as through the open discussion of gender roles in communities (Cairncross & Valdmanis 2006). The significance of gender in WASH programs is indicated by the list of NGOs and other agencies who have produced specific documentation on gender inclusiveness in WASH programs; WaterAid; UNICEF; International Women’s Development Agency (IWDA); PLAN international; The World Bank Water and Sanitation Program (WSP); bilateral donors and research centres.

Gender awareness within WASH programs is just one action in a larger social struggle that may eventually lead to a tipping point in gendered power relations in Timor-Leste. The aim of this research has been to incorporate broad community contexts into an understanding of WASH and as such it will be seen that the position and roles of women within NGOs and communities forms part of these contexts.

5.3 Sociology

The sociology of development is highly variable in terms of language, fields of thought and geopolitics. Any sociology of development is dealing with one or more parts of the highly diverse, majority world which is spread over several continents, a large number of countries and hundreds of cultural groups (Foster-Carter 1985). The search for patterns or generalizations amongst this diversity, in particular looking for insights to how positive change happens for either individuals or whole societies, occupies a well-deserved space in the academic
5.3.1 Sociological frameworks

The nature of sociology is that of the dialectic, where many theorists are searching for a truth, so the public realm of the sociologist is about ideas and the critique of ideas. Therefore there are many different approaches and frameworks available from within the sociological field. In this thesis the merging of theory, research and practise requires that the theoretical framework is logical, useful and valid. Given that the stated aim of this research is to explore the development sector from a complex adaptive systems perspective, any sociological underpinnings also need to at least avoid direct conflict with the principles of CAS theory. It is preferable that the sociology applied here acknowledges the overarching principles of interconnectedness of agents and environments.

Another significant factor is in the pragmatic use of mixed methods. In the integration of the qualitative with the quantitative it is not possible to reconcile this research with the extremes of sociological theory. Any theory that relies on the extreme of a dichotomy, be it positivist vs relativist or structure vs agency is unlikely to be of value in informing this research. Theories that attempt to integrate these dichotomies and hence reflect the reality of a messy world full of individuals who are sometimes predictable and often not, are of far more value in this context. This pluralist use of epistemologies is not unprecedented and has been justified in the context of complexity research by Midgley (2000) who suggests that theoretical and methodological pluralism are a natural consequence of critical reflection on boundaries and an awareness of the multiple perspectives that may be brought to bear on the research or intervention.

5.3.2 Theory of practise, Pierre Bourdieu

Before discussing Bourdieu’s work it should be noted that he was a prolific theorist and tended to return to ideas and themes and add to them or work them into newer contexts (Jenkins 2002). It is likely then that this particular piece of research will not reflect a significant part of Bourdieu’s theories and may be perceived to suffer from “cherry picking” his work at a stage that suits the author. In part, this is done consciously in order to blend the theoretical and practical bases for this work. In part, it is an inevitability that anyone who has not spent years in the study of Bourdieu’s works will miss something that others, with more grounding in his theories, will consider to be of significance.

Pierre Bourdieu, whose theory of practise includes the concepts of habitus and field brought together the disparate ideas of structure and agency into an integrated theory that indicated that structure and agency have an impact on each other. Structure and agency are not mutually exclusive constructs where human behaviour is either entirely a response to structure or entirely created by agency. Bourdieu states that individual and collective practises are both the
product of history and the creators of history and that human interaction is influenced by our history, as enacted in our status (Bourdieu 1977). Habitus is therefore the history of a life accumulated into a specific way of being. Habitus tends to represent the ‘unexplored’ assumptions, cultural activities, likes, dislikes and an ability to find one’s way within the social milieu that dominates one’s life. Habitus defines us, to ourselves and to others. Any thought, action or disposition that is left unexamined is likely to reproduce itself by influencing future actions. In this way habitus and field become intimately intertwined (Bourdieu 1977). The field is the environment in which adults are expected to be competent. Competence implies a habitus that may be constituted as status, educational background, work and family. To a large degree the field is inherited but the habitus is learned and they both interact to maintain the status quo in regard to social status and wellbeing.

There are notable parallels between the concept of habitus and the idea of emergence. Habitus is created when an individual repeats actions within a field. Structures emerge when interactions are repeated among elements of a system. The field both impacts on the individual and is impacted upon by the individual. Systems respond to a changing environment and simultaneously create stimuli for change in other systems, in a co-evolutionary manner.

Defined from within a Bourdieuan perspective, the aim of development is to change the field and therefore also the habitus of the ‘subjects’ of development. The field is comprised of multiple aspects, therefore changing any aspect in a way that impacts the daily interactions of individuals has the potential to cause their habitus to change. When daily rituals, like groups of women collecting water together at a spring, are interrupted by the implementation of new water systems, social and physical structures adjust to accommodate this. Women may still walk to collect firewood together but the paths to the spring may become overgrown. The bonding that is usually reinforced during water collection and bathing rituals may be neglected for want of a female social space. Changes to the field may also open up spaces for the emergence of new social structures. The next section looks at this possibility.

**Bourdieu and CAS Theory**

In this thesis it is maintained that much of sociology and CAS theory work in parallel and are not mutually exclusive. The theories of Bourdieu stand out as being easily understood within a CAS framework. Indeed, several authors have attempted to map, combine and synthesise key concepts from both. Martin (2011), attempts to develop a model for understanding social inclusion and integration through the synthesis of fitness landscapes (from CAS theory) with habitus and field (from Bourdieu’s *Language and Symbolic Power*). The theoretical exploration of these areas indicates that this can be a useful way for sociology to frame issues of relationships and integration.

Mowles, Stacey and Griffin (2008) critique development management in terms of complexity theory and note that development mangers deal with competing
and contradictory claims for their organisation on a daily basis. They note that systems thinking may be used inappropriately in looking for “levers” that will cause linear, predictable change in development environments and they ask “What would it mean to manage and to practice in organisations committed to a more complex, paradoxical and contingent understanding of the world?” and they conclude that “radical engagement with the other” is required in development management in order to change the field (in Bourdieu’s sense) to accommodate understanding of the complexity of social change and to ensure that actions are coherent within this understanding.

Morrison (2005) compares Giddens’ structuration theory, Bourdieu’s habitus and CAS theory, as they all integrate structure and agency into theories of social change. He finds many similarities in terms of the inter-connection between structure and agency, an emphasis on co-evolution, self-organisation and the freedom of individuals to respond and adapt within social constraints. In the end Morrison (2005) declares that CAS theory is the best fit for theories of change, despite the specific drawback he identifies in the lack of explicit acknowledgment of power as a factor in change and survival. CAS theory treats power as a part of the fitness landscape and therefore power is only made explicit if it is recognised and accounted for in a particular context. This thesis follows Morrison’s work by addressing theories of change as development methods applied to create movement of communities between attractors (see section 9.1.9).

In a paper describing a theory of recursive cultural adaptation Binder (2012) describes practise and change as social phenomena. His proposal that practise is “the embodiment of social structures” and effectively the “way things are done around here”, and that agency as “the pursuit, or defence, of practise” are useful conceptualisations for understanding drivers of behavioural change. This again concurs with both Bourdieu’s concepts of habitus, field and agency as well as CAS theory.

There appears to be little critique of the use complex adaptive systems theory (or similar theories) in the sociology fields. One critique by Houchin & MacLean (2005) notes that the tendency for humans to prefer equilibrium and to avoid change and anxiety by withdrawing to the familiar, creates policy resistance. What Houchin and MacLean fail to elucidate is that this behaviour is in itself an emergent pattern based on a particular attractor. Their argument that CAS theory forms an incomplete metaphor because human systems have “histories that cannot be ignored” reflects the application of a narrow range of CAS concepts. A broader application of complexity theory brings to light the constructs of ‘path dependence’ and ‘lock-ins’, which in fact do acknowledge the history (and the perceived future) that humans bring with them.

This thesis brings together the above correlations of Bourdieu’s field, agency and habitus with systems thinking. Field and fitness landscape are perceived as being well correlated as they are both used to describe the social spaces in which lives are led. Habitus and the iterative interactions that lead to emergence
are also seen to be related entities. They have in common the unobserved or unconscious acts of being, or of fitting in, although it is argued that emergence may be precipitated when iteration of the social norm is not exact and diversity flourishes. Understanding CAS theory as being contiguous with Bourdieu’s sociology allows for the examination, within CAS theory, of power and the uniquely human capabilities of learning, response and communication within social groups.

5.3.3 International Development, Sociology and CAS

Richardson (1999) discusses Malthus (1766–1834) as being probably the earliest sociologist to include conceptions of feedback loops (although not explicitly) in his work regarding population growth. In the 1960s Walter Buckley explicitly used the term Complex Adaptive Systems in regard to society and sociology, and while he defined it using different terms to those currently applied, his conception of CAS as non-linear, non-equilibrium systems is recognisably the same as today’s definitions (Schwandt & Goldstein 2008). So the ideas behind CAS are not foreign to sociology in any way, and in some cases it is clear that, as a way of conceptualising societies, CAS theory while not necessarily new in concept invokes the use of a new vocabulary to describe sociological theory. Bringing a modern understanding of the language and tools of CAS theory, into sociology and specifically into the sociology of development, opens up further ways to understand issues that arise in these areas (Neely in press-a).

Long (1990) describes development interventions in terms that make development immediately recognisable as being amenable to complexity theory. His call to action…

“to understand the process by which external interventions enter the life-worlds of the individuals and groups affected and thus come to form part of the resources and constraints of the social strategies they develop” and to “develop new modes of conceptualizing the complexities and dynamics of social life…. Bring together within the framework of a single analysis an understanding of agency, power and structure.”
(Long 1990, pp. 16, 9)

In defining a methodology for an actor oriented sociology of development, Long recognises the multiple levels of social organisation that impact individual lives, and the necessity of observing as many of these as possible – hence incorporating both structuralist (field) and humanist (agency) aspects to an understanding of development.
The feedback loops between power, agency and structure are described diagrammatically in Figure 13. This map indicates that any changes that affect either power or agency or structure have the potential to affect the other two aspects. So development work, which according to Sen (1999) should explicitly seek to increase freedoms, will impact on agency (individual freedom to act) and therefore will also impact on social structure and power relationships. This was also noted by Giddens who states that “in social systems, however, it is vital to recognise degrees of interdependence, since relations of interdependence are always and everywhere also relations of power” (Giddens 1993, p. 128).

Power was discussed in section 5.2.2 and agency has been used throughout this thesis to denote the self-determination of the individual. The following section expands the conversation to incorporate structure in the form of social capital.

5.3.4 Social norms and social capital

“social capital of any significance can seldom be acquired without the investment of some material resources and the possession of some cultural knowledge, enabling the individual to establish relations with valued others.” (Portes & Landolt 2000)

From Bourdieu’s theory of practise we understand that social capital is contingent on being able to “walk the walk” of the associated social group. Hoy explains that “Acquiring a habitus and an understanding of the field is not a matter of “pretending”, but of learning how to walk or talk with the skills of an accomplished adult” (2004, p. 111). In living that life without resistance there is an implicit acceptance of the social norms of the group, including the rewards and punishments that are part of the group politic. The transubstantiation of
types of capital; economic, cultural and social as indicated in the above quote, was put forward in the landmark text ‘Forms of Capital’ by Bourdieu (1986). Woolcock and Narayan (2000) describe the increasing influence of the idea of social capital across the social sciences in the 1990s. They stress the importance of relationship building in development at both the political and local levels and of understanding the influence of power within social networks at those levels. Furthermore they acknowledge that social capital or social networks in ‘poor communities’ constitute a form of security and risk management, as economic and cultural capital which may play this function in affluent societies, are scarce.

In discussing social capital there is some differentiation to be made between the individual or small group social capital talked about by Bourdieu and the broader idea of community social capital that has evolved separately:

“This confusion becomes evident when we realise that the individual and collective definitions of the concept, though compatible in some instances, are at odds in others. For instance, the right ‘connections’ allow certain persons to gain access to profitable public contracts and to bypass regulations binding on others. Individual social capital in such instances consists precisely in the ability to undermine collective social capital, defined as ‘civic spirit’ and grounded on impartial application of the laws. To cite another instance, the strong solidary bonds in Mafia families and inner city gangs confer benefits on their individual members at the expense of public order and peace.” (Portes & Landolt 2000)

In combining ideas of social capital and social networks it is possible to conceptualise individual social capital as a position within a social network that defines the access that an individual has to the resources of the group in which they are embedded. Positionally, individuals may be able to access resources of several groups or they may act as gatekeeper between cliques. Sutton and Rudd discuss this in terms of leadership in small scale fishing communities:

“It is assumed that social capital and networks are central to collective action. An individual's embeddedness within those networks is an important attribute of a leader. Structural characteristics of social networks provide leaders with a mechanism for the diffusion of ideas, information, and knowledge. Leaders utilize and enhance bridging social capital, the ability of groups to engage with other communities and external agencies. It is often suggested that people are more influenced by, and have more in common with, those people they frequently interact with. For example, small scale fishing community members often have similar backgrounds, livelihood patterns, ethnicities, and religious views. The bridging function that leaders may play between communities
or otherwise unconnected actors is important. Local leaders who are positioned to act as links between communities open crucial doors to social learning and creativity, as they are exposed to different ideas, views, and knowledge types. Opportunities also come to leaders who play a gate-keeping role as they can take advantage of their connections to control the flow of information between networks. The combination of increased social capital and trust in strong leaders can facilitate successful collective action. However, the presence of social capital and strong leadership is unlikely to be enough to ensure successful CBFM on its own given its potential to work as a positive or negative force, and due to the array of conditions that may facilitate or hinder community capacity to manage local resources.” (Sutton & Rudd 2014, pp. 266-7)

Whereas individual social capital can be seen as being beneficial to the individual, the same is not the case for community social capital, which is not intrinsically beneficial. While the social capital that accrues to the individual is a function of the individual’s position in a social network, that value is also influenced by the position of the social group in relation to other social groups.

5.3.5 Resilience and resistance and risk

Within development there is much concern with resilience (Gaillard 2010) but little discussion of resistance. This thesis proposes that resilience and resistance are both responses to a complex environment. From the viewpoint of complex adaptive systems theory resilience and resistance may be the same phenomenon, but judged within the values of the development sector as being either beneficial (resilience) or detrimental (resistance). If resilience or resistance are understood as the ways in which communities consciously or unconsciously maintain the status quo, then both behaviours are signs that the community is acting as a CAS being influenced by a specific attractor.

Acknowledging that the term resilience is used in different fields of academia with different meanings, the definition applied within this thesis is that resilience:

“is broadly seen as the capability to ‘bounce back’ from adversity [where] Such adversity includes economic recession, natural disasters, climate change, and the psychological effects of stress and family breakdown” (Harrison 2013).

Harrison’s concern is that the idea of resilience in poverty studies can be misunderstood, in ways that neglect to acknowledge that for every instance that an individual or community is forced to “bounce back” it may erode their longer term resilience. In a development context van Donk and Gaidien (2014) add three specific criticisms of the use of resilience theory. Their first criticism of
resilience theory is that it neglects to acknowledge the requirements and implications of resilience in the state of “generalised precariousness” that characterises most development contexts. Further to this, Harvey and Lind (2005) in the context of refuting aid dependency, note that successive shocks tend to “erode the resilience and coping capacities” of those experiencing them. Secondly the use of power and issues of structural disadvantage are not incorporated in resilience theory and hence there is a tendency towards appropriation of resilience by the neoliberal hegemony which demands that the individual or community is responsible for its own situational resilience and vulnerabilities. Brown and Westaway (2011) add support to this claim as they acknowledge that resilience is often used as a rationale for reducing the state’s responsibility to ensure that policy is used to create structural support for individuals facing adversity. Harrison’s (2013) third criticism of resilience is that its origins in systems thinking results in lack of focus on points of difference. In the context of resilience as a generalised policy framework these are all valid criticisms. As a critique of resilience in its application to community development work it oversimplifies the implications of systems thinking which can lead to significant examination of context, as will be seen in the case studies in this thesis.

From the understandings above the use of the term resilience in development studies tends to indicate a characteristic that can be built up in a kind of “resilience fund” and then spent when the prevailing conditions require it. Despite the fact that resilience is built through acquisition of capital; skills, material goods and social networks, this accumulation is rarely seen as a deliberate act on behalf of those that demonstrate it. On the other hand resistance is more commonly seen as a deliberate act against a particular situation. Hoy (2004) looks at critical resistance through the lens of several sociological theorists, including Bourdieu, Focault and Derrida and determines that individuals accept (or even invite) some forms of personal and social constraint, but that they may also resist constraint once they are conscious of it. This form of resistance is definitely seen as a considered, deliberate act mediated by our lived and embodied experiences.

Hoy (2004, p. 120) also states that “We tend to prefer the familiar problems with which we have already coped, and we build up non-conscious, unwilled strategies for avoiding the perception of other possibilities.” This leads directly to the idea of subconscious, or unconsidered, resistance. Many of the actions of individuals resist change and therefore reproduce the status quo as per the social theories of Bourdieu and Giddens (Seidman 2008). As these actions are often part of the habitus of the individual, they remain unobserved and not in any way unusual within their field. Fitting with the integrated sociology that this thesis focuses on, Foucault’s conception of modern power is of institutional or hegemonic discipline rather than rule by repression, and social resistance is therefore seen as requiring local, diverse and contextualised action (Hoy 2004). Along a similar vein Brown and Westaway (2011) note that resistance is viewed within environment change literature as a consequence of structural inadequacy. In this context then resistance may be considered as resistance to
the imposed hegemonic power and may take forms of both critical and/or unconsidered resistance. By placing the idea of habitus within a framework of CAS theory it is possible to see that the actions of the habitus fit the CAS conception of resistance as being the effect of a specific attractor and as reinforcing the attractor.

Risk

If a community is coping with some form of adversity, and therefore is already implementing strategies that deplete its long term resilience (Harvey & Lind 2005), it is worth considering that any change either internal or external to the community may constitute a form of risk. Davis (2014) notes that when communities invest labour, materials and money into a water system that subsequently fails, the community ends up poorer than it started out. Most development is essentially risky in its nature (Bennett 1996) and the development enterprise asks people in adversity to take on most of the risk. Often the ‘beneficiaries’ of a development project are asked to gamble whatever resources they have (eg time, money, labour) that the development intervention will improve their situation. The lack of predictability of outcomes means that in some cases

“people have been persuaded to scrap useful institutions and technologies in the promise of better ones only to find the innovations don’t work due to some fatal flaw, or, increasingly, to the scarcity of resources” (Bennett 1996).

Whitfield (2014) recently identified that when participants have negative experiences based on exogenous expert advice, trust is broken down and risk is internalised. For (agricultural) development participants internalised risk results in the need to create their own small scale experiments that produce convincing evidence that change is worthwhile rather than placing their trust in outside entities (Whitfield 2014).

Despite the current rhetoric about partnerships with communities and communities having the power to hold agencies accountable for outcomes (Carothers & Brechenmacher 2014; Tandon 2000), it is unlikely that the impact of project failure on either a development worker or a development agency has been particularly detrimental. Davis concurs that when the risks and consequences of poor outcomes are not shared by NGOs or other implementing agencies:

“Investments continually fail to produce the long-term benefits promised, and yet, no one in a water development organization loses a job because a water system fails. No charitable organization goes out of business when the water systems they built fail…. Almost anyone can work in rural water supply forever without ever being held accountable for their actions.”(Davis 2014, p. 8)
McGregor (2007) indicates that development organisations in Timor–Leste have power that is not matched by their partners and that they rarely allow local partners or communities to access funding for programs that are not within current “development imaginaries” of the NGOs, although local partners may co-opt the processes of development in “locally meaningful ways”. This means that while NGOs are prepared to ask communities to take a risk on gaining beneficial development outcomes, they are not prepared to give those same communities an opportunity to choose and to risk a failure of their own design.

5.4 Systems thinking and CAS in the development sector

In reading the current and recent literature on development it becomes apparent that there is an implicit understanding and acceptance of relief and development aid, communities, NGOs and governments as systems. The language used in development dialogues essentially points to complex adaptive systems as a model for understanding aid intervention – words and phrases that occur frequently include – system, feedback loop, community learning, shared knowledge, path dependent, linked, participatory, poverty spiral, tipping point, resilience, boundaries and more.

The application of systems thinking has been at a range of levels, from policy to program, but has mostly been contained to fitting known facts about the sector with the language and tools of systems theory. The following section introduces some previous applications of systems thinking tools in development contexts.

Letukas and Barnshaw (2008) take a world systems view of aid. This approach is very broad, as it includes a “whole of world” concept and specifically views long term economic development over a period of hundreds of years. Letukas and Barnshaw’s (2008) analysis of the perceptions of international relief efforts after the 2004 Indian Ocean Tsunami indicates that donor countries lack a systemic view of the policies and needs of affected communities and often ‘get it wrong’ because of a lack of will to understand affected communities from their own perspective or to work with the political systems already in place. This implies that a systems understanding of relief, that takes into account local insights, would be of benefit for relief workers and organisers.

In discussing the global food aid system, with particular emphasis on the history of the World Food Programme (WFP), Clay (2003) incorporates many aspects of systems thinking including feedback, resilience, evolution and contextualisation. Rogerson, Hewitt and Waldenberg (2004) also have a view of international aid as a system in the everyday sense, and put forward the need to review programs from a systemic perspective. They extend the use of systems thinking to developing future scenarios within the perspective of a global system of multilateral aid partners. While neither of these authors explicitly references complex adaptive systems theory, the use of systems thinking in their analysis indicates that they perceive the development environment to be a complex adaptive system.
In a different approach, Bosch (2011) compares the “international aid system” with a complex ecosystem and posits that the need to change and increase aid delivery should be balanced with a view to the effectiveness and harmony of delivery. Whilst Bosch’s main concern is evaluation of the effectiveness of aid delivery, she does attempt to take a broad systems view of funding for climate change initiatives and the role of multilateral aid partners within the system. Whilst Bosch’s use of the term complexity is almost synonymous with complicated, the recommendations that arise include ideas around networked approaches and the use of existing and emergent structures that could be based in a CAS model of aid.

Of the authors who are unambiguously applying systems thinking there are several different approaches and rationales. Howe (2010) uses system dynamics based on Senge’s management work to describe archetypes (common formats of influence diagram) found in famine and responses to famine. Howe uses feedback loop archetypes to explain why famine and the various responses to famine tend to be non-linear and therefore often catch observers by surprise. He demonstrates the usefulness of system dynamics in finding leverage points – the points where a system can be usefully influenced to avoid the pitfalls inherent in reinforcing feedback loops. He also points out the difficulty created by delays in feedback loops (noted as a double slash across an arrow). For example, a delay in aid response during a famine can mean that food shortages (and death rates) peak and begin to recover before adequate aid is made available, usually in response to media exposure (Figure 14). Note that in this archetype the impact of increased aid flows is to reduce the numbers of pictures of starving people being shown in the media. If the flow of aid starts late but responds to the peak situation it is likely that too much aid will be sent to places that are already recovering and this can have other adverse effects, like reducing the price that local farmers can get for grain.

![Figure 14: Overshoot archetype. Source: Howe (2010)](image)

Clark, Perez-Trejo & Allen (1995) use complex adaptive systems theory to approach economic development of poor countries via “integrated management of social and natural systems with the aid of non-linear models as decision tools”. They distinguish between the use of modelling to represent the reality of a static environment and the use of modelling to understand a constantly
evolving reality. Their aim to do the latter influences the way that models are constructed and used in their study – the ultimate end of which is a simple flexible modelling approach rather than detailed inflexible modelling approach. This explicit use of systems theory as a lens to observe and understand the aid and development sectors leads to some new insights and the confirmation of some ideas originating from other perspectives. In discussing the issues that beset decision makers the view that “intervention in socio-economic systems tends often to be of an unduly ‘top-down’ or ‘expert’ nature, with not enough attention being paid to the tacit knowledge of local stakeholders” (Clark, Perez-Trejo & Allen 1995, p. 4) is confirmed. Engineers Without Borders (Bowen & Acciaioli 2009; Third et al. 2009) have trialled an approach to the development of a community water supply that looks to the community rather than the experts for direction. Their approach explicitly acknowledges the complexity of community and of both endogenous and exogenous stakeholder relationships. Unfortunately no long term evaluation of the process and outcomes is available.

Ulrich (2010) highlights the advantages and pitfalls of applying complex adaptive systems theory to the global development sector. The advantages perceived by Ulrich are the potential to apply aid more effectively by understanding the interactions between global policy, aid and local policy. The drawbacks are mostly around the size of the problem – to describe globally hierarchical and complex systems and the interactions of policy at various levels. He comes to the conclusion that a smaller-scale approach may be preferable to the overwhelming global scale approach. He suggests that this would require a thorough examination of interacting factors but would ensure that resources are not squandered on projects that cannot be successful due to competing policy or material factors.

A relatively early article from Elwert and Bierschenk (1988) explicitly identifies communities of aid recipients as dynamic systems, rejecting the “general assumption” that these communities are static and will only change when acted on by an outside influence (e.g. aid). Elwert & Bierschenk’s critique fits well with current understandings of society, ecosystems and technology as complex adaptive systems where self-organisation may lead to unpredictable emergent and co-evolutionary responses to outside influence. They offer many examples of unexpected (unwanted) effects of development projects through inappropriate intervention within existing dynamic social systems. Bar-Yam (2004) takes a similar approach as he identifies intrinsic problems with the delivery of aid. In particular Bar-Yam focuses on aid as a replacement of existing social networks and its intertwining in new networks. His analysis leads to similar conclusions to that of many others – that in a practical sense the best aid results are likely to be achieved by small scale projects supporting grassroots development. Bar-Yam and Elwert & Bierschenk all point out that our ability to plan for development is severely curtailed by our inability to fully comprehend the initial conditions of a community. Hence the complexity theory concept of sensitivity to initial conditions precludes the use of prescriptive top down plans. This is echoed later in Easterly’s view that excessive top down planning constitutes a problem within the aid sector (Easterly 2006).
Rihani (2002) equates the development of countries as steps in the evolution of complex adaptive systems. He somewhat reflects the work of economist Amartya Sen (1999) in elaborating the point that the freedom of agents in complex adaptive systems theory is equivalent of the freedoms of individuals in society. The ability of a country to ‘develop’ is therefore dependent on the freedoms of its people. Providing basic needs will not create a development environment if there are significant limitations to social, economic or political participation by members of the community. Rihani makes a strong case for a paradigm change in the theory and practise of international aid towards a more contextualised, complex adaptive system based understanding of intervention.

Ramalingam et al (2008) explore the idea of aid and complexity science for the UK based Overseas Development Institute and conclude that there is scope to apply our understanding of complexity to the relief and development sectors and that

“development is a complex adaptive process – it is highly local, particular, context bound, time-specific, path-dependent, etc. Similarly immediate responses to humanitarian crises are local, complex and adaptive” (Ramalingam et al. 2008, p. 65).

This is a view that would seem unlikely to be seriously challenged by practitioners but which has been explicitly investigated more at the policy and management levels than at the community intervention level.

Finally, the Sustainable Water Services at Scale project (Triple-S) is explicitly based on “an understanding of rural water supply as being a complex adaptive system” (Schouten & Moriarty 2013, p. 8). The Triple-S program, as its name suggests is looking for scaleable solutions for water services. Whilst Triple-S acknowledges the need for contextualisation there is still an evident drive to find a single model that can be applied and a single pathway that countries can follow from necessary infrastructure intensive programs through to the creation of a service delivery approach that is a particular blend of government and private entrepreneurial interests (Lockwood & Smits 2011).

This brief overview of the different uses of systems theory within the aid sector literature shows that there is no universal approach to the implementation of systems thinking at a practical or a policy level of development. At this point the literature tends to indicate that systems theory is an interesting way to look at the development sector, while the lack of discourse around the handful of published papers in the area might be indicative of an immature understanding of the topic from within the academic environment. There are a relatively larger number of books, book sections, articles and blogs that deal with systems thinking as part of the development discourse within the grey literature. This discourse indicates that practitioners are gaining an interest in the implications of understanding complex adaptive systems and applying systems thinking techniques within international development.
6 A pluralist perspective of development theories

This chapter looks at the proposition that development environments are complex adaptive systems and argues that the areas of crossover between sociology, development and systems thinking provide a space in which development processes can be understood as actions that increase the complexity of a community. These processes encourage emergence and freedom and individual agency whilst avoiding unnecessary rules, reporting and constraints. This chapter specifically uses NGO development programs as a way of identifying development as being from outside of the community, whereas the inclusion of local or government based development programs would unnecessarily complicate the discussion. Section 6.2.1 uses causal loop diagrams to illustrate the interlinked and reinforcing nature of the factors under discussion.

6.1 Is it reasonable to treat NGO development interventions as complex adaptive systems?

The parallels between sociological theory and complex adaptive systems (CAS) theory point to the proposition that development interventions are complex adaptive systems. There is an increasing interest in understanding society and development from within a complexity framework (Bar-Yam 2002; Buckley 1998; Ramalingam et al. 2008). Our understanding of nested recursion within CAS means that we can see an intervention site - a village or community - as a level of recursion within a larger state that forms part of the external environment of the intervention site. One of the lessons from CAS theory is that a system can only be properly understood by investigating it at multiple levels, so acknowledging where a system fits in its environment, and how it links to other systems, is a significant act in understanding the system. Ison (2008) describes it as taking an “as if” approach that allows us to perceive a system and its boundaries and the reason for its existence (articulated epistemology) from multiple perspectives. An NGO conducting a development intervention is a part of the external environment of a community. The actions of the NGO may have a significant influence in the community for the short period of time that they are located with the community for intervention purposes. Over the intervention period the NGO may influence many areas of village life – resources available and resources mobilised will include time, labour, money, materials, food, knowledge, training and more. The community will also be concurrently affected by local and state governance policies (e.g. roadbuilding projects), they may be affected by actions of neighbouring communities (e.g. upstream water pollution) and they may be affected by the actions of internal community members (e.g. attendance at weddings or funerals).
For villages or communities, interactions with an NGO may put a village into a situation of “edge of chaos” where the possible outcomes are various and unpredictable (Stacey 1995). From an organisational perspective the edge of chaos is the point where innovation and adaptation happen (Pascale, Milleman & Gioja 1999). It is seen as the point where change is possible and where organisations, systems or societies sit at the verge of many alternative futures (Figure 8). While it isn’t made explicit by NGOs, bringing communities to the “edge of chaos” is an intended outcome of much development work, especially work that includes a focus on changing power and gender roles. Development interventions do not consistently succeed in creating the positive and lasting changes in communities that are intended, regardless of whether the aim is changing power and gender roles, hygiene behaviours or more pragmatically, the implementation of a robust water system.

In places where social structures are entrenched, and freedoms are limited by poverty or power, it is possible that outcomes of interventions will be short-lived and unremarkable. In Timor-Leste NGOs in the WASH sector try to avoid this by ensuring that communities are keen to have a particular intervention, and that they build ownership through community participation in planning, and community contribution of labour and locally available materials (GoTL 2010b). There are differences in the initial conditions of each community. Social structure, poverty and diversity of livelihoods all change the social dynamic. The CAS theories of path dependence and ‘lock ins’ explain why, under these different historical conditions, the use of participatory development practices do not reliably achieve planned changes (Rihani 2002a).

Recursion and longitudinal relationships that are part of the ordering of society, as described by Hinde (1976), are analogous to the nested systems and the path dependence that we associate with a complex adaptive system. There is also a correlation with Bourdieu’s concepts of habitus in the sense of iterated action creating a social structure. Hinde’s (1976) paper comparing social structures in humans and primates indicates that societies are based on the recursion of action and structure and that society consists of individuals who interact, cooperate and compete over a period of time. Hinde’s work has been broadly cited in studies of social behaviour in both humans and other animals, as a foundation for understanding emergent social structures and behaviours.

Specific interactions become patterns of behaviour and these patterns create relationships which, in turn, produce social structures that then form institutions. This iteration appears to apply to all societies. Despite the variations that are caused by the diversity of individuals and environments, the overall pattern seems ubiquitous. Adapting a diagram from Hinde’s original paper, these interactions are illustrated in Figure 15. Hinde’s work doesn’t look explicitly at the effects of constraint at any level of recursion, but looking at Figure 15 it is possible to see that the less constraint there is at any single level the more diversity there should be at the higher levels. Therefore freedom of interaction, facilitated by wellbeing, resources and communication technologies can result in more diverse relationships, social structures and institutions. This diversity
enables adaptation to changes in either internal or exogenous conditions at each level.

Hinde (1976) describes relationships as being interactions across time, indicating that the history of a relationship is significant and so is the perception of the potential future of the relationship. From this temporal nature of human relationships, it can be understood then that memory, history and purposeful planning are all interdependent factors in an emergent society. Development interventions are intimately entwined with these factors, as the history and the memory of a community bring it to its present point, and inform the actions of individuals within the community. The act of intervention is an act of deliberate planning and guidance, and even though the outcome may be unexpected at the local level, it still an organic emergent product of the global environment in which it is located.

Communities, and the development interventions that they engage with, can be seen to be emergent structures with significant path dependence, nested within larger recursive social structures. It is therefore clear that complex adaptive systems theory is an appropriate framework from which to understand communities and development interventions.

6.2 Ideas from development and systems thinking

In the previous sections I have explored ideas that are put forward from a number of fields, including Bourdieu’s habitus, Max-Neef’s human scale development and Sen’s development as freedom. Resilience and resistance have been noted within both development and complexity fields. In this section I integrate those ideas to propose a theory of development as a dynamic process.
within a complex adaptive systems framework. I present the notions discussed above as a series of influence diagrams that include development, freedom, choice, diversity, emergence and complexity.

**Development and Freedom**

Sen (1999) and Nussbaum (2003) have expounded the meaning of increased freedoms in the context of development. Sen (1999) advanced the argument that the extension of capabilities – defined as substantive freedoms - provides a basis for assessing development as it affects the most vulnerable individuals. Capabilities are thus placed in apposition to an averaged economic improvement such as gross domestic product (GDP) that may not translate to improvements in the lives of the poorest or most vulnerable members of society. Sen (1999) also argues that a capabilities approach avoids the pitfalls of adaptive preferences that are seen in the utilitarian approach, where current preferences and satisfaction are identified based on a grounded perception of what is possible now, rather than what should be or could be possible in other circumstances. Nussbaum (2003) links capabilities to rights and identifies that for capabilities to form a coherent social justice platform for development, they require more definition than Sen is able/willing to provide. She argues that the securing of rights is only evident when there exist the "capabilities to function" in the relevant area (Nussbaum 2003, p. 37). Nussbaum puts up for discussion a list of “Central Human Capabilities” that strongly correspond with Max-Neef’s axiological categories, these include; living a natural lifespan; having good health; secure bodily integrity; intellectual and creative pursuits; emotional freedom; sense of future; play; access to ‘nature’, enacted political and property rights; and freedom to affiliate with others (Nussbaum 2003, pp. 41-2). Nussbaum, Sen and Max-Neef all indicate that gaining freedoms or capabilities for some individuals may mean the restriction of freedoms or capabilities for other parts of society, they all indicate that this is a matter of social justice and that the actual ways that these capabilities are satisfied will vary with the cultural context (Max-Neef 1991; Nussbaum 2003; Sen 1999).

**Choice**

It is recognised that choice is a significant driver of development when it takes the form of self-determination (Ife 2009; Kenny 2010). In the context of the majority world there are many levels at which the ability to make decisions over the use of resources can be withheld. Development funding is applied at state, local government, city and village or community levels as well as at the household or individual level. In each of these contexts there are examples to be found of aid resources being directed by the donor rather than the recipient. Multilateral and bilateral donations are regularly directed by the donors according to their own specific concerns creating uncoordinated “aid chaos” in recipient countries (Woods 2005) and particularly in humanitarian aid situations, as reported in the wake of Cyclone Pam in Vanuatu in 2015 (ABC 2015). At the other end of the spectrum, when an agency supplies a single type of water filter to households rather than offering information and choice, then allocation of
resources has been determined by the agency. Regardless of the research and development that has gone into choosing the ‘best’ technology, the recipient of the water filter has not directed the resources. Recipients are then left with few choices about the future of the water filter; they can commit to ongoing maintenance and consumables, they can neglect the ‘proper’ use of the filter or they can reject the filter outright.

The ground-breaking “Voices of the Poor” project indicated that poor people felt both unheard and left out in decision making processes (Narayan et al. 1999, p. 24). Following from this perhaps we need to question each point in the development process where decision making is taken out of the hands of those affected the most. In community level development with participatory action planning and other similar processes, increasing the choices that are available regarding the deployment of resources would create a development environment with more choice, more freedom, more complexity and more diversity.

“Broader participation is likely to change the use and allocation of resources in society. Indeed, this is why it is often advocated, since such change is associated with the development process.” (Cohen & Uphoff 1980)

More choice for recipients in development activities will lead to the emergence of more locally appropriate development practises.

**Diversity**

Diversity is not a uniquely human trait, but the agency that humans have to determine their actions and reactions, adaptations and responses is unique. While other organisms and even non-living articles can form complex adaptive systems, human systems show by far the most diversity in terms of behaviours and adaptive traits. Across the development sector alone there is an amazing diversity of staff, programs, volunteers, methods and motivations but it seems that it is easy to forget that the across the majority world, where international development activities take place, the diversity of people, cultures, religions and societies is just as amazing (or more so!). As a generalisation NGOs and donors tend to look for the similarities between communities in order to provide enough scale to justify expenditure and keep costs down. The rationale for working at scale is that if the similarities in each situation are the problems then we can justify ‘fixing’ them with the same ‘solution’. Taking a leaf from a strengths based practise of community development perhaps less focus on the similarities of the problems and more focus on what makes communities different might result in better tailored and longer lasting ‘solutions’, or even more significantly it may lead to communities building the skills, diversity and self-determination to create more solutions over time.

**Emergence**

Policy or actions that act to restrict the organic emergence of higher level
organisations will hinder development. So development activities should aim to not inhibit the emergence of locally appropriate social structures. Wilson and Eyben (2006) discuss emergence as a function of social networks and history, they warn that a lack of understanding of the social history in the region of an intervention can lead to agencies undermining the evolution/emergence of robust democracy by distorting access to power and resources among civil society groups. This warning, while appropriate, is taken to a conclusion that suggests that you simply have to be careful when “picking a winner” in regards to what group gets support or not. Ellis (2010) takes this further by asserting that NGOs need to acknowledge that every act they undertake is inherently political and that in any intervention “they are simply taking sides in an existing political struggle” (Ellis 2010, p. 65). It is inevitable then that the act of intervention in any social group involves some change to the structure of the existing society. In fact the decision by an NGO to intervene implies a perceived need for externally driven change. It would be disingenuous to pretend that change is not the aim of any intervention. All interventions therefore have the potential to affect the course of history or the emergence of particular social structures. The implication of emergence for development practitioners should therefore be about time. Emergence, like evolution, takes time as actions are iterated and social structures are strengthened. There may be a requirement to stay and observe, act as a resource and be willing to continue to revise and reflect and intervene over periods of years, to see community driven development leading to community desired outcomes. Long term engagement would go some way towards avoiding detrimental outcomes that may be associated with short term, ‘one off’ interventions that change political structures in unanticipated ways. Good participatory practises (Chambers 2008b, pp. 174 - 6) also encourage the emergence of local solutions and structures.

6.2.1 Development as a Complex Adaptive System

From the preceding section, Amartya Sen introduced the idea that development can be defined as a process of “expanding the real freedoms that people enjoy” (Sen 1999, p. 3). So it can be asserted that for development to be seen to be occurring there should be an increase in the freedoms that people enjoy across a range of areas including the ability and capability to access and use education services, health services, political voice, civil rights, financial and other resources (or capital) appropriate to a decent standard of life, as defined by themselves. This can be represented as a causal loop diagram (Figure 16) which would indicate that increases in freedoms would result in increases in development and increases in development should result in increases in freedom. As the loop is a reinforcing feedback loop, decreases in either freedom or development would also reinforce each other unless something else acts to stop the exponential reaction.
At its most basic, freedom may simply mean having spare time, beyond the tasks that are required for survival, which can be used in a way that is determined by the individual. Increasing freedoms, or the decreasing of ‘unfreedoms’ (as per Sen), implies that individuals and communities gain some power towards determining their own paths. They become less constrained by poverty, illiteracy, poor health, repressive political regimes or inaccessible public institutions. In gaining this power of self-determination there is an everyday increase in the choices that individuals and communities can make. They have resources (or forms of capital) and they can choose how to use them, when to use them and whether to use them. Economic capital is the most obvious resource that can apply to a range of chosen uses e.g. food, shelter and material goods. Other forms of capital such as cultural and social capital make it possible for individuals to choose whether to use public institutions such as legal process and political process and what they will use them for. Increased freedom implies that a choice can be made to (or not to) access health services, education services or transport infrastructure. Freedom thus reinforces the capability (as per Nussbaum) to make choices while increased choice is a measure of freedoms as shown in Figure 17.

To make a choice is to enact our agency. The use of agency from a sociological perspective includes understanding our social position and either confirming it by maintaining our habitus (as per Bourdieu) or transforming it through acts of resistance and transgression (Hoy 2004). Enacting and embodying agency leads to diversity beyond the natural diversity that exists in a purely non-agentic natural system. Agency creates diversity of action, beliefs, responses, understanding, adaptation and many other characteristics that are unique to
human cultures, societies, religions and sub cultures. Enacting our agency to make choices creates diversity in human social settings at the same time that increased diversity tends to lead to increased choice as shown in Figure 18.

![Figure 18 Reinforcing feedback loop between choice and diversity](image)

Diversity is a necessary but not sufficient condition for emergence. From a complex adaptive systems perspective the emergence of new patterns or structures can be created by a single small change in an existing pattern. This is the premise behind the aphorism that 'a butterfly that flaps its wings in Japan can cause a cyclone in New Orleans'. In human social settings relationships are patterns that form from repeated interactions. The potential for a single different action to change the course of a relationship (pattern), or the course of world history, is the subject of much contemplation. Part of human agency and diversity is the ability of individuals to imagine and to create change in their own lives and to influence the lives of those they interact with, thereby creating political and social movements. Therefore the emergence of new or different social structures is dependent on the diversity of the population but in turn emerging structures also increase the diversity of a system (Figure 19).

![Figure 19 Reinforcing feedback loop between Diversity and Emergence](image)

As new social structures and institutions emerge in a society, society increases in complexity. The emergence of new (social) structures or patterns is typical of a complex adaptive system. Emergence of social structures also implies other characteristics of complex adaptive systems including; relationships within and between structures at different levels of society; the ability for social groups to learn, adapt to change and influence other levels of social systems; and a tendency towards becoming ‘stuck’ in a particular state for long periods of time, coupled with a tendency for dramatic change over relatively short periods of time (Ramalingam 2013). Hence, once the emergence of new social structures begins, the characteristics of complex adaptive systems tend to ensure that complexity continues to increase in a reinforcing feedback loop (Figure 20), unless stopped by an external agent.
Taking the discussion above and combining the causal loop diagrams to illustrate this, we see that development and complexity are both part of a chain of reinforcing feedback loops. Figure 21 illustrates that an increase in any of freedom, choice, diversity, or emergence should cause both an increase in development and an increase in complexity. On the same basis, actions that decrease freedom, choice, diversity or emergence could be expected to reduce the effectiveness of development interventions and limit complexity. If the links described between development and complexity are accurate, and the factors are measurable, then the causal loops shown in Figure 21 can help to explain the successes or failures of development interventions.

For each of the factors discussed above and shown in Figure 21 there are myriad other sub-factors that will affect them. This diagram can therefore be applied as the basis to explore the trajectory of development interventions. The impact of the development process can be interrogated and explored in relation to the factors and sub-factors identified. For example: Does the development process increase choice for beneficiaries, or decrease choice? Does the development process increase diversity or decrease it? Does the development process increase freedoms, or decrease them? Does the development process allow for local emergence?

Beyond the description above, the same diagram allows the exploration of development at different levels (community development, state development, regional development) and with different aims (economic development, educational development, health development). So the questions above may become more specific, for example: Does the development process increase health choices for community members?

Overall, the relationship between increased complexity and increased development is elucidated via the factors that connect them. Hence freedom,
choice, diversity and emergence are the factors by which changes in
development and complexity may be effected and measured. Chapters 8 and 9
build on the causal loop diagram above (Figure 16) in order to begin to
understand the sub-factors which drive the success or failure of water services
interventions.
7 Methodology and Methods

This chapter will integrate the theory and research process used, to create a clear overall picture, in the face of what is a pragmatic methodological approach based on a social justice world view (as explained in section 1.6.1). This section broadly explains a mixed methods approach underpinned by a pragmatic-transformative methodology. The research is conducted in several contexts; an INGO office in Melbourne Australia; several INGO and government offices in Dili, Timor-Leste; and case studies of five rural villages in Timor-Leste. The diversity of contexts chosen necessitated a flexible approach to interviewing, data collection and analysis.

Section 7.2 discusses the rationale for applying mixed methods. Section 7.3 provides detail on the use of case studies as explorative methods. Section 7.4.1 describes the use of participative observation which in conjunction with semi-structured interviews described in section 7.4.4 form the main vehicle of data collection. In such a broad field, sampling techniques and boundaries are important and these are discussed in section 7.4 and 7.5.2.

The research methods need to highlight the relationships between individuals, organisations, knowledge, policies and resources through the application of social network analysis as discussed in Section 7.7, the application of system dynamics is explained in Section 7.8. This use of a multi-methods approach enables the perspectives of different stakeholders to be gathered and analysed in ways that are appropriate to the context of the participants and of the information that they were willing to share.

7.1 Methodology

This research is conducted within a pragmatic methodology based on a social justice agenda that

“...engages with the complexities of mediated voices, interdisciplinarity, empowerment, and researcher reflexivity. [It has] an explicit objective to contribute to a social science that engages critically with contextualised narratives.” (Neely & Whitburn in press)

Pragmatic and transformative research paradigms are defined as part of a continuum of research paradigms that reaches from the positivist to the constructivist (Teddlie & Tashakkori 2009). On this continuum, pragmatic and transformative research are both placed centrally as they neither fully accept nor fully reject the tenets of positivism or constructivism (Teddlie & Tashakkori 2009). The main differences between transformative and pragmatic methodologies are described in terms of the axiomatic rationale; transformative research is seen to be based in a social justice perspective whereas pragmatic research is based on the values of the researcher and these need not be of a
social justice persuasion (Teddlie & Tashakkori 2009). Teddlie and Tashakkori (2009, p. 88) give the following descriptions for the dimensions of pragmatic research:

- **Methods**: Both qualitative and quantitative methods are used with methods chosen to suit the question at hand

- **Logic**: Both inductive and deductive logic are applied (abduction may also be applied)

- **Epistemology**: both objective and subjective points of view are applied within the research cycle

- **Axiology**: Importance of values in interpreting results

- **Ontology**: Values based explanation of reality

- **Possibility of causal linkages**: Causal relationships are considered to exist but are difficult to identify and likely to change.

- **Possibility of generalisation**: Contextualisation is considered important along with internal validity and external credibility.

This research claims a social justice agenda and therefore applies several aspects of a transformative methodology. Firstly, the epistemological position taken is pluralistic in its acknowledgement that a single reality that may be perceived in differing ways (Mertens 2007). Secondly, the voices of the participants “who have traditionally been excluded from positions of power in the research world” (Mertens 2007) are incorporated in shaping the emergence of research practices and questions as well as in directing the activities undertaken in communities. However, any claim to a transformative research methodology is limited by the lack of inclusion of vulnerable participants in the early design and final publication and review process (Mertens 2007). While this limitation is due mainly to the impracticality of frequent travel to rural districts of Timor-Leste, the researcher revisited participants and shared her results in order complete the research cycle and to maintain newly formed relationships.

### 7.2 Mixed Methods

Mixed methods research combines both qualitative and quantitative techniques of research and analysis in order to develop, and appropriately convey, a contextualised understanding of the research question and findings.

The use of both quantitative and qualitative research methods within a complexity framework allows the research to work within a pluralistic set of epistemologies, a practise that is somewhat disputed by Yanchar and Williams (2006) but championed by Midgley (2000). Yanchar and Williams (2006) claim that methods cannot be separated from theoretical background and that the use of particular methods implies a specific perspective and frame to the research.
conducted. Their argument is specifically against the eclectic use of research methods based on a “what works” pragmatism that may result in practises that are based on values and assumptions that remain unexamined (Yanchar & Williams 2006). Yanchar and Williams (2006) go on to propose a set of guidelines for examining the assumptions and theoretical basis for applying specific methods within a mixed methods research paradigm that they argue “are likely to lead to research programs and evaluations that differ in important respects from those marked by either rigid paradigm affiliation or methodological eclecticism” (p8). This approval of mixed methods based on sound contextual and methodological awareness is then reflected by Midgley (2000) who argues that methodological pluralism is valuable in opening up a range of methods to new theoretical lenses whilst allowing the practitioner to learn from and compare discipline based methodologies including positivism and constructivism. Midgley (2000) then justifies the use of mixed methods as a way of ensuring that the researcher ‘has the toolbox’ to be able to respond reflexively and appropriately to diverse perspectives and changes to the research focus.

Taking on board the need for both conceptual awareness and contextual sensitivity (Midgley 2000; Yanchar & Williams 2006) this research applies multiple mixed methods in order to respond to the needs and capabilities of different participants. Numerical and narrative data are then analysed and combined with different aims, but incorporated within a complex adaptive systems world view.

This research applies quantitative methods such as social network analysis (Wasserman & Faust 1994) as an important way of finding patterns within the data but at the same time attempts to avoid generalisation or averages of the observed path-dependent and context-dependent events. In addition to quantitative analysis the use of narrative provides a significant way of understanding the same events (Josselson 2011). The combined use of both qualitative and quantitative techniques creates scope for a comprehensive understanding of the study environment (Tashakkori & Teddlie 2010). In discussing the paradigms of things (positivism) and the paradigm of people (constructivism), Chambers rejects the absolute dichotomy in favour of a continuum but brilliantly describes either end of the continuum as such

“the paradigm of things comes from, fits and works with the physical world: it is top-down, centralized, standardized, simplified and reductionist; it values measurement; and its outputs are physical things such as infrastructure and reports. The paradigm of people comes from, fits and works with the social world: it is bottom-up, decentralized, diverse, complex and inclusive; it values judgement; and has outputs that are social such as capabilities and relationships” (Chambers 2008b, pp. 172-3)

The intention of this research is to understand both things and people. More so,
it is to map the intersection of these two worlds where we “need good physical infrastructure on the things side and good relationships and capabilities on the people side” (ibid). In this research ‘things’ include water and water systems, sanitation and hygiene tools. The amount of water collected and the distance and time to collect water both constitute ‘things’ that were analysed quantitatively on the basis of surveys conducted. People in this research include residents of rural communities in Timor-Leste and staff of NGOs and governments. The researcher and interpreters also form a very people oriented aspect of the research, particularly during participative observation and hence are not excluded from the qualitative analysis. Personal and professional stories and relationships were gathered and analysed. The researcher is also located within the researched environment as an advocate for improved WASH outcomes for rural communities.

The main quantitative methods of data collection and analysis applied in this research were:

- Survey instrument applied in a single village
- Conversational survey of water use in rural villages

The qualitative methods applied in this research are:

- Semi-structured interviews of NGO and government staff
- Participative observation conducted while staying in rural villages and participating in daily life
- Conversational surveys in rural villages
- Discussion groups in rural villages

Data collected using qualitative methods were transformed to quantitative data in order to create social network maps of villages (section 8.3) and influence diagrams of water management (section 8.4). Interviews and field notes from participative observation were used to build narratives for each case study. Thematic analysis was then used to interrogate the qualitative data (Charmaz et al. 2011). The use of narrative methods within this research is designed to “capture the lived experience of people in terms of their own meaning making and to theorize about it in insightful ways” (Josselson 2011, p. 225). The gathering of narratives from a range of positional perspectives gives breadth to the analysis as water systems implementation is described from the perspectives of the donors, the implementers and of village residents.

7.3 Case Studies

The use of case studies to understand the process, thoughts, actions and relationships of real people and events has a strong history in qualitative studies (Flyvbjerg 2011). This research describes five case studies of water use and
management in different villages in one district of Timor-Leste.

The investigation of five cases does not imply a comparative study but rather is a reflection of the exploratory nature of the research and the need to fully understand the application of a new suite of tools to an existing set of issues. According to Stake “A case study is expected to catch the complexity of a single case” (Stake 1995, p. xi). For the purpose of this research, the complexity of several cases will provide the data for comprehensive quantitative and qualitative analysis.

7.3.1 Participants

This research was conducted across a variety of settings and included participants from each setting:

- International NGO offices in Australia
- International NGO offices in Timor-Leste
- Local NGO offices in Timor-Leste
- Government offices in Timor-Leste
- Local villages, mostly from a single district

Research in each of these settings was approached transparently with clearly identified goals and research intent. Access to the various settings was initially through formal introductions, with further access gained through less formal introductions via existing networks.

**INGO and NGO staff members**

Understanding the actions and intent of staff working for non-government organisations is significant to the research objectives as CAS theory requires multiple perspectives. The analysis of these perspectives through both SNA and system dynamics allows social and organisational perspectives to be made explicit.

The case study approach to contextualised understanding was ratified by an early interview with a staff member of an INGO who claimed that “..all that knowledge is useful for us because it is culturally and contextually specific. We can’t apply the broad literature to development – it doesn’t work so you have to really invest in research.”

New participants within NGOs and government staff were identified using the “snowball” technique. This technique is an accepted design method for qualitative studies (Patton 2002). It allows the researcher to locate key agents through asking existing participants ‘who else may be important to speak to and what information should be accessed?’ (Patton 2002). The snowball technique occurred fairly naturally during the interviews, given that informants were describing their networks of influence. New participates identified during interviews were only approached with permission - and often an introduction - by the informant. In this research, the snowball method was complemented
through access to the expatriate social networks that exist in Dili and which provided introductions to various individuals.

Timorese government staff and Australian government staff

The inclusion of several staff from both the Timorese government and Australian government in Timor-Leste (AusAid) was the result of snowball sampling as these individuals were reported within the networks of NGO staff. This group includes both heads of departments and staff members of sub-district and district offices and one elected official.

Residents of Rural Villages in Timor-Leste

The lived experience of the residents of villages where access to water has been, or is still, an issue is central to this thesis. To facilitate my access to these villages I requested introductions to communities where there were known differences in the functionality of the water systems. The range of water system functionality in the villages visited was designed to ensure that I could observe both strengths and issues around the management of water systems. The NGO assisted me by choosing villages based on my criteria for particular characteristics in terms of their water system. As a result of this purposive sampling (Creswell 2012) the specific case studies were:

- Village 1 - a fully functioning water system
- Village 2 – a newly built system, not yet fully operational
- Village 3 – a 20 year old, inadequate system (not chosen by the NGO)
- Village 4 – a poorly functioning system with few local alternative water sources
- Village 5 – a poorly functioning system with many alternative water sources

Clamagirand (1980) indicates that the term village has no particular meaning within Timorese society. The geo-political structural distinctions currently used by the Government of Timor-Leste, in decreasing size, are district, sub-district, suco, aldeia and, bairo or grupo. The aldeia is the smallest recognised administrative unit and may encompass several geographically distinct groupings of houses (bairo/groupo) or it may encompass just one group of houses. Within this thesis, I use the term village to describe the areas that local people considered as their community and which they have indicated through mapping and walking these areas with me.

Within each village, participants were recruited by moving from house to house and interviewing whichever resident was available and willing to answer questions. In particular this process was intended to raise open ended questions about water collection and management allowing for stories and issues of importance to the participants to emerge and be heard. As a result of this sampling technique the individuals who answered questions regarding
household water collection were quite diverse, including both those who are responsible for water collection and those who aren’t.

7.4 Data Collection

Data collection for quantitative and qualitative research is often achieved through survey or interview techniques. In this research data gathering techniques included:

- Participative observations
- Semi-structured interviews of NGO staff, individuals from affected communities, Timorese government staff and Australian government staff in East-Timor
- Discussion groups
- Interrogation of the grey literature and existing databases

7.4.1 Numbers of participants

Interviews/key informants:
INGO staff in Australia 4
INGO local office staff in Timor-Leste 8
Local NGO staff in Timor-Leste 2
Government of TL 6
GMFF/ABBS 1
BESIK 6
Consultant 1
AusAid 1
Volunteer 1

Discussion groups 5

Village observations during ‘joint monitoring’ 1
Village observation of volunteer activity 1
Village observation in separate district 1

Villages surveyed 6
Individual residents surveyed/interviewed 139

7.4.2 Participative Observation

Participative observational data was collected during stays of between three and four days in each of five villages. I observed the general flow of daily tasks both related and unrelated to water, I also made specific trips to water sources, springs and taps in order to understand the distances and the difficulties of collecting water and to observe first-hand the technologies applied along the technical system of pipes, tanks and taps. These walks provided a good opportunity to get to know my hosts and discuss with them how they feel about
the water implementation.

This type of observation is perhaps more commonly seen as an activity that would be coherent with anthropological or ethnography studies. The method in its short form is described by Guest, Namey and Mitchell (2012) as participant observation, in order to distinguish it from direct observation. The term participative is used here in order to locate the researcher within the field of practise and action research as per Reason and Bradbury (2008, p. 5) who also link participative observation to the emergence of methods within the act of research. Furthering the claim that this research can be considered within the action research agenda was the reliance of the researcher on the participants' definition of the field. During village stays I explained the questions and asked for help in finding answers and in meeting people, this enabled residents to plan the activities that they considered appropriate to the research.

Living in each rural village for several days, in order to conduct interviews, meant that I was also able to observe and participate in the daily life of the village, whether that was the picking of vegetables for dinner, cooking, collecting water, drinking palm wine or other activities.

Two interpreters, Nivia and Adia were involved in the fieldwork, both were young women who had completed some post-secondary study but neither was trained as a professional interpreter or translator. The pilot study and interviews of participants in Dili - completed in 2012 - were assisted by Nivia.

During the field work in 2013, the interpreter selected needed to have local knowledge in order to assist with interviews in remote areas, they also needed to be able communicate in English, Tetun and Tokodedi. Therefore, the homestay visits to regional villages were assisted by a different interpreter. Adia was accustomed to life in a small village and was able to answer many of my questions about Timorese language and culture.

On a further expedition to a different part of the island I was taken by a young man to a family celebration and we stayed several nights with different family members, this experience reinforced for me the difference in gender expectations within Timorese culture and the advantages of having a female interpreter who was able to work with me in situations such as communal bathing areas and in facilitating women’s meetings.

Along with observations, further information was collected in conversation with Chefe Aldeias, Chefe GMFs and short meetings with householders as well as discussion group meetings (see section 7.4.3). Meetings with householders were short semi-structured interviews (see Appendix A for typical questions). These interviews tended to be a group affair, I was working with a translator and usually the Chefe Aldeia, Chefe GMF or senior village member would accompany me. Neighbours would stop to observe as well. I tended to interview any person from the household who was willing and able to answer my questions. This meant that my interviews were not always with heads of households and so the responses came from a range of young, old, male and
female participants thus ensuring that many different perspectives were gathered.

7.4.3 Discussion Groups

The use of discussion groups came about as a response to several different situations encountered in the field. The first situation, leading to three of the discussion groups, was the inclination of villages and organisations to organise group meetings when an interview was requested – so interviews turned into discussion groups.

The other two discussion groups arose as a response to my reflections on gender norms. As I was often accompanied by a male Chefe Aldeia while visiting houses, I observed that women frequently appeared reluctant to speak and were often “coached” by the men who were involved. In response to this situation I requested women's meetings.

Storytelling

At the women's meetings storytelling was used to engage women with answering “what if…?” questions, as I had found that asking for opinions about hypothetical situations (if this … then what?) was not garnering responses that seemed coherent with the questions. A discussion of this issue with Dr Marie Quinn, an experienced linguistics researcher living in Dili, led to her suggestion that

“telling stories about a situation that might have happened somewhere else, would give respondents an opportunity to consider the matter without having to be critical of their own situation” (Quinn 2013).

This technique turned out to be a satisfactory way to encourage conversation with groups of women who engaged with the idea of ‘the other’ village as a non-threatening, non-critical way to consider the issues presented. This was the case even though the participants clearly understood that the stories were designed to reflect situations that they may encounter, as one participant in a discussion responded “This seems true, we are always tired”.

The stories and questions used can be found in Appendix B.

7.4.4 Semi-Structured Interviews

Within a case study situation, it has been indicated by Stake (1995), that the interview is the predominant method to discover the multiple views of participants. The exploratory nature of this research lends itself to data gathering through semi-structured interviews loosely starting with the techniques described by Fontana and Frey (2008). Fontana and Frey identify several critical areas in the design of semi-structured interviews: Understanding the language and culture of respondents; Deciding how to present oneself;
Gaining trust; Establishing rapport; Collecting empirical material.

This form of semi-structured interview specifically allowed me to incorporate additional collaborative techniques into the interview process. While “collaborative interviewing” is not a well-documented qualitative technique in social studies, it is justified by Newell et al (2005) as appropriate for the nature of cross-disciplinary (integrative) research, due to the possibility of using approaches that create mutual comprehension among small groups.

In asking informants to complete influence diagrams the process is changed from dialogue to collaboration. The researcher and participant create a shared understanding of the local and broader networks surrounding the delivery of water. They do this through sharing information and perceptions and discussing how the diagrams look and what they might imply. While the collaborative nature and development of influence diagrams within interviews reflects the ethos of participatory action research, being that the research process should be co-constructed and of benefit to both the researcher and the participants. While participants benefit from learning about social network analysis and are encouraged to lead the construction of their own network maps, the research does not involve participants in the design process and is therefore a limited version of action research in this regard.

In terms of the much more conversational survey technique used in rural villages, this interview method was allowed to evolve somewhat in response to the needs and desires of participants as they were encountered. As Ison (2008) explains, “methodology involves the conscious braiding of theory and practise in a given context”, so the emergence of methods in response to changes in understanding and context is appropriate. Some questions for householders were consistent while others changed depending on the willingness of the participant to tell their story or give their opinion. Questions were also constructed in response to information gleaned from previous participants.

Returning to the critical areas defined by Fontana and Frey, the following section will explore several of these in detail.

Understanding the language and culture of respondents

In this study I interviewed participants from diverse academic disciplines, worldviews, cultures, religions and language groups, using an interpreter when necessary. Difficulty in understanding language and culture in this context does not refer simply to working with people in other countries. The researcher’s background is relevant to the way that they understand what is presented to them. Patton (2002) acknowledges that an interviewer’s cultural and cognitive background are significant to both the collection of data and to the analysis of data collected.

One of the preconditions for inter-disciplinary research is that “team members must be prepared to spend a significant amount of time in detailed discussions of the meanings of words”(Newell et al. 2005, p. 303), indicating that even
within relatively homogenous groups of academics, there is a likelihood of misunderstanding. Therefore, even when interviewing English speakers, the differences in academic backgrounds and world views, necessitated the type of interpretive conversation, where terms were defined to ensure a common understanding between researcher and participant.

"Deciding how to present oneself"

As I was identified in all settings as a researcher there was no need for dissemblance in my presentation. I made every effort to ensure that my physical appearance was socially and culturally appropriate at all times by covering my shoulders and knees. As a researcher I was keen to learn from all participants and conscious of not presenting myself, or being presented, as an expert. ‘Co-learning’ is described by Diver and Higgins (2014) as a significant aspect of community-engaged research and certainly as I was attempting to learn from individuals as I was also attempting to engage them with the relevance of the research question to their own lives and practises.

"Gaining trust"

On the surface, it would appear that a two hour interview which covers aspects of water systems requires little in the way of trust. At a deeper level there are many parts of the research that are open to trust, including the legal framework of confidentiality and the goodwill and honesty of participants. Research and evaluation into international aid, aid agencies, aid workers and development has been ongoing for many years. On this basis it was likely that at least some of the intended participants would have taken part in academic research projects or evaluations previously, and may have had existing positive or negative views of the processes and outcomes. Some misinterpreted the research as being of an evaluative nature, as for many residents of rural villages their only experience of ‘research’ had been NGO needs analyses and program evaluations. The flexibility of a semi-structured interview allowed me to give time to the informant to discuss those things that mattered to them – even if they appeared unrelated to the subject at hand. This assisted in building trust and confidence.

"Establishing rapport"

There is no prescription to establishing the rapport necessary to create an environment of understanding in the period of a two hour interview or even over the longer term of staying in a village for several days. The information being collected is relatively transactional. If the knowledge and memory are there then there are few obvious reasons why it would be withheld with the exception of issues of trust, as previously discussed. The technique of creating influence diagrams helped to create a deeper and more rapid mutual comprehension.

"Collecting empirical material"

Key informant interviews of ~1.5 hours duration took place at locations that
were comfortable for the participant, myself and where applicable the translator. These interviews were followed up by email to confirm participant satisfaction and check for further information that might have become available. Notes and voice recordings were taken during interviews and the transcripts of these were emailed to key informants for verification. Ego maps of professional networks form an important aspect of the empirical material collected from key informants. These ego networks were collected to be used as the basis of the social network maps that are analysed and discussed in Chapter 0.

7.4.5 Thematic Analysis

Thematic analysis in this research was based on interviews and field notes which were imported to NVIVO 10 software for coding and analysis. Themes that were coded were: water sources, water treatment, uses, sanitation, safety, sacred, money/funding, hygiene, GMF, gatekeeping (power), gardens, extra time, extra water. Many of these codes are a direct reflection of the questions asked during conversational surveys. The specific themes that arose during reflection and analysis were safety and gatekeeping.

7.5 Exploratory Social Network Analysis

Social Network Analysis (SNA) focuses on “relationships among social entities, and on the patterns and implications of these relationships” (Wasserman & Faust 1994, p. 1). It has also been stated that “the main goal of social network analysis is detecting and interpreting patterns of social ties among actors” (de Nooy, Mrvar & Batagelj 2005, p. 5). From this, it is clear that, alongside other forms of social research, which may focus on individual entities and their specific traits, it is important also to recognise that the links or relationships between agents are important. Agents in this case were individuals, groups and organisations.

Within SNA it is notable that:

- Agents are viewed as autonomous and interdependent
- Agents are linked to each other through social ties
- Resources move between agents through links/ties
- Resources may be material, or non-material- knowledge, respect etc..

The use of exploratory, rather than experimental, techniques, in social network analysis reflects the nature of the research as developing an understanding of social networks around delivery of potable water rather than seeking to control or organise those networks.

7.5.1 Data Collection

Data collection for social network analysis is often achieved through survey or
interview techniques. In this research the data was collected during interviews and occasionally during a general discussion. Data from NGO staff was mainly provided in the form of ego network diagrams that were completed and narrated during interviews as described above.

7.5.2 Boundary Specification

Social network analysis requires a boundary specification with regard to the agents that will be included, both in regard to data gathering and in the analysis. The boundaries for this research were set using a combination of realist and nominalist boundaries as per Wasserman and Faust (1994).

The realist boundaries (set by the participants) were determined during interview processes as the participants disclosed the knowledge, resources and other agents (individual or positional) who are integral to the system. The nominalist boundaries (set by the researcher) involved as much of the endogenous system as practicable (as per the realist boundaries) and any identifiably significant interactions with exogenous systems.

Part of the boundary setting was geographic, as case studies were set in the specific geographic areas where water projects were delivered. This allowed for the inclusion of direct endogenous influences that exist within villages. Exogenous influences required much broader geographic boundaries in order to include informants in Dili and Australia.

Section 0 contains maps of villages. These maps were usually drawn by young adult, educated men. Most of the maps provided used a fairly standard notation for features, consistent with the notation used by NGOs. This notation been reused in the maps within this thesis.

All social network maps are drawn using NodeXL software.

7.6 System Dynamics

This thesis incorporates the use of the system dynamics technique of creating causal loop diagrams from qualitative data. While system dynamics modelling tends to rely on quantitative data in order to create and test feedback models the initial problem formulations and further descriptive aspects of modelling are acknowledged to rely on qualitative information (Luna-Reyes & Andersen 2003). From the perspective of a mixed-methods research program, the ability to extend analysis from the qualitative to the quantitative, from influence diagrams to stock and flow models, holds significant appeal. While the actual data collected in this research was unable to support a quantitative feedback modelling process, this should not deter others from attempting to create such a model in the future.

The models produced within this thesis were created using Vensim PLE software. These models are presented not necessarily as a final description of a situation
but as an interpretation of the qualitative data collected and analysed. Models are never 'complete' and so the boundaries of the model and the different viewpoints that are assimilated will be open to critique, modification and improvement. I present models within this thesis as launching points for further discussion.

7.7 Ethics

The case based, semi-structured interviews and participative observation which provide the majority of the data for the analyses in this research were conducted with participants from a wide range of cultural, linguistic, educational and socio-economic backgrounds. The research was conducted using transparent, ethical practise. Deakin University Human Research Ethics Committee have reviewed the aims and methods of the research and have given approval for the research to be conducted with appropriate guidance and review procedures in place. See Appendix E.

To ensure confidentiality, the maps in this thesis are drawn in such a way as to deliberately obfuscate identification of the village, whilst maintaining their primary purpose in showing the geographical and social relationships within. It should be noted that none of the maps are drawn to scale and north is not necessarily the top of the map as no compass heading is provided or intended. Additionally key informants and residents of villages are not identified by name unless they have given explicit permission for this use.

7.8 Strengths and Limitations

For the situated researcher it worth noting Bourdieu's caution that

"Having discovered the regularities or structure in accordance with which the phenomena are organized, and having stated them in the form of more or less formalized models or theories, the social scientist tends to place these models, which belong to the order of logic, in the individual or collective consciousness of the individual agents or groups." (Bourdieu 1981).

This warning, that we may attribute our newfound knowledge of systems or causes as being understood by the agents involved, is worth considering in light of CAS theory. CAS theory indicates that the social structures that exist, only exist because of individual actions based on simple sets of rules and reasoning and iterative practises. The social structure that emerges through a combination of thousands of actions and interactions is not a consciously built social structure, but an evolved and evolving social structure with all of the redundancies and 'lock-ins' that you might expect from an evolutionary process. In terms of observing and questioning activities therefore it is necessary to acknowledge that an individual does not always have, or know, a reason for the phenomenon that might be observed.
7.8.1 Participative observation

It is acknowledged that the research itself created a departure from regular daily life in most places, as people were asked to be available for interviews, or joined discussion groups, or simply came to where I was out of curiosity. It should also be acknowledged that many residents misconstrued the purpose of the research and were inclined to “lobby” me to intervene with the appropriate NGOs to request bigger/better water systems. Despite the fact that there is a Tetun word for research (peskiza), it became apparent that the only research that most people were familiar with tended to be “need analysis” by NGOs so this influenced their perception of my aims and position, an idea that was exacerbated by being introduced to communities through an NGO.

In addition to this Guest, Namey and Mitchell (2012, p. 79) state that “Embedding into a scene as a participant inevitably means that the information collected is, in certain ways, unique to the individual collecting the data.” While this poses little challenge to relativist thinking it does lead to challenges for positivist perspectives where replicable results are a standard expectation.

7.8.2 Use of grey literature

Grey literature is information that is not under control of commercial publishers. Grey Literature may or may not be subject to peer review, it is produced by governments, NGOs, academia, business and industries (Schöpfel 2006). This type of literature is more and more common (White et al. 2013) and in this case includes the research and evaluation reports commissioned and produced by development agencies. Some of these reports are destined for open access electronic publication and policy work in Australia is significantly influenced by grey literature (Lawrence et al. 2014) but some reports are produced purely for stakeholder use. Knowledge of the existence of ‘stakeholder only’ reports appears to be often only by word of mouth, or internal cross referencing, and access may be tightly controlled within particular organisations. While the existence of this type of literature in the development sector is undeniable, the use of it in academic publications and theses appears to have not been widely discussed in the peer reviewed journals or methodology texts.

The prevalence of this type of literature within the development and government sectors in Timor-Leste and Australia means that much information is available therein, that is not available in peer reviewed publications. The grey literature that has been used is based on rigorous research methods and is considered to constitute valid information, although future compliance by NGOs with the suggested ‘Grey Literature Review Code’ (Lawrence 2014) would make assessing the validity and acceptance of reports a much simpler matter. As Russell et al (2008) indicate in their discussion on multi-disciplinarily, a highly educated, informed and engaged public are now producing knowledge outside of academia and it is a legitimate form of knowledge. Concerns about the quantity, quality and ephemeralness of grey literature are reasonably recent and are well described in a working paper produced by CEDEFOP and Eurolib:
The nature of the grey literature in the WASH sector, and the ‘outsider’ status of the researcher combine to ensure that some significant reports will be overlooked, not known of by the researcher, or not made available to the researcher. Such is life!

7.8.3 Privacy

Poland (1995) notes that interviews are socially constructed events. Most of the village interviews involved not just myself, a translator and a resident, but also others from the village sometimes including Chefe Aldeia, Chefe GMF, family and neighbours. This means that the situation for the resident was that they were talking both with strangers and with people that they are familiar with and whom they see often. This may have had an impact on what was said. There are relationships of power that were obscure to me, but it was apparent in at least some interviews that the informant was being coached, and in other interviews that the informant was unaccustomed to being the centre of so much attention and reluctant to speak about their own experience. In one interview a woman who was part of the women’s representative group for the district was having a discussion with me when she was physically displaced by the arrival of her husband. Regardless of my attempts after this to direct questions towards her, her husband answered all questions from there on. This is a clear example of enacted power relationships and gender norms in Timorese society.

Issues around reluctance or inability of women to make their opinions known in front of men were mitigated to some degree by the women’s meetings that were called and through less formal conversations with young women while cooking or cleaning together.

7.8.4 Interpreters/Language

I worked with several interpreters in different situations. It became apparent that I required an interpreter who could act as both a cultural and a linguistic interpreter. The ability to employ young people who had lived in the regions that I visited was good for me and judging by their subsequent employment success it was a useful experience for them as well. Kapborg and Berterö (2002) discuss issues of validity when interviewing participants with an interpreter and conclude that validity is threatened by interpretation both through loss of nuance and lack of cultural familiarity that may prompt further probing in a single language interview. Added to this Edwards (1998) suggests that interpreters should not be ‘invisible’ in the research as their cultural knowledge and role within the research are worth some reflection. In this research the role of the interpreter, Adia, who travelled with me and stayed at the five villages where
case studies were conducted is particularly significant to the outcomes of the research. Adia was integral in most of my conversations both around the research question and more generally in regard to other arrangements. Her linguistic abilities and her dedication to accuracy both play a role in my results. Moreover, her needs were also factored into the structure of interviews and visits as interpretation is tiring (Kapborg & Berterò 2002) and an expectation that she would be available 24/7 would have been unreasonable. Adia was briefed on the research and it was made clear that her thoughts were welcome during the processes of interviewing and reflection whereby Adia became a key informant (Edwards 1998) and her insights are noted at several points in the thesis.

7.8.5 Lack of collaborative modelling

The modelling that has been done in this thesis would have benefitted from stronger collaborative ties with organisations and with villages. The models are based on the information gained over short periods of living, talking and walking with the people of Timor-Leste and several days of interviews and cross checking with NGOs. It is nonetheless possible that errors of understanding have been included in the models. A practise of collaborative modelling should minimise the potential for errors. This is an area of further research that requires investigation.
This chapter outlines the data collected during two field trips to Timor-Leste and several interviews conducted with staff of an Australian based INGO. The data was collected in four identifiable stages. The first stage was interviewing staff at an INGO based in Melbourne. The second stage was interviewing staff in the Timor-Leste office of the same INGO as well as several other Dili based INGOs and local NGOs. The third stage was a pilot survey conducted with the residents of a single aldeia regarding their networks around WASH. The fourth stage consisted of participative observations and discussions about WASH in five villages in rural areas of Timor-Leste. The data collected across the four stages included:

Stage 1: Interviews with INGO staff in Australia
- interview transcripts
- professional ego network maps

Stage 2: Interviews with NGO staff from a variety of organisations in Timor-Leste
- interview transcripts
- professional ego network maps

Stage 3: Pilot Study – survey
- survey results

Stage 4: Participative observation in rural villages
- familial and uma lisan network maps of villages
- infrastructure maps of villages
- observational data as field notes
- household level semi-structured conversational survey notes

The data collected was analysed using social network analysis and system dynamics from the systems thinking toolbox. Thematic and keyword analysis was used to identify trends from the transcripts and notes of interviews and observational data. The results from this research are particularly visual and descriptive. The use of SNA maps overlaid on infrastructure maps of villages shows some surprising relationships between functionality of water systems with geographic groupings by family or by uma lisan. The use of influence diagrams shows the causal links between policy and practise and gives indications of the feedback loops that may be driving WASH outcomes in Timor-Leste. Descriptions of places, conversations and people are used rather than codes in order to give a sense of context. Attempting to understand the strengths and issues of water services in rural areas without paying close attention to context would be antithetical to a systems thinking approach.
Data collection:

Interviews:
- INGO staff in Australia: 4
- INGO local office staff in Timor-Leste: 8
- Local NGO staff in Timor-Leste: 2
- Government of TL: 6
- GMFF/ABBS: 1
- BESIK: 6
- Consultant: 1
- AusAid: 1
- Volunteer: 1

Discussion groups: 5

- Village observations during ‘joint monitoring’: 1
- Village observation of volunteer activity: 1
- Village observation in separate district: 1

- Villages surveyed: 6
- Individual respondents: 139

8.1 Social Networks in the WASH sector

As an outsider to the WASH sector, at the start of this research I was curious about the way that information is transferred amongst development workers as it seemed to me that within and across organisations there were various cliques where information would move freely inside the clique but may be lost to the wider sector through lack of connections across cliques. This was eventually confirmed partly through the data collection but also as I realised that there is a significant amount of ‘in house’ research that is conducted and reported within development agencies. This research forms a body of ‘grey literature’ that is often only available to stakeholders or evaluators in specific programs and may only be accessed for a short amount of time, depending on staff turnover. Discovering the existence of some of these reports was often more a case of serendipity than of good research methods.

My sampling regime was dominated by snowball sampling of professional networks with some extra interviews being gained through social connections. In the process of interviewing participants from NGOs and associated agencies most participants were asked to draw a map of their professional connections. Invariably this involved “talking through” their connections with prompts from me if there were particular directions that I was curious about, or where there seemed to be an oversight in the map. Responses to being asked to draw networks were varied, most people were fine and needed very few prompts beside “start with yourself in the middle” it was notable though that some participants were more comfortable mapping their own networks by organisation rather than by the individuals that they know within those organisations.
The WASH sector in Timor-Leste consists of NGOs, government departments and foreign government project teams as well as direct action service clubs and “friends of…” groups. The NGOs can be further classified as international NGOs (INGOs) with local offices or local NGOs (LNGOs). Local NGOs are currently the preferred service providers for implementing projects and often have regionally based local staff and offices. Government departments that are most directly involved in WASH sector activities are the National Directorate of Water and Sanitation Service (DNSAS) and the National Directorate of Sanitation (DNSB). Foreign government WASH projects have been dominated by the Australian Government’s AusAid project currently known as BESIK 2, but have included programs from Japan, Germany and the USA.

Direct action groups tend not to provide information about their activities to the Government of Timor-Leste (GoTL). Direct action may be undertaken by church groups, “friends of…” associations, service clubs or other groups or individuals who aim to provide material assistance to villages but who are not coordinated by, or with, any other organising body. In discussions at the 2014 Working Together with Timor-Leste Conference, some members of Australian local government friendship groups acknowledged that village level activities including implementing water supplies may be instituted with little understanding of GoTL priorities and strategic plans. They also noted that it would be rare for them to report their activities to any government agency. It was apparent though, that friendship groups have become increasingly aware of the potential for conflict or confusion between their activities and government strategy.

Understanding the networks of information flow across the WASH sector in Timor-Leste involved gaining insight into the professional ego networks of many actors in the sector to see where and how these ego networks intersected. The notable exception in these networks are the friendship groups and service clubs which appear to “fly under the radar” in Timor-Leste. There was no reference to these organisations as contacts within the government and NGO professional WASH networks that were investigated.

The result of combining the ego networks from the participants (in green) gives a social network map. Figure 22 shows a social network that is based around the professional ties generated through interviewing staff at an Australian NGO and then snowball sampling within Timor-Leste including the local offices of several Australian INGOs and other connections. In the graph shown above the green nodes are people who have been interviewed, so the higher centrality (denoted by increased size) of these nodes is simply a reflection of the fact that each of these specific nodes is the centre of their own ego network. The black nodes toward the centre are of interest as these nodes indicate people who form part of the WASH network and whom are connected with more than one of the informants or other WASH sector actors. The black nodes that are connected to the graph only by a single edge tend to indicate peripheral or temporary actors in the WASH network, but it is worth looking at these to see if any are in positions that would be expected to be better connected (see Table 5).
Figure 22: Social Networks across the WASH sector, focussing on snowball sample from an Australia NGO with a local office in Timor-Leste.

Table 4 Aggregate data for the WASH network in Timor-Leste

<table>
<thead>
<tr>
<th>Total nodes</th>
<th>% of total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Entire network</td>
<td>148</td>
</tr>
<tr>
<td>Informants (green)</td>
<td>21</td>
</tr>
<tr>
<td>Degree 2+ (inner group)</td>
<td>46</td>
</tr>
<tr>
<td>Degree 1 (outer circle)</td>
<td>81</td>
</tr>
</tbody>
</table>

The individuals who have a single degree of connection, meaning that they are only linked to a single participant can be organised into the following groups:

Table 5: Composition of one degree actors in the WASH network of Timor-Leste

<table>
<thead>
<tr>
<th>Group</th>
<th>Percentage composition n=57</th>
</tr>
</thead>
<tbody>
<tr>
<td>Foreign Consultants</td>
<td>16%</td>
</tr>
<tr>
<td>Residents of rural communities</td>
<td>21%</td>
</tr>
<tr>
<td>Government (total)</td>
<td>12%</td>
</tr>
<tr>
<td>Government (national level)</td>
<td>11%</td>
</tr>
<tr>
<td>Government (district level)</td>
<td>0%</td>
</tr>
<tr>
<td>Government (sub-district level)</td>
<td>2%</td>
</tr>
<tr>
<td>Local NGO staff</td>
<td>30%</td>
</tr>
<tr>
<td>INGO staff</td>
<td>40%</td>
</tr>
</tbody>
</table>

The WASH actors who were connected to two or more other actors and who weren’t key informants (central black nodes) are grouped in Table 6.
Table 6: Composition of 2+ degree actors, other than participants

<table>
<thead>
<tr>
<th>Group</th>
<th>Percentage composition n=19</th>
</tr>
</thead>
<tbody>
<tr>
<td>Consultants</td>
<td>16%</td>
</tr>
<tr>
<td>Residents of rural communities</td>
<td>11%</td>
</tr>
<tr>
<td>Government (total)</td>
<td>42%</td>
</tr>
<tr>
<td>Government (national level)</td>
<td>32%</td>
</tr>
<tr>
<td>Government (district level)</td>
<td>0%</td>
</tr>
<tr>
<td>Government (sub-district level)</td>
<td>11%</td>
</tr>
<tr>
<td>Local NGO staff</td>
<td>0%</td>
</tr>
<tr>
<td>INGO staff</td>
<td>38%</td>
</tr>
</tbody>
</table>

Combining information about 1 degree actors and 2+ degree actors it can be seen that local NGO staff are poorly connected to the INGO WASH network with staff members making up 30% of the group of 1 degree actors and not appearing at all in the 2+ degree sector. Government staff at the sub-district level are also quite isolated from the INGO WASH sector as they make up 11% of the 2+ degree actors and only 2% of the 1 degree actors. Local NGOs and government sub-district staff are among the most closely linked with communities. Their lack of incorporation into the INGO WASH network indicates that they are currently unlikely to be included in discussions about policy and practise either through the WASH forum that is facilitated by the GoTL or through other means.

Overall what we see from this is that staff of INGOs connect with each other, with the national government and with external consultants in much greater numbers than they connect with communities, local NGO staff or rural government staff. Local NGOs and rural government agencies are likely to be missing out on up-to-date WASH knowledge from external experts and are not given opportunities to contribute field knowledge or local solutions into planning processes.

8.1.1 Connecting WASH networks to CAS

In accordance with the theory put forward in section 6.2.1 I can now interrogate the development process to see where this information fits into Figure 21. The formation of the WASH Forum in Timor-Leste was a deliberate act of institution building that brings together government and NGO staff to learn with, and from, each other. Groups like this create ‘bridges’ between different network cliques (Wasserman & Faust 1994) and therefore allow the flow of knowledge and resources across cliques with the possibility of ‘new’ information leading to change and innovation. The intentional inclusion of staff who are most connected to rural water services has the potential to increase the emergence of broader and stronger professional networks. Inclusion in professional knowledge exchange networks could also facilitate the implementation of a broader range of water services based on increased technical knowledge and options for implementation. Figure 23 illustrates how extended professional networks might work to improve WASH outcomes in Timor-Leste.
Figure 23 Projected Impacts of Extended Networks of WASH Professionals in Timor-Leste
8.2 Pilot Study - Social Networks of Information Flow in a Village

In 2012, an initial exploratory pilot study of a proposed survey was conducted in a village located less than 5km from a larger market town. The survey aimed to determine which people or positions were considered to be important sources of information and action around water, sanitation and hygiene issues. The village was identified by a WASH sector INGO's local office, who had worked in the village to provide water taps fed from a nearby spring. The village is close to a river, with households located on either side of the riverbed. The river is dry for at least part of each year and impassable for at least part of each year. I visited the village twice, the first visit to the village was to introduce the research and gain familiarity with the local area and people. During this visit both a translator and a staff member of a local NGO who had been involved in implementing the water project accompanied me. The visit started with a gathering of residents, mostly men, on the veranda of the Chefe Aldeia’s house. Women were in an adjacent room and took notice of the proceedings whilst maintaining a distance and preparing food. The men answered questions and agreed to draw a map of the village that was mostly completed by the local NGO staff member (see Figure 24). While the men were drawing the map, one woman unobtrusively started a conversation with me through the interpreter. She was obviously reluctant to be heard or noticed by the men but had several issues that she wanted to air. This was followed by conversations with members of the GMF, the chefe aldeia and with the local NGO staff member. All of these conversations were conducted on the veranda and generally involved interjections from other participants at the general meeting.

From this community meeting the story of water intervention as related by residents is that:

In 2009 all the residents of the village collected water by walking to the river, about 100m away. The water from the river was clear but was not considered clean and caused illnesses in the community. In 2009 the Chefe Aldeia asked the Chefe Suco to request a water system be implemented in the village. The Chefe Suco brought this up with a local NGO who brought it to the attention of an international NGO. It was agreed that a water system would be implemented, but first the community had to improve its sanitation by building latrines. Once that was done, the water system was designed and implemented in consultation with the community. The community contributed labour and some local materials. There is a tap for roughly every 5 houses in the village and the residents use hoses to fill a 44 gallon tank closer to their houses. Of the 10 taps that were installed in 2010, only 3 were still functional in 2012 despite the formation of a water management group (GMF) including a technician who was trained by the local and international NGOs to be able to respond to small problems and do regular maintenance. Each house is expected to pay a fee of 25c per month per household to cover minor repair costs, this amount was stipulated by the NGO who implemented the system. Households who are in arrears are not penalised or sanctioned, but records are kept when payment is
made. In the short time the system has been running it has been fraught with problems, plastic is being used to block pipes to divert water flows, extra (illegal) pipes are run from the main pipes and there is some concern over the lack of transparency of the use of community funds collected by the GMF. There has been a landslide that caused the main pipe to break and required financial assistance from the government (DNSAS) to fix it, as the NGO couldn’t help.

The Chefe Aldeia, who was both interviewed and surveyed, identified that he had his own water source (a bore hole) in his backyard and wasn’t dependent on the NGO implemented system. The Chefe Aldeia spoke about conflict that had been caused within the community, as some households were using a lot of water and not giving opportunities to other households to access the water. He also indicated that the GMF doesn’t have enough money to fix the problems that arise with the water system and that if individuals have the resources then they are prepared to fix problems for themselves rather than relying on the GMF, an NGO or the government. The times when the government and NGOs become relevant are when there are not enough community resources to do the maintenance required. The Chefe Aldeia made it clear that broken taps were not such a big deal, as the pipes were still holding water and could be used directly to access the water whether the tap was functional or not.

This situation shows the resourcefulness of a community who values the water piped to their villages. Community members didn’t revert to collecting river water very easily, and they were willing to fight (each other) to maintain access to this water source. It also shows that the community, as defined by the geography of the water system, is not an egalitarian, socially cohesive group that looks to ensure fairness and equality within its borders, as considered in section 5.2.2.
Figure 24: Stylised map of pilot village
The survey results (see Appendix C for full list of survey questions) and subsequent social network analysis are shown in Table 7 and Figure 25. The second part of the survey (see Appendix D) was used to expand on the questions about “who” is sharing information or “who” is seen as being responsible for tasks involved in WASH system maintenance. It involved a checklist of positions (and names where possible), respondents were asked to indicate if this person would be someone that they would expect to talk to about water, sanitation or hygiene. The result of asking less open-ended questions than in the first part of the survey was that more than one person or position was identified as being significant. In this community the Chefe Aldeia was most commonly identified as the person who residents would speak to about the water system in the village. This is despite the fact that most residents were familiar with the water users group and indicated that they could talk to them or go to meetings if they wanted. The result of the survey question “who would you talk to about the water system in your village?” is shown as a network map in Figure 25 where all respondents except the Chefe Aldeia are indicated as green nodes in an outer circle.
Table 7: Results of selected survey questions in the Pilot Village

<table>
<thead>
<tr>
<th>Survey question</th>
<th>Response</th>
<th>Notes:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Does the water tap nearest your house turn on?</td>
<td>Yes: 67%</td>
<td>19% responses that a tap will open but not close</td>
</tr>
<tr>
<td></td>
<td></td>
<td>24% responses that a tap is permanently closed</td>
</tr>
<tr>
<td>Does the water stop running completely when you turn the tap off?</td>
<td>Yes: 80%</td>
<td></td>
</tr>
<tr>
<td>Who would you speak to about a broken tap or tap stand?</td>
<td>Chefe grupo: 19%</td>
<td>Chefe Aldeia: 5%</td>
</tr>
<tr>
<td></td>
<td>Chefe Aldeia: 5%</td>
<td>GMF: 33%</td>
</tr>
<tr>
<td></td>
<td>GMF: 33%</td>
<td>SAS: 14%</td>
</tr>
<tr>
<td></td>
<td>SAS: 14%</td>
<td>NGO: 5%</td>
</tr>
<tr>
<td></td>
<td>NGO: 5%</td>
<td>Self fix: 5%</td>
</tr>
<tr>
<td></td>
<td>Self fix: 5%</td>
<td>No response: 19%</td>
</tr>
<tr>
<td>Do you ever still collect water from the river?</td>
<td>Yes: 40%</td>
<td></td>
</tr>
<tr>
<td>Does your house have a useable toilet?</td>
<td>Yes: 100%</td>
<td>Families that didn’t claim to have a useable toilet have described having a pit toilet made of local materials.</td>
</tr>
<tr>
<td>Description of toilet</td>
<td>Pit 43%</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Local materials 43%</td>
<td>Concrete pan 24%</td>
</tr>
<tr>
<td></td>
<td>Concrete pan 24%</td>
<td>Ceramic pan 0%</td>
</tr>
<tr>
<td></td>
<td>Ceramic pan 0%</td>
<td>Pour-flush 0%</td>
</tr>
<tr>
<td>If you wanted to repair your toilet whom would you talk to about it?</td>
<td>Family / fix own: 92%</td>
<td>NGO: 8%</td>
</tr>
<tr>
<td></td>
<td>NGO: 8%</td>
<td>Government: 8%</td>
</tr>
<tr>
<td>Is there anything that you do NOT like about having:</td>
<td>Conflict 5%, low flow 10%, rubbish 14%, responsibilities 10%</td>
<td></td>
</tr>
<tr>
<td>a water system</td>
<td></td>
<td></td>
</tr>
<tr>
<td>a toilet</td>
<td></td>
<td></td>
</tr>
<tr>
<td>handwashing facility</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Has anything happened because of the village water system or the toilets that you were surprised about or didn’t expect?</td>
<td>Damage by river 33%</td>
<td>Damage by animals 29%</td>
</tr>
<tr>
<td></td>
<td>Damage by animals 29%</td>
<td>Intentional damage 10%</td>
</tr>
<tr>
<td></td>
<td>Intentional damage 10%</td>
<td>Unpredictable flow 24%</td>
</tr>
<tr>
<td></td>
<td>Unpredictable flow 24%</td>
<td>Broken toilet 14%</td>
</tr>
</tbody>
</table>
The network map (Figure 25) highlights some interesting features of the survey results. It shows that some members of the community are highly connected and more confident that they can speak with NGOs, government agencies and community leaders. Other members of the community appear to be less well connected (the two individuals at the top of the circle) and may be quite vulnerable due to their lack of perceived options for dealing with water issues. These two residents have little in common, one is a middle aged male who is head of his household and the other is an elderly female. Another resident spoke only in the local language and couldn’t communicate with the students who were conducting the survey. In the same way that this woman was excluded from the survey, language may constitute a form of vulnerability in terms of being unable to easily understand and contribute to public discussion in either of the national languages.
Every person who was surveyed indicated that they were able to discuss the water system with at least one person who they considered responsible, the GMF, Chefe Aldeia, the implementing NGOs or a government officer. Despite this plethora of responsible individuals, the Chefe Aldeia indicated during his interview that of the ten taps in the village only three were functioning properly. While several residents indicated that they would fix their own taps if required, no-one suggested that they would discuss it with their (non-family) neighbours whom they may share a tap with. This lack of apparent neighbourhood discussion or complaint may be an artefact of the way that the questions were put to the residents. It could also be an indication of a low perceived need for community mobilisation around this issue. If residents don’t perceive a need to mobilise around the issue of water system functionality it is less likely that social structures ensuring reliable water access would emerge.

There are several possible reasons why this emergence might be inhibited. As noted above there are multiple groups who are considered responsible for the water system already and perhaps confusion over this makes it more difficult to ensure that a single group functions effectively. The existence of a GMF which was originally organised by an NGO to provide maintenance may have resulted in what Urry (2003) has termed “the Titanic effect”. In an attempt to engineer a perfect water system including the GMF, the space for locally emergent rules, norms and management is diminished. The ultimate effect of applying exogenously determined guidelines or processes may be detrimental to local empowerment and emergence.

8.2.1 Connecting WASH planning to CAS

Figure 26 illustrates the above observations as applied within an influence diagram of factors that affect development outcomes.

![Diagram showing the impact of non-local, non-democratic, decision making on development, freedom, choice, diversity, and emergence.](image)
8.3 Village observations and surveys

In trying to understand how rural communities use water and how they gain, use and maintain water systems it was important to spend time in villages, walking around, talking, observing and to some degree taking part in everyday life. I recognised that as an outsider to the village, and as a foreigner to the country, my understanding would always be restricted by the modernism of my upbringing, by language barriers and by lack of scope to genuinely understand what constitutes subsistence life in a rural village. This was stage four of data collection. The results of this stage are presented in a discursive manner in order to convey a sense of how residents of rural villages view themselves and how they responded to the research. This highlights the voices of the residents rather than the ‘facts’ of their existence. Maps are derived from those provided by residents and water collection and usage is self-reported. While self-reporting may lead to some inaccuracies, these are likely to be trivial when placed in the context of ensuring that residents' views are expressed as directly as possible.

There is a hierarchy of permissions to be gained before visiting and conducting research in the villages. In some places I was introduced by staff from an NGO who had worked in the villages. Even in these cases I still followed the process in order that there was full awareness of what I was doing, and perhaps more importantly, what I was not doing. This meant that I needed to discuss my plans with the District Administrator and the Sub-District Administrator as well the Chefe Suco and/or Chefe Aldeia of each place that I visited. In each case I stayed in the house of the Chefe Aldeia or Chefe GMF or another respected family in the aldeia. I travelled with a young Timorese woman, Adia, who acted as interpreter both in the sense of language and often in the sense of culture as well. Whilst I had intentionally sought an interpreter who had lived locally, Adia was particularly well suited to my research – she spoke Tetun, Tokodedi (the most common language in the sub-district) and another local language as well as Bahasa Indonesia and English. Adia had grown up in rural villages so understood the working rhythm of the days. She is intelligent, funny and personable, often entertaining our hosts with stories of her family and friends and of life in Dili. Adia would spend the early part of most meetings introducing herself through her family lineage and introducing me through the people that we had met at previous villages. This was a (perhaps) unconscious exercise of “who do I know that you know?” that I feel contributed to building trust and rapport with strangers. At some point each day Adia and I would discuss some of the events of the day, ask and answer questions about culture or language and discuss some of the local news or information that Adia had picked up along the way.

Adia and I visited five villages together between September and December in 2013. Villages 1, 2, 4 & 5 were selected with the aid of an NGO working from Dili who had instigated water supply systems in the villages and was aware of the status of the water system functionality. Village 3 was selected on the basis that the Chefe Aldeia was the father of a friend of Adia's and the village had had no
recent assistance with their water system. Functionality varied across villages, from Village 1 that had been functional for several years with no significant problems, to Villages 4 and 5 where water systems were currently almost completely non-functional following problems over the period of existence. Village 2 was still in the process of building its system. I was told in the case of Village 3 that the “village has no water” leading me to expect the situation to be significantly more dire than it in fact was. Table 8 shows the diversity of the villages visited in terms of size and types of water supply accessed along with data on actual water collection times and amounts.

Table 8 Comparison of aldeia sizes and water supply

<table>
<thead>
<tr>
<th></th>
<th>Village 1</th>
<th>Village 2</th>
<th>Village 3</th>
<th>Village 4</th>
<th>Village 5</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>No. of Houses</strong></td>
<td>29</td>
<td>19</td>
<td>50</td>
<td>21</td>
<td>23+</td>
</tr>
<tr>
<td><strong>Water sources</strong></td>
<td>springs</td>
<td>pools</td>
<td>springs</td>
<td>springs</td>
<td>springs</td>
</tr>
<tr>
<td></td>
<td>pools</td>
<td>taps</td>
<td>taps</td>
<td>taps</td>
<td>wells</td>
</tr>
<tr>
<td></td>
<td>dams</td>
<td>taps</td>
<td>dams</td>
<td>taps</td>
<td>taps</td>
</tr>
<tr>
<td><strong>Average time to tap/well (mins)</strong></td>
<td>27</td>
<td>6</td>
<td>16</td>
<td>13</td>
<td></td>
</tr>
<tr>
<td><strong>Average water carried to house daily from taps (L/household/day)</strong></td>
<td>30</td>
<td>64</td>
<td>70</td>
<td>38</td>
<td></td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>12</td>
<td>13</td>
<td>7</td>
<td></td>
</tr>
<tr>
<td><strong>Average water carried to house daily from unimproved sources (L/household/day)</strong></td>
<td>26</td>
<td>38</td>
<td>66</td>
<td>44</td>
<td></td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>6</td>
<td>9</td>
<td>8</td>
<td></td>
</tr>
</tbody>
</table>

The following sections apply the responses of the villages’ residents to creating social network maps of kinship and religious affiliations that is overlaid on a stylised map of the physical infrastructure of their villages. While mapping social and physical geography is a common development tool for users of participatory rural appraisals (PRA), overlaying these with relationships as per SNA is less common in development practise. The advantage of this type of mapping is that it can be used to pinpoint vulnerable households or well-connected individuals. It can also be used to note geographic clusters of particular relationships perhaps indicating a form of homology in the bairos.
8.3.1 Village 1

Located in the mountains about a one hour drive from a large market town, Village 1 is in fact only part of a village (a bairro), containing ~ 29 houses. Amongst these households, access to water sources includes two separate NGO-provided protected spring fed systems with tanks and taps, one unprotected spring, a river and a pond. The pond and the river are not shown in Figure 28 as they are secondary sources of water, used only when piped water is unavailable. A visual inspection of the distribution of houses (Figure 28) shows a tendency towards being geographically grouped.

Village 1 has two functioning water systems. For this discussion, the water system shown to the right of Figure 28 is ‘System A’, the water system in the centre is ‘System B’ and the unimproved spring is ‘The Spring’. The original Chefe GMF of System A had gained a position as head of a small local NGO where he mentors other GMF’s who are having trouble maintaining their system. The system is fully functioning with pipes and spring protection in good condition (Figure 27) and plentiful water at specific times of the day available to the six households using it.

![Figure 27: Protected spring at Village 1 (System A)](image-url)
Figure 28: Stylised map of Village
System A

System A is managed by the GMF so that water is available early in the morning and mid-afternoon at each of the households on the system. The main reservoir is closed at other times to allow water to accumulate. The times that water is available coincides with the times of the day that households require water for bathing and cooking and watering vegetable gardens. Early in the morning water is used for dampening the ground (keeping dust down) and large pots of water are boiled and the water is either allowed to cool in clean containers or is kept in a thermos for cold and hot drinks respectively throughout the day. Mid-afternoon and early evening are the main times for bathing – after much of the day’s work is finished and everyone has returned home before the day starts to cool down.

For System A, each house has a tap in or near the compound and hoses or bamboo half pipes are used for filling *mandis* and drums for water storage during the day. Prior to the water system implementation the family that I stayed with collected water from springs in the river bed. Walking to the river took about 15 minutes down a steep, rugged, narrow path. The walk back took around 30 minutes even without carrying any water. The family owned a horse that had been employed to carry water up from the springs and was now not given any tasks at all. While visiting the springs I asked the young women (early teens to early twenties) why the houses weren’t built closer to the springs and was informed that the steepness and rockiness of the land and the large snakes were reasons for houses to be built away from the gullies that the creeks run through. Given the state of the track to the river, which was not overgrown, and the state of the springs with bamboo half-pipes still intact (see Figure 29), it is likely that these springs are still used by someone but I was unable to gain answers to my questions of why or who. I did note that when we (women/girls) all decided to come for a walk the older man of the household tagged along with a machete, he was unobtrusive but the girls told me that he felt that we needed protection, although again I was not answered as to who or what we might need protection from.

Having stayed in the household of the Chefe GMF I observed that the family showed some concern with sanitation and hygiene – a pour flush toilet with a mandi was used during the day, although in the evening most of the family were happy to urinate behind the main buildings as the toilet was about 50m down a dark narrow track and torches and batteries were not available. Several hours after our arrival soap was made available for handwashing at the toilet although no toilet paper was available. There was also a separate “bathroom” with a mandi for washing. The mandi was topped up twice a day via a hose. In general though, there was no overt effort at handwashing throughout the day, although it may have in fact occurred at the beginning of meal preparation without being observed.

Each household using this water system had a sizeable vegetable garden and was able to water the garden using the water provided through the system.
Figure 29: A natural spring in the river. This would have been used prior to the water system implementation and appeared to be still being used as the bamboo pipe was in place several years after System A was installed.

**System B**

System B serves a different group (*grupo*) of houses within the same aldeia as System A. The houses served by system B are gathered along a ridgeline, with the reservoirs or tanks that accumulate water situated below the ridgeline. The distance from each household to a tank is reasonably short but in each case it is very steep – making the collection of water a difficult and tedious task – the paths are loose dirt and gravel with no steps or handholds.

Notably, the response of households to this situation is to shower and wash clothes at the tank, rather than transporting water to the house for this purpose. System B provides some water for vegetable gardens but these are not as common or as large as those supported by System A. I was surprised that the vegetable gardens weren’t placed closer to the tank for ease of watering and was told that the land surrounding the tank was *lulik* (sacred) and the ancestors had given permission for the water tank but other than that the land had to be left alone.
Households relying on System B appeared less affluent than those with access to System A. They had dirt floors rather than concrete floors in houses and few decorative or functional plants around the houses. From residents who responded to my conversational survey questions I got the impression that the GMF was not seen to be inclusive of the needs of these households although they paid their fees and their groupo had been the site of a meeting of the two local GMFs at one stage. One man indicated that they “feel difficult about water, they would like a [nearby] tank, it is difficult to have a garden” while a woman indicated that her household “will fix any problems by themselves when possible (not funded by GMF)” and another woman said that she “attends GMF meetings that are nearby, [but] ones that are further away are difficult because of the kids”.

The residents of this bairo indicated that they were not satisfied with the situation – they would like to have a supply of water that is closer to their homes and can be used for gardening and sanitation. One man indicated that he had filled in the pit toilet that he felt he had been coerced by the local NGO into building. He was choosing open defecation because he had really wanted a pour flush toilet but there was not enough readily accessible water for one to be installed and used.

From field notes: “previous to this water was collected at the river twice a day, taking 2hrs each trip to carry 2x 5L. Now she collects water 3 times a day, 2x 5L bottles for her household of 2 adults and 6 children.” Collecting water from the tap takes about 35mins per trip. For this resident the water system saves her about two hours a day and she can collect an extra 20L each day. Overall the use of water in the household is around 7.5L per person per day, an amount that is inadequate for cooking, drinking and hand hygiene.

**The Spring**

The Spring (Figure 31) is a source of water for the groupo around it – all the houses are located above the Spring, and the length of walk is longer and almost as steep as that of the users of System B. The Spring not only supplies water to this groupo but also supplies water to houses up to 2km away via a system of bamboo half pipes (Figure 30).

The water from the spring is collected for drinking and cooking but is also used at the spring, as nearby residents come to bathe and wash clothes at the spring. As they leave residents simply move a single bamboo pipe by about 20cm to allow the water to flow along bamboo pipes to more distant residents. This type of management appears indicates good cooperation between the different groups of water users.
In describing the Spring as a source of water and place for bathing one man indicated that there are “A lot of people …we follow the line… stories, laughter and heaps of water for everyone” whilst one woman said that there are “No men – if they did then the women wouldn’t go.” And because there are “No bathrooms in houses so women get some privacy when together” and “Men tend to wash at a different time of day” but that “If a tap were available she wouldn’t miss the social time and she would have a big vegetable garden”.

One man who was growing tobacco in a very dry garden indicated that he was in the process of building a house closer to the water source and would move there when it was ready.

Overall those residents for whom the spring was their main source of water seemed inclined to be satisfied or accepting of this situation. Residents here appeared to be more affluent than residents of System B. They had concrete floors in their houses and children were able to attend school and university. While it is not possible to state from this data that water supply directly influences affluence, it seems likely that the increased affluence observed in System A and the Spring may be attributable to the existence of a permanent supply of water that was adequate to household and small farm or kitchen garden uses.
Water use statistics

It is perhaps unsurprising that the amount of water used at the household level, for each of the three different groups described above is not the same (Table 9). Ease of access to water, and in particular the amount that can be carried in one
trip seems to play a large part in determining the amount of water used. Observation and questioning showed that women tend to carry four or five 5L containers of water at a time, this is done by having one in each hand, two to four in a basket slung from the forehead and one balanced on top of the head. Children tended to carry less than this, generally one or two containers at a time.

Figure 33: A pregnant woman carrying water, 4x5L water bottles are in the basket

The diversity of water sources used by residents in this village allowed observation of how residents use water from different sources (Table 9). Note that these numbers are taken on a very small sample size and not all households responded to questions about water collection and use. The average return walking time to the Spring was quite low, given the distance and gradient involved. On the basis of observation of several ponies at the roadside near the spring it is possible that the respondents use a horse to carry water for at least the steep sections of the walk, making this a less time consuming and easier task than would otherwise be expected.

In each groupo the responses to questions about whether there is (or was) a social aspect to water collection indicated that there is a social aspect to it – that women and men bathe in single sex groups (either separated by time or location) at the spring or the tanks in system B and that there tended to be a lot of story-telling and laughter. It was unanimous though, that even though they might miss this social aspect of communal water collection or bathing, the reduction of time and effort involved in having a tap near the house was of much greater value. One woman when “asked if she would miss going to the creek and telling stories etc.. and she said that no because they would continue to tell stories and laugh together” and a man said that his “nearest neighbour is
less than 1km away, they visit if they have time”. The grandmother where I was staying elaborated a little more, saying that she “had fun at the river but its better now [even though] she misses the fun and stories. She used to go with neighbours but now visits about once a week with the neighbouring women”. Hence there were several indications that the social aspects of bathing and collecting water were easily replaced by other activities such as simply visiting neighbours or attending community events.

Table 9: Water collection and use in Village 1

<table>
<thead>
<tr>
<th></th>
<th>Average Return walking time to water source (mins)</th>
<th>Average household water use per day (L)</th>
<th>Average in house water use per person per day (L)</th>
<th>In-house uses of water</th>
</tr>
</thead>
<tbody>
<tr>
<td>System A</td>
<td>&lt; 1</td>
<td>&gt;200L</td>
<td>&gt;20L</td>
<td>drinking, cooking, cleaning, showers, sanitation, gardens, washing</td>
</tr>
<tr>
<td>System B</td>
<td>34</td>
<td>30</td>
<td>3.455</td>
<td>drinking, cooking, cleaning, gardens</td>
</tr>
<tr>
<td>The Spring</td>
<td>45</td>
<td>27.5</td>
<td>4.21</td>
<td>drinking, cooking, cleaning</td>
</tr>
</tbody>
</table>

Emerging ideas

Initially during the research I was not aiming to understand the significance of the sacred houses but towards the end of the visit I was speaking with the Chefe GMF, finalising some details, and it came about that the Chefe GMF described her father-in-law as a liurai which led to a conversation about uma lisan and the realisation that these groups of “sacred houses” are important social institutions within villages. I began to understand that each village may have more than one uma lisan and hence more than one liurai. This leadership structure is quite different to what I imagined prior to the field work. Overlaying the network of uma lisan within a village indicates that these extended family/sacred groups may form a natural grouping for some functions, including water provision and maintenance. The different uma lisan in the village are indicated in Figure 34 as coloured nodes associated with specific people/households.
Figure 34 is a social network map laid over a map of Village 1. The social network map has nodes (dots) that indicate the heads of households and their spouses, and edges (lines) that indicate familial relationships within the village. The type of relationship is indicated by the colour of the line, dark blue for a married couple (these nodes are also co-located), light blue for parent-child relationship, dark green indicates a sibling relationship (often forming a triangle/triad with parents). Other types of relationships including adoption are shown in light green. The other relationship shown on this map is membership of the different uma lisan- indicated by different node colours. Looking at the map there appears to be some overlap between uma lisan and geographical locations (clustering of the coloured nodes). There are less obvious, but still apparent grouping of families in geographical locations shown by clustering of the lines/edges.

The map with social network overlay helps to identify households that might be at risk of being excluded by the community as they lack family and/or sacred house connections. For example looking at the two households in the centre of Figure 34 who are associated with Uma Lisan 3, these households appear to have neither family nor sacred house connections with the rest of the community. This was a household that I wasn’t taken to visit during my stay despite it being very close to the household that I stayed with.
Figure 34 Familial relationships and sacred house allegiance in Village 1
8.3.2 Village 2

Village 2 is located in the mountains on a road that is used infrequently by anyone other than residents of the villages along the road. The road has evidence of previous infrastructure implemented during the Indonesian occupation by way of drainage channels and old galvanised iron pipes along the verges. The situation in Village 2 during the research visit was that a newly constructed water system was almost complete and would supplement an existing supply that was only available to some residents (four houses shown on the right hand side of Figure 36). There was still work being done on building tanks and access paths still needed to be built as the first tank in the system was built several metres below road level.

At the time of data collection residents were accessing water directly from the pipes, in lieu of connection and access to the tank and taps. Some residents carried water back to their houses by hand whilst others had access to a wheeled cart to transport containers. A 44 gallon drum was also providing temporary storage for water that was used for bathing in-situ by the younger boys in the community.

Figure 35: Adia using the temporary access to the new water system
Figure 36: Stylised map of Village 2
One resident told me that the new system was unlikely to provide adequate
water resources for the needs of the whole community but that the NGO serving
the aldeia was not prepared to implement a system that would provide a higher
volume of water. The household that I stayed with in this village had very close
access to the water system and commented in passing that while they weren’t
using a hose or pipe to deliver water to the house they expected that they would
do so in the future.

A recent change of leadership had occurred but the new Chefe Aldeia was
indisposed due to a family bereavement and an illness. The ex-Chefe Aldeia
accommodated Adia (my translator), myself and another young woman from a
local NGO. The ex-Chefe Aldeia acted as a source of information and
introductions and accompanied all of our household visits.

Previous to the implementation of the new water system the residents of Village
2 had mostly been collecting water, bathing and washing at any of three springs
that flowed into the nearby river bed. One of these springs had been ‘protected’
and this was now providing water for a nearby aldeia.

Those households that hadn’t been using the springs had access to water that
flowed through a system implemented and used by the Indonesian military
during their occupation of Timor-Leste. The new system carries water from the
same spring as the previous system but with new pipes, better protection of the
source (see Figure 57), and distribution to more residents in the main part of the
village.
The walk to the previously used springs was hard, the gullies were steep and thick with plant life and insects. We came across a bright green venomous snake (probably a type of pit-viper) we all bushwhacked around it giving it a large berth. That led to stories of snakes that were “large enough to swallow a dog” living around the creeks and gullies. No surprise then that several residents indicated that they felt some fear when collecting water in these places.

The social network map of Village 2 (Figure 39) shows a considerable number of sibling and extended family relationships between households. Uma lisan 2 – indicated in dark green - clearly has more members than other uma lisan. Again the family relationships tend to be concentrated geographically with a single distinct family located around the previously available water source. This grouping includes the current Chefe Aldeia.

There are several households that seem to be isolated from familial relationships in the village, these appear to have come about due the death of a spouse who would have been connected by familial relationships. Despite an assertion by da Costa Magno and Coa (2012, p. 166) that “Everyone knows their uma lisan, and understands their rights and their obligations to others through the broader relationships that are established within and between different uma lisan”, it seemed that some people did not know their uma lisan. Being asked created confusion for some and resulted in prompting from the previous Chefe Aldeia who was accompanying us. It is possible that the privacy accorded to the sacred was extended to not wishing to tell this information to a stranger, although this was never indicated to me as the reason. Women often didn’t claim allegiance to a particular uma lisan, probably due to the tradition of taking their husband’s uma lisan (as explained by Adia). Village records, including information about uma lisan, are kept in a book by the Chefe Aldeia and were made available to me in several villages, not including this one.
Figure 39: Social network map overlaid on physical map of Village 2
There is a couple in this village who appear isolated in the SNA diagram (circled) but who were in the process of building a new house using concrete breeze blocks (as opposed to most houses which were built with concrete or dirt floors and traditional bamboo walls) which was being funded by remittances provided by sons who were working for the army. A widow in the village was baking fresh bread rolls early in the morning and selling them as a breakfast item (yum!). As with most villages there is a small household based kiosk that sells sugar, salt and other staples.

Table 10: Water collection and use in Village 2

<table>
<thead>
<tr>
<th></th>
<th>Average Return walking time to water source (mins)</th>
<th>Average household water use per day (L)</th>
<th>Average in house water use per person per day (L)</th>
<th>In house uses of water</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spring</td>
<td>65</td>
<td>38</td>
<td>6</td>
<td>drinking, cooking, cleaning</td>
</tr>
<tr>
<td>Tap</td>
<td>9</td>
<td>70</td>
<td>9</td>
<td>drinking, cooking, cleaning</td>
</tr>
<tr>
<td>Older system</td>
<td>4</td>
<td>52</td>
<td>16</td>
<td>drinking, cooking, cleaning</td>
</tr>
</tbody>
</table>

From Table 10 it can be seen that while the average amount of water collected each day in Village 2 has almost doubled with the implementation of a new system, the amount of water available for each person in a house is still very low at 9L per person per day. The use of tap water in the house for bathing and washing clothes is limited to the households that are closest to the tap stand.
8.3.3 Village 3

Village 3 is located in the mountains in a neighbouring district to the other villages in the study. The village is high in the hills, located on the only reasonably flat piece of land available, and there are a lot of springs nearby. Most residents rely on subsistence farming and growing coffee as a cash crop for a living. The residents of the village suffered under the Indonesian occupation and assisted the Timorese resistance through subterfuge. Many village men were killed, leaving widows and young people as heads of households.

The daughter of the Chefe Aldeia told me that this village “has no water” and she organised that Adia and I could stay with her family in the village. The reality was that the village had two water systems – one functional and one semi-functional and several springs. The functional system was inadequate to the needs of the village and was running from an unprotected spring. The other, semi-functioning system, had been implemented by the World Bank (WB) in the year 2000. Sections of this system had been dismantled and the parts scavenged and used to provide water delivery for some houses located near springs. There was another tank that was also functional (not shown on map) and several families used it as a source of water.

The functioning water system culminated in a ~5000L tank in the school grounds and had been implemented by an NGO approximately 25 years previously. The village had collaborated to maintain the system ever since. In a bit of research serendipity, the system suffered a minor breakage shortly after I arrived in the village. Given a general difficulty in the translation and response of “if… then” questions, this created an opportunity to put concrete questions about a current situation into action rather than creating stories that could be responded to. In this case I could ask questions like “How did you know that the water system was broken today?” and “When you noticed that there was no water in the tank, did you tell anyone about it?” and “Who did you tell?” These questions were designed to assist me in understanding how knowledge is communicated through the village and who was seen to be responsible for the functionality of the water system. The answers that I received to these questions though didn’t necessarily assist with this. There was a distinct sense of knowledge by osmosis, which is understandable given that much of village life is visible and so observation rather than conversation would be responsible for some information/assumptions/knowledge transfer. It appears that having a breakage in the water system is not such a remarkable event that it would create significant consternation among the community, as evidenced by the report from one community member who said that:

“Once a week the tank goes dry due to breaks in the pipes and reservoir. Broken pipes are fixed with ‘mandala’ (rubber from inner tubes) by her son Rueben. Never has to pay for fixing. If the system really needs parts then the Chefe Aldeia would organise to collect money from all, but some don’t want to”. 
Others reported that they didn’t bother telling anyone because they believed that the tank was dry due the spring having stopped running because of the season (late in the dry season), indicating that water accessibility is a seasonal issue for the community.

Three residents identified Rueben as the technician who would fix the pipes, as he was trained during the implementation of the now defunct water system implemented by the World Bank. He was away from the village at the time the tank was discovered to be empty and hence it took several days before any action was taken. Most residents of the village were in a period of intense agricultural activity which may also explain the delay.

The younger brother of the Chefe Aldeia, along with the Chefe Aldeia himself, have identified a spring that they think would be suitable to use to bring water to the village. They have a plan that would see every household in the village with a tap close enough to connect a hose so that water would be available at the household level. They have costed the plan but have had no assistance with gaining either finances or engineering expertise, despite requesting assistance through the Chefe Suco and direct representation to several NGOs. According to the Chefe Aldeia this village was not currently serviced by any NGOs, they have little contact with government, and seemed to have a difficult relationship with the Chefe Suco.

Figure 40: The bamboo pipes that are currently directing spring water to the galvanised iron pipes in Village 3.
Figure 41: Stylised map of Village 3
Although this village (Figure 41) is geographically small it has a primary school that takes students from nearby villages as well. Secondary school is a one hour walk away. The village is serviced by an angunna (a truck with seats in the back) that acts as a bus service to Dili several times a week, although this isn’t on a timetabled basis – it requires a phone call to find out when the angunna is going to run. The angunna is not a government provided service – the private owner drives to Dili (about 5 hours away) according to the number of people that are likely to pay a fare on any particular day. If the angunna is not running then a one hour walk to the nearest large township is required to catch a more regular service.

The village does not have access to electric power, although a couple of houses have solar panels. There is a power line being built that was scheduled to be operational in 2014. The village is quite isolated and few government services are provided. Despite this, some residents have managed to send their older children to university in Dili. The cost and distance involved in travel means that the children only return for very special occasions, and despite the ubiquity of mobile telephone coverage, the expense of phone calls makes general communication problematic.

The residents of this village use a number of different springs depending on their location. A few households are situated below a spring, they collect water in dams for agriculture and aquaculture and pipe it directly to their yards for household use.

![Figure 42: Plenty of water if you live below a spring](image)
All of the residents use the springs to wash clothes and bodies. Almost no-one in the village has a toilet, and sanitation is a prominent issue. In one instance, when I was interviewing a young man, his toddler defecated (diarrhoeal) on the dirt floor of the house. The toddler was scooped up and put outside to ‘finish’ and then a pack of puppies were shooed inside to ‘clean up’ the mess. This is not an isolated incident as dogs commonly eat human faeces in villages where open defecation is a social norm. Added to this are my observations of dogs being allowed to lick plates in the kitchen and also that the *ema* Timor eat dogs (Adia assured me that when roasted over a fire with some herbs, dog meat is delicious). It is beyond the scope of this thesis, but it would be unsurprising to find that this set of behaviours around dogs might be responsible for a significant amount of disease transmission.
Figure 44: Social network map overlaid on physical map of Village 3
The social network map of familial and sacred relationships in this village (Figure 44) shows strong connections between households with little geographic clustering except in the case of the Chefe Aldeia and the families of his adult brothers and their uma lisan (uma lisan 6, shown in yellow).

Table 11: Water collection and use in Village 3

<table>
<thead>
<tr>
<th></th>
<th>Average Return walking time to water source (mins)</th>
<th>Average household water use per day (L)</th>
<th>Average household water use per person per day (L)</th>
<th>In house uses of water</th>
</tr>
</thead>
<tbody>
<tr>
<td>School tank</td>
<td>9</td>
<td>70</td>
<td>12</td>
<td>drinking, cooking, cleaning, shower (25%)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>washing (5%), new baby (5%)</td>
</tr>
<tr>
<td>Spring 1</td>
<td>73</td>
<td>41</td>
<td>5</td>
<td>drinking, cooking, cleaning, shower (20%)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Spring 2</td>
<td>77</td>
<td>75</td>
<td>11</td>
<td>drinking, cooking, cleaning, shower</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>new baby (7%)</td>
</tr>
<tr>
<td>Spring 3</td>
<td>0</td>
<td>unknown</td>
<td>unknown</td>
<td>drinking, cooking, cleaning, shower washing</td>
</tr>
<tr>
<td>(direct to household)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>WB tank</td>
<td>26</td>
<td>88</td>
<td>21</td>
<td>drinking, cooking, cleaning, shower (40%)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>washing (40%), new baby</td>
</tr>
<tr>
<td>WB tap</td>
<td>16</td>
<td>40</td>
<td>7</td>
<td>drinking, cooking, cleaning, shower (50%)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>washing (50%)</td>
</tr>
</tbody>
</table>

The most significant use of water in the home is by the families near the WB tank (Table 11). This tank was part of the World Bank system implemented in
2000, several of the households towards the centre of the aldeia indicated that they collected water from this tank when the main tank ran dry. In this village the school tank is shared by around 20 households which may explain why the amount of water collected is low despite its nearness to the houses. The WB tank on the other hand is used by fewer households but on average they collect twice as much water per person.

In comparing the time and amount of water collected between the school tank and the most commonly used alternative source (Spring 2) it can be seen that there is not a significant increase in the amount of water collected despite the significant decrease in time taken to collect water. The inadequate water supply at the tank means that residents still need to bathe and wash at the springs. Whilst the time taken to collect water is reduced, the overall amount of time to complete both tasks not reduced as residents still need to walk to the spring to bathe.
8.3.4 Village 4

Village 4 is located in the mountains and was described by the staff at NGO who introduced me to the Chefe GMF, as having issues with its water supply. The village consisted of two bairos within a ten minute walk of each other with quite different situations.

Bairo A (on the right of Figure 45) where Adia and I were accommodated, had a functional solar pump system with good access to water close to the homes of each resident. The water was managed on a timed basis – water was available at the times when the pump could be relied on to provide peak flows (i.e., in the afternoon when the sun was at its zenith), and at other times by request or negotiation amongst residents.

Bairo B had a water system implemented by an NGO in 2007 but which was, at the time of visiting, effectively non-functional. The NGO had stockpiled pipes near the village, and then transported them out to other villages for multiple implementations. However by the time Village 4 got to their implementation there weren’t enough new materials to do the job. As with many places in Timor-Leste, at least one previous water system had been implemented in Village 4 and this village tried to build their ‘new’ system using parts recycled from an older system. This meant that pipes were old and rusty and joints were failing on a regular basis.
Figure 45: Stylized map of Village 4, Bairo B on the left, Bairo A on the right
Other problems have also occurred with this system; the spring had at some point flooded the intake and no-one from the *bairo* had been able to repair it. This means that water source is not protected. According to residents, during high rainfall periods the water is quite muddy and unusable. The last tank in the system has been detached as there wasn't high enough water flow to fill it. Taps are non-functioning (either on or off) and when the tanks get low during the dry season residents use buckets to dip water out of the tank, further compromising the potability of the water. The Chefe GMF explained that he could not get community agreement to invest money in repairs for the intake or the pipes. The residents of Bairo B struggle to maintain flowing water in the face of dry weather, deteriorating pipes, broken intake, and a lack of agreement amongst themselves about the expenditure of the funds collected by the GMF.

The amount of effort required to ensure that water is available is significant, walking to the spring that feeds the systems takes approximately 45 minutes. The break in the pipes shown in Figure 47 was a 30 minute walk from the village. Repairing it was reasonably fast but since the pipes are supported by sticks and the repair was a piece of rubber re-tied around the joint it is likely to break again fairly quickly. The young man who acts as the village water technician indicated that he might need to fix the system up to four times in a week and that if a tree has fallen on the pipes and needs to be cleared away then it can take a couple of people up to five hours to fix.
Looking at the social network map of familial relationships in Village 4 (Figure 48) it is interesting to note that there is little inter-relationship between the two bairos with only three households from Bairo A having direct relatives in Bairo B. The Chefe Aldeia lives in Bairo B and appeared to be having the same issues regarding access to water as the rest of the residents there.

Table 12: Water collection and use in Village 4, bairo A

<table>
<thead>
<tr>
<th></th>
<th>Average Return walking time to water source (mins)</th>
<th>Average household water use per day (L)</th>
<th>Average in house water use per person per day (L)</th>
<th>In house uses of water</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tap</td>
<td>13</td>
<td>44</td>
<td>8</td>
<td>drinking cooking cleaning</td>
</tr>
<tr>
<td>Spring</td>
<td>60</td>
<td>38</td>
<td>7</td>
<td>drinking cooking cleaning</td>
</tr>
</tbody>
</table>

Household water use in this bairo is very low, as indicated in Table 12 residents are coping with less than 10L per person per day for drinking, cooking and some cleaning.
Figure 48: Social network map overlaid on physical map of Village 4
8.3.5 Village 5

Village 5 was described by the NGO staff who introduced me as having intractable problems with its water system. The village is spread along the banks of a river and a road at the foot of the mountains and close to the sea (Figure 50). The river was dry at the time of the visit but many springs were still flowing. Water sources for this village included several springs and wells, with water quality (taste) varying depending on the depth of wells.

Several families in this village had significant vegetable gardens and were obviously accessing adequate amounts of water whilst other families suffered shortages. This village had experienced migration to the village and was geographically spread out, with a Chefe Aldeia who was not located near the study area and not well accepted as a leader, one resident noted that, in their opinion, the Chefe Aldeia’s different religion (Protestant) made him disinclined to engage with village issues as the majority of the village is Catholic.

This village is clearly separated into 2 sections. Houses close to the road and below the last tank in the system all have access to either private or public wells. The second group of houses are spread along the river between the last tank and up to the spring. These residents mostly had access to alternative springs and many were piping water from a local spring to their house compound. At the end farthest from the road several households were using a common bamboo system to pipe water to their compounds from a strongly flowing spring.

Figure 49: A piece of mesh is used as a water filter
Figure 50: Stylised map of Village 5, not showing all houses
Comments from residents of different areas of the village indicated some of the issues around the water system that affected them:

Near the road:

“The water used to come here but now it stops at the tank [named] because too much water is used by those with vegetable gardens… Sticks are being put in pipes so water stops (and others get more water).”

“They [residents near the road] were quite annoyed at putting in a lot of work for the [NGO] system and then not getting any water.”

About the middle of the system:

“Water comes from [source] and right now the water is dry. NGOs are supportive, but he [a resident – not a member of the GMF] wants a metal pipe rather than plastic which gets cut (wants me to ask for a big metal pipe). Has a water pipe but no water [from the NGO system]….. Why would someone cut the pipe? Because some don’t get water, or they put a stick in the pipe to get more water to vege gardens (upstream). All the community built the tank but only one person uses it…”

“Use [neighbour’s] tap and pipe – no closure so it’s permanently on”

Above the middle:

“When the [NGO] system dried up they didn’t want a community meeting. Who? The people in the middle.”

Upper end – the family who were indicated by other as taking most of the water for themselves:

“Our water comes just from the [NGO] system, during dry season there is less water than the rainy season but there is enough water.”

In general the interviews conducted in this village indicated that the community felt that other people in the village, interfering with the system, were causing many of the access problems with the water. While these comments show that there was some acknowledgement that the dry season meant that there was very low water flow, there were also indications that there had been problems for quite a while. This was especially the case towards the end of the water system near the road. At this location many residents who should have been able to rely on the taps had given up and were accessing water from local wells.
In this village the research encompassed seventeen households, of those, only four indicated that they could get water from an NGO provided system/tap; one (at the bottom of the system) had managed to store more than 1000L which would last several days; another two were sharing a tap which they said was only providing a few litres a day, I noted in my field notes that I questioned the validity of this as there appeared to be a significant amount of water lying on the concrete pad; a fourth household indicated that they had enough water. The fourth household and one of the households sharing the tap had conspicuously large vegetable gardens, which may have been watered using alternative water sources however this was not verified one way or the other.

Meeting with the Chefe GMF I ascertained that he and the Chefe Aldeia had not discussed the issue of water access and fairness and how to ensure equitable distribution. The residents of the village, both those who are new and those with a long family history in the area have found alternative solutions. These alternative solutions include wells, electric pumps and accessing other spring fed sources using bamboo half pipes. Residents relying on these alternatives
had varying degrees of satisfaction with them. Wells and springs afford enough water for families to drink and cook without issue. For some however, it means that they need to walk or ride to a water source to wash themselves and their clothes, and for a few it means an arduous amount of work merely to gather enough water for cooking and drinking.

The research indicates that this village doesn’t act as a cohesive group, the Chefe Aldeia and the Chefe GMF appear to have little input or effect on the residents, so there appears to be a lack of leadership and collaboration. Unlike the other villages that I visited, there was no-one who could tell me about the relationships between the different families and sacred houses and hence there is no social network map in this section. The data that I collected at this village is much less comprehensive than other villages and I noted in my field notes that I consistently felt that there was something missing from my understanding of the situation.

Figure 53: The owner of this tap stand demonstrated that the water had stopped flowing from the tap

It is clear that many residents are unhappy with the water supply provided by the NGO, and many of the tap stands are unused. However, residents have also seen the value of a reliable water supply and have invested in whatever infrastructure they require and can afford. Strategies for self-supply of water include: individuals or groups building a bamboo half-pipe water delivery system, the use of metal or plastic pipes to deliver water from a spring, investment in the professional building and reinforcing of a well with electric pump, or the hand digging of wells and use of buckets to collect water from these. While the system designed and delivered by the NGO may be
considered to be only semi-functional it is clearly creating opportunities for increased market gardens for some residents and may have contributed to stimulating actions for self-supply. As the system is still capable of delivering water as designed, there remains the potential for some form of emergent leadership to deal with the social issues that surround this water system.

Figure 54: A disused tap stand

Figure 55: Self-supply.  
Left: A tank that has been disconnected from the NGO system and connected to a private supply (plastic pipe), in front of another private supply (bamboo pipe). Right: A spring-fed dam
8.3.6 Comparisons between villages

The five villages included in the case studies comprise a very small section of rural Timor-Leste. This research has looked at the specific contexts within each village, and for several of the villages it has also looked at differences of access to water supply within the villages. In this section some comparisons are made across the villages.

Table 13: Village Comparison Descriptive Statistics (merged from previous tables)

<table>
<thead>
<tr>
<th></th>
<th>Village 1</th>
<th>Village 2</th>
<th>Village 3</th>
<th>Village 4</th>
<th>Village 5</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. of Houses</td>
<td>29</td>
<td>19</td>
<td>50</td>
<td>21</td>
<td>23+</td>
</tr>
<tr>
<td>Water sources</td>
<td>springs &amp; pools</td>
<td>springs</td>
<td>springs</td>
<td>springs</td>
<td>springs &amp; wells</td>
</tr>
<tr>
<td>Average time to tap/well (mins)</td>
<td>27</td>
<td>6</td>
<td>16</td>
<td>13</td>
<td></td>
</tr>
<tr>
<td>Average water carried to house daily from taps (L/household/day)</td>
<td>30</td>
<td>64</td>
<td>70</td>
<td>38</td>
<td></td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>12</td>
<td>13</td>
<td>7</td>
<td></td>
</tr>
<tr>
<td>Average time to unimproved water source (mins)</td>
<td>113</td>
<td>65</td>
<td>77</td>
<td>60</td>
<td></td>
</tr>
<tr>
<td>Average water carried to house daily from unimproved sources (L/household/day)</td>
<td>26</td>
<td>38</td>
<td>66</td>
<td>44</td>
<td></td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>6</td>
<td>9</td>
<td>8</td>
<td></td>
</tr>
</tbody>
</table>

Table 13 is missing data in the last column as residents from Village 5 had such diverse situations in terms of accessing water that the data collected could not be collated into this table. Another issue with this data is that average water carried to households doesn't include the amount of water used at the household when a tap or hose was available to the house, as was the case in Village 1 and for some households in Village 2 and many households in Village 5. This means that increases in water usage tend to be underrepresented within the table.

From the table it can be seen that Village 1 had the greatest average time savings for water collection when water systems were implemented. Recall
that Village 1 also has the best functioning water systems and part of Village 1 has a water supply that is available at the household rather than shared village tap stands.

![Average daily amount of water used at home (L/person/day)](image)

**Figure 56: Household water use from improved sources, per individual, when water is carried to the house**

From this data (Figure 56) it can be seen that more than 50% of individuals with access to an improved water source, that is not supplied to the household, are coping with less than 10L of water per day at home. Observations and interviews of household water use in households where water was supplied directly to the household (no carrying required) show that water use is enough to include bathing and clothes washing at home along with cooking, drinking and other cleaning so probably over 40L per person per day.

Overall it can be seen that even with a functioning water system, residents of villages are still spending up to 30mins a day to access water and more than 90% of residents whose water supply is from a village tap stand will use less than 15L per day at home. Beyond this, many will use either the tap stand or a local spring for bathing and washing clothes.
8.4 System Dynamics of Water Use

This section combines the use of quantitative data from interviews, surveys and the SIBS database to understand the social dynamics around the implementation and maintenance of small rural water systems. The use of causal loop diagrams in this section accords with Sterman’s (2000) notation as discussed in section 4.3. The use of system dynamics is a relatively novel approach to integrating technical and social understandings around water supply in a development context. Using a complex adaptive systems perspective as a framework necessitates including knowledge and understanding from different levels of the system. For the rural water supply systems observed in this research this includes local communities and local, national and international NGOs, as well as government bodies and the implementation charters that are applied. The motivations and actions of donors (e.g. AusAid) are only included in terms of very broad understandings gained through literature research or through information given by key informants due to the boundaries selected for this system.

8.4.1 Value of water system

In beginning this research I had assumed that the value of a water system for improving health and freeing up time was self-evident. Over the course of speaking with many development workers and researchers, there was no indication that this might not be the case. However, in spending time with the families that use the systems, it became clear that water supplied through protected spring fed systems is not guaranteed to be free of pathogens, is often subject to seasonal variation of quality and quantity and in many cases still needs to be carried to households for use. The actual value of the water supply for improving lives is limited by its poor potability, poor reliability and poor water system design. In situations where quantity and accessibility are fine and the value is potentially quite high, issues with lack of dependability may act to reduce the value of the water supply.

Potability/Water Quality

In every household, in every village, the residents who participated in this research told me that they boil water for drinking regardless of whether it comes from a protected or unprotected source. This was verified through observation at the household level. All households where I was offered a drink had containers that were used specifically to cool and store water that had been boiled, as well as a thermos flask to keep hot water for coffee making. Very few people said that they would ever drink water without boiling it. Those who did drink unboiled water only did so because boiled water was not available at their specific location. For example, in Village 3 I was told by the Chefe Aldeia that occasionally he would drink from a spring when he was at the farm and hence too far away from home to wait for a drink.

This rigorous adherence to the boiling of drinking water should ensure that
reversion to non-improved sources of water would create little increase in the incidence of waterborne diseases transmitted through ingestion, such as diarrhoea. The use of unimproved sources may increase the incidence of diseases transmitted through the skin during water collection, or through poor hygiene as a result of decreased water availability. On this basis it may be that very little improvement in overall health is observed when water systems are implemented without concurrent uptake of sanitation and hygiene improvements.

Spring protection is considered essential by NGOs working in Timor-Leste. It is interesting to note that the rationale behind this appears to be that large animals such as pigs and cows and buffalo and horses and goats pose a threat to the integrity of the system – either through disturbance of sediments, faecal depositing or breakage of infrastructure. Spring protection generally did not remove the threats of faecal deposit by birds, dead animals such as frogs, toads, birds or small mammals, or rotting vegetation being incorporated into the water stream. Nor did it exclude the likelihood of increased sedimentary loads after heavy rain, except in a couple of springs where a local palm fibre was inserted into the water flow, within the protective concrete structures, as a filter.

Potability of water may be further affected during the wet season as the amount of water running through springs and down streams may overwhelm the ability of source protection to function adequately. Lack of adequate source protection may result in sediments or other particulates being pushed into the system by torrential rains. Additional water flow could also increase the risk of animal or human faeces or other pollutants being washed into the system. Figure 57 shows the protection of the spring for Village 2. According to NGO staff the use of above ground pipes is a response to the sulphuric soils of the region that cause degradation of buried metal pipes. It does however leave the pipes subject to damage by large animals, falling trees, heavy water flows or soil slippage.

Figure 57: Newly protected spring in Village 2
Carrying water

The GoTL guidelines state that water points should be available within 200 metres or 5 minutes walking time for a round trip (GoTL 2010b). From the data collected from villages 1, 2, 4 and 5 only 51% of total households met this criterion for minimum time to access an improved water source. Only 15% of total households had a water supply that was accessible in under 5 minutes. Only 6% of total households had a hose or pipe that delivered water directly for household storage and use. Accessibility of water, if it needs to be transported to the house in containers (as in Figure 58 below), is significantly lower than having a pipe or hose to the house. In many cases the location of taps would still be problematic for residents with low mobility. For example, in Village 2 the newly installed tank and taps were a short distance down a very steep embankment.

Figure 58: Water collection and storage containers

Quantity

The amount of water that is supplied through spring fed systems is limited by natural flows and the inability to store large amounts of water. Timor-Leste has a wet/dry seasonal climate that leaves many springs with low flows at the end of the dry season. The tanks that I observed tended to be ~2m x 2m x 2m \(\approx 8000\text{L}\). Based on the 2010 census the average rural household in Timor-Leste is 5.43 people (GoTL ND-a). The recommended amount of water to be made available is 60L of water per person per day to meet household needs for drinking, cooking, cleaning and hygiene (GoTL 2010b). An 8000L tank can hold enough to provide 24 households with water, for household use only, for one day.
Table 14: Potential water storage in villages

<table>
<thead>
<tr>
<th>Village</th>
<th>Households relying on tanks</th>
<th>Tanks</th>
<th>Approximate number of days of possible water storage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pilot</td>
<td>24</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Village 2</td>
<td>18</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Village 3</td>
<td>~25</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Village 4</td>
<td>21</td>
<td>3</td>
<td>3.5</td>
</tr>
</tbody>
</table>

Table 14 indicates the amount of water storage available to communities. Village 1 is left out of this table as the actual potential for storage wasn’t assessed. Village 5 has been omitted as self-supply is prevalent across the village. For the other villages, if a pipe breaks and water is no longer delivered to the tank, there is little excess storage. The possible maximum of three days’ worth of water storage in Village 4 is based on the number of tanks but one of these tanks is completely disconnected from the system bringing the realistic water storage potential to less than 3 days. On top of household use there is the requirement for further water provisions for health centres, schools, offices, churches, livestock, kitchen gardens and small businesses.

Meeting water needs beyond minimum requirements for cooking, drinking and household use would enable village practices to include better sanitation, kitchen gardens and looking after the wellbeing of those who are ill or infirm as well as providing adequate conditions for sanitation in schools and health centres.

**Dependability/Reliability**

Hunter, Zmirou-Navier and Hartemann (2009) indicate that there is a lack of reliability of water systems in Africa and that this negates any improvement in water quality as reversion to unprotected systems increases the risk of reintroducing waterborne diseases to the population. While this issue may not be of the same magnitude in Timor-Leste a lack of technical dependability affects the ongoing use and maintenance of many systems. Research has shown that 40% of the cause of water system breakdowns in the districts of Aileu and Lautem are due to technical unreliability, as shown in Figure 59 (Grumbley & Hamel 2010).
In a village not included within the case studies I observed a tank being built which had run into materials shortages in the process of concreting, but because of the previous investment and the timing, the residents of the village were trying to complete the concreting with inappropriate materials, making the process overly difficult and likely to fail in the long run. This is a single circumstance but it leads to questions regarding the training and qualifications of local and foreign staff/volunteers, in particular their ability to manage projects and their ability to call on extra resources as required when circumstances change.

8.4.2 Connecting amenity to CAS

Taking each of the sub-factors for the value of a water system/service discussed 8.4.1 and illustrating their relationship using an influence diagram (Figure 60) it is possible to see that creating a valued resource from the start of the process is contingent on initiating a reliable and ‘more than adequate’ supply of water. Difficulties are caused by environmental factors but some of these could be overcome with extra training of implementers so that they have better knowledge and options for customising water supply to the village. Customisation would include working through issues of materials and building quality, appropriate solutions for acidic soils, adequate storage and other responses to environmental issues.
Figure 60 Sub-factors in the value of a water system to residents of rural villages in Timor-Leste
8.5 Household water management

In the small rural villages of Timor-Leste the quantity of water made available through most new water systems is not predicated on the full water needs of an expanding village population, but based on either the minimum standard or the recommended standards for current household needs only of 30 – 60L per person per day (GoTL 2010b).

On the basis of discussions with households at the villages I stayed in, the amount of water each household collects, each day, is based on the amount that can be carried, the distance to be carried, and on the household needs for cooking, drinking and minimal cleaning. Regardless of the number of people living in a household, the quantity of water carried to each household is rarely more than 100L and is mostly significantly less than this (see Figure 61). In fact the figures show that household water use is almost as low as the recommended standards for individual water use.

Figure 61 shows total quantities of water carried from taps to households. When the same data is used to analyse the amount of water available at the household for each person in the house, the range of water supply is between 2.5 litres per person per day and 36 litres per person per day (see Figure 62).

Figure 61: Water Used at Household Level

The higher volumes here reflect two households where women had recently given birth. These figures don’t include water used at the tap for washing. There was a lot of variability in the alternative sources used for washing (clothes and bodies), sometimes at the tap-stand and sometimes at the alternative water source (spring or river). This is governed by social norms, agreed rules of the GMF and by the availability of water at the tap stands. Of the villages I visited only two grupo indicated that they were entirely satisfied with the situation.
Water is rarely carried to the house for washing clothes or bathing purposes. In households where water is available directly to the house or yard, it was observed that bathing is often conducted in purpose built structures, usually a concrete slab and *mandi* surrounded by bamboo walls. Washing clothes is also done at home if water is piped to the house. If water from a protected source is plentiful but only available at a communal tap then bathing and washing might be conducted there depending on privacy, gender and local agreements about use of water points. If water supply from the protected source is limited, then bathing and washing occur at the nearest/best alternative source – a river, pond or spring. Carrying water, even a short distance, results in a significant reduction of amenity – bathing and washing water is not carried back to the household. One of the rare exceptions to this is for women who have recently given birth. It is traditional for a postpartum mother and child to be confined to their own house for a period of time. The mother is not expected to work, cook or go out to wash. Family and friends contribute their labour to provide copious amounts of warm water, meals and child care for older children.
Figure 63: Influence diagram of household water use within a village based on participative observations across five villages.
Table 15: Description of the influence diagram (Figure 63)

<table>
<thead>
<tr>
<th></th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>The amount of water available at the tap will affect the amount used by other households</td>
</tr>
<tr>
<td>2</td>
<td>The amount of water available will impact the amount available to an individual household (5). Multiple households using a single tap tend to be aware of each other’s usage patterns and may negotiate the amounts available to each household</td>
</tr>
<tr>
<td>3</td>
<td>If tap water is available, then it is used for drinking</td>
</tr>
<tr>
<td>4</td>
<td>Rainfall is highly seasonal and water from springs and wells rely on rainfall for recharge, therefore spring fed and well fed systems have reduced water when there has been little rain</td>
</tr>
<tr>
<td>5</td>
<td>The amount of water that is actually available at the tap will impact the amount used, especially if the tap is shared with close neighbours</td>
</tr>
<tr>
<td>6</td>
<td>The closer the tap is to a house the more water the household is willing to carry/pipe to the house.</td>
</tr>
<tr>
<td>7</td>
<td>Building and use of pour flush toilets is contraindicated if water cannot be directly transported (hose or pipe) to a mandi beside the toilet pan</td>
</tr>
<tr>
<td>8-19</td>
<td>Increased tap water availability leads to increased use for a list of prioritised uses</td>
</tr>
<tr>
<td>20 - 25</td>
<td>When tap water isn’t available for each use then the likelihood of accessing an alternative water source increases</td>
</tr>
<tr>
<td>26</td>
<td>Willingness to access an alternative water source for “extra” water decreases according to effort required.</td>
</tr>
<tr>
<td>27</td>
<td>If alternative water sources are regularly accessed then the importance of the “tap” is lessened and the effort involved in maintenance is seen as lower value</td>
</tr>
<tr>
<td>28</td>
<td>Lack of perceived or actual value leads to lack of maintenance action (see Figure 60)</td>
</tr>
<tr>
<td>29</td>
<td>Lack of maintenance actions leads to system breakdowns and water shortages across the system</td>
</tr>
<tr>
<td>30</td>
<td>Lack of water in the system leads to lack of water at the tap</td>
</tr>
<tr>
<td>31</td>
<td>Available water will impact willingness to build and grow a vegetable garden</td>
</tr>
<tr>
<td>32</td>
<td>Knowledge and availability of materials will impact willingness to build and grow a vegetable garden</td>
</tr>
<tr>
<td>33</td>
<td>Growing a vegetable garden means that water may be extracted from the system for this purpose (even when that is not the intention of NGOs)</td>
</tr>
<tr>
<td>34</td>
<td>A limited amount of water flows sequentially through pipes and tanks and those users at the “top” of the system have access to more water than those at the bottom as they have the ability to “turn off” the flow down the system.</td>
</tr>
</tbody>
</table>

In the influence diagram Figure 63 a cascading set of water used versus water available decisions (arrows 8 to 27) is based on compound observations of the hierarchy of use of limited water sources within the villages visited. At each decision point there is the possibility that householders will resort to the use of unprotected sources, for gardening and handwashing there is also some likelihood of the activities not being undertaken at all. Further to this, the diagram shows that location of water has an impact on the sanitation technology chosen,
Pour flush toilets are seen as the optimal technology but are not used where water is not able to be piped to the outhouse. There are two balancing loops in the influence diagram that ensure that the more water that is available to a community or a household the more water will be used. One of these includes the implementation vegetable of gardens and the other is simply household use of water. When water is scarce it is prioritised for particular uses. My observations indicated that sanitation and hygiene are low priority uses.

### 8.6 Safety

I am not a naturally cautious person, so I find “safety” as general reason for not doing something to be a bit difficult to understand. Whilst I was in Timor I wasn’t inclined to consider the relevance of feeling safe when collecting water and it has only been in the thematic analysis phase that I recognised the messages about women’s feeling of safety that have emerged from the interviews, observations and survey results.

Having seen a lurid green snake near the springs in one village and discussed this with the people that I was with, they explained to me that these snakes are very venomous and there is no way to get to medical help quickly. In several villages it was also noted that there are very large snakes near the water, which can be quite aggressive. So being bitten by a snake in this area with long grass and little forward visibility is a valid fear. Some snakes were said to be so large that they could eat a dog, so small children would also be at risk from this sized creature.

In one village, in the household I was staying at one evening, the men were away for the night and it was dark when the older woman noticed that there were lights from people walking with torches in the forested area uphill from the house. She became very fearful and demanded that we turn off the light, go inside and lock the doors. I wasn’t able to get an explanation that night of why there such concern about people walking about in the night time but the following day she told me of a disagreement with the neighbours, and accusations of witchcraft. In a context where several women who had been accused of witchcraft had been killed in the previous years (Wright 2012), this is again a very valid fear.

Grenfell et al. (2009) surveyed community members in Timor-Leste regarding how safe they feel and while the feedback they received indicated an overall positive sense of safety there were more specific instances of respondents noting that they were afraid of others. Grenfell et al. (2009) specifically noted that young women tended to be afraid of groups of men and either avoided them by staying home or by ensuring that they walked with other women. I observed that people in Timor-Leste seem to never be alone and that questions about meeting people by chance don’t translate well as there seems to be no time that women, in particular, are inclined to move about by themselves.

Safety is also a point that is often highlighted in NGO reports and media – the idea that women and children are scared of people, animals or their environment is indicative that yet another rationale for delivering water close to
houses is to remedy issues of safety and security. For example a Timorese child’s fears are used in an article by Plan USA to highlight the dangers of water collection “Shallow swamps, steep ravines, and death-defying cliffs..... “I feel scared when I’m standing at the top of the cliff”..... The trio carefully climb the cliff face they were so terrified of earlier, struggling with the big bottles” (Plan USA 2014). Problematically the idea of safety during water collection and the idea of safe water may be conflated by NGOs in their media. Many water systems deliver a safer option for water collection but they are not necessarily delivering water that is considered safe from pathogens or other contaminants (Sobsey 2002).

8.6.1 Connecting safety with CAS

Maslow’s hierarchy (Maslow 1943) and Max-Neef’s (1991) schema both refer to safety or protection as being intrinsic human needs. Feeling unsafe creates constraints on our choices, as shown by Pantazis (2000), who also indicates that poverty, gender and age act together to multiply risk and exacerbate feelings of being unsafe for UK residents. Pantazis (2000) shows that the more ‘at risk’ or vulnerable an individual is (or feels), the more likely they are to constrain their own choices in order to avoid the negative consequence of being a victim. Recovery from an incident that negatively affects livelihoods or economic capital is much harder for those living in vulnerable circumstances. Hence increasing safety and perceived safety are important factors in increasing real choices for individuals (Figure 64).

![Figure 64 How perception of safety influences real (enactable) choice](image)

8.7 Costs

The cost to a community of maintaining a water system and of adequate sanitation and hygiene practices to maintain a healthy environment are significant in the context of low incomes and subsistence agriculture. For individuals surviving on less than $1 per day the choice to purchase consumables, like soap (~25c a bar) and toilet paper (~30c a roll), that are not a social norm in Timorese society means making choices that will impact other aspects of their families lives. Further to this each family that accesses a new water system is expected to pay fees. The fees are generally low enough (about 25c a month) that most families don’t see them as a particular hardship. The payment of fees to a GMF creates an expectation of continuous benefit so if the
system breaks down and water isn’t being provided, it is seems reasonable that fees are withheld and any cash that it is being held in reserve is repatriated to the families who have contributed. GMFs however are not well supported in understanding how to apply the funds collected, as indicated by a WASH program engineer:

“People struggle to decide what to do with funds especially in the difference between a public and a private decision. For example if you are a buying a tap for a single family you choose based on cost if everything else is pretty much the same, but for a public tap you can’t just buy a cheap tap, they need to be really robust and generally are much more expensive than a standard tap. The people on the GMF are not used to making decisions on this basis. It’s quite hard to do from their position and they don’t get much guidance, either technical (what to get and where to get it) or social.”

If the issues of cost for replacement parts, travel and even phone calls for support are not made explicit within the community at the time of implementation, then the community doesn’t have the option to create a set of guidelines that will work for them.

The other cost issue is that of time, some post-implementation activities of the GMF can be very time intensive. In Village 5 which is very spread out, the treasurer complained about the amount of time taken to collect water fees. In Village 4 where the spring was quite a long way distant and trees falling onto the pipes were a common issue, the technician spent up to five hours a week making repairs. This is a significant contribution for a volunteer to make to their community. Time spent in these activities could be to the detriment of the livelihoods of the individuals who volunteer as shown in Figure 65.

![Figure 65 Projected impacts of volunteer time and access costs for WASH services.](image)

As is illustrated in Figure 65, there appears to be a counter-intuitive impact of charging water user fees. Charging for access to water could be seen as a hardship for families living in low income circumstances but in the face of alternative (although not desirable) water sources, paying for access to water becomes a choice. In particular, in the villages that I visited, it was clear that
there were few actual repercussions of not paying water user fees and that the
time of payment was quite flexible depending on circumstances. So payment of
fees, when not forced, becomes an enactment of choice and a vote of approval
while non-payment could be used to signal discontent. This type of signalling is
well known in the minority world and is often referred to as “voting with your
feet” or “voting with your wallet”. In Guatemala, Vásquez (2015) found that non-
payment of water bills was predicated on dissatisfaction with services rather
than lack of ability to pay and that non-payment was more likely when water
services were community managed.

8.8 Customization

In many of the villages that I visited, at some point someone would comment on
the pipes being cut or broken or plugged in order for one user or group of users
to be able to access more water or water closer to where they needed it. This
tendency to customise the system occurs regardless of the type of pipes used,
galvanised iron or plastic are both susceptible. From my field notes residents
perceive that plastic pipes are more susceptible to this abuse and stated a
desire to have steel pipes because of it:

“.want to fix the tanks and doesn’t want plastic pipes because they are too
easy to break, would rather use metal pipes” Chefe GMF

The movement by NGOs towards using cheaper, more flexible and less rust
prone plastic pipes is rarely seen as a positive step by communities who are
much more concerned with the immediate effects of customisation than the
longer term effects of acidic soils. So customisation is both a well-known and
quite prevalent activity but plastic pipes are generally much more practical than
iron pipes in the long term. On this basis it would seem that having parts and
equipment available to create changes in water system configurations - ones
that could be agreed to and supervised by GMFs - would lead to better
outcomes than ‘self-customisation’ creating problems for ‘legitimate’ water
system users. As illustrated in Figure 66, an adaptable water system that can be
changed in response to evolving needs, by adding pipes and tanks and
connecting to extra springs would allow for the diverse users and changed
circumstances to make the most of the service. It would also allow for users to
‘upgrade’ their service from a communal tap stand to individual household taps
if the resources (cash, materials and water) become available for this level of
service.
8.9 Socializing

There is a story about a village where a new well was installed in the village centre but the women chose not to use it. Instead they walked to a spring to collect water because that would give them more social opportunities away from the men. The aphoristic nature of the story has led to a sense that it might explain some of the abandoned, non-functional or barely functional water points that exist across Timor-Leste and the majority world. For development workers and researchers – including myself – this story holds some of its appeal because it would explain the counterintuitive observations of broken and disused water systems that might be made useful with the input of very few resources. This research took the ideas of the story and looked for social theory and data that might explain it, if it were true in the context of Timor-Leste. I started my research and data collection from the basis that this story might be plausible. However, I found that whilst women in Timor-Leste generally do enjoy bathing and telling stories together while they are collecting water and doing their washing, almost no-one (the exception being teenaged girls) felt that they would be (or were) missing out on social bonding when tap stands were made available in the community. So the theory that women don’t push to have the water system fixed because they enjoy ‘getting away’ from the men is an unlikely explanation for the phenomena of failed water points.

Contrary to my findings, and in-line with the aphoristic story at the start of this section, Subramanian (2015, pp. 124-5) speaks of “a toilet project in one village [in India] that failed simply because women valued their walks into the fields too much.” She asks “What other private moments did they have to share?” so context and culture may have a significant contribution to the uptake and maintenance WASH services if women are in fact drivers of change in this respect.

8.10 Participatory practice and accountability

NGOs attempt to instigate community ownership through participatory development in order to ensure the ongoing maintenance and sustainability of water systems. The language used by NGO staff and volunteers and by the community itself indicates that the local community rarely feels full ownership of the water systems they are expected to manage. The response from a resident
of Village 4 when asked what she might do about tank that had been broken for a year was that “she thinks that it is a government or NGO responsibility” as they had installed the system.

While INGOs are quite clear that participatory practises are important, when I questioned their contractual structures with local NGOs there is a trend towards more highly specified contracts based on measurable outcomes. In regard to implementation of water systems around 2003 it was stated that “contractors were required to obtain community backing for the projects using participatory methods” (Schoeffel 2006). Little seems to have changed as a key informant explained to me that implementation of the community action planning (CAP) process and of the community led total sanitation process (CLTS) are both often included as contractual requirements of WASH implementation. This runs counter to the recommended use of CLTS as a way of allowing communities to realise and internalise the disgust factor of open defecation and not as a process for coercing communities to create sanitary conditions. In fact Kar and Chambers (2008) state that “Any top-down target and disbursement-driven approach is liable to undermine CLTS” (p11). It is difficult to assess how effectively CLTS and CAP processes have been used to engage communities and to ensure genuine community participation, understanding and ownership.

The delineation of positions even within a small single focus NGO adds to this complication as health and hygiene are seen as separate, female oriented issues. The technical side of building water systems is dominated by male staff and is treated separately to the behaviour change and ‘socialisation’ aspects of WASH implementation.

Figure 67: Causal loops for implementation training and payment of local NGOs

Figure 67 is a causal loop diagram indicating the premise that while training to implement and complete robust water systems using participatory practises is conducted by INGOs for their staff and for local staff, the reality of payment for project completion is potentially in tension with genuinely participatory practises. This based on an understanding of participatory practises as inherently time
consuming. The time taken to ensure genuinely participatory practises would decrease the potential number of systems that can be implemented each year. Payment for implementation encourages coverage (as per the MDGs) rather than quality processes. The result of contracting for implementation, rather than paying wages for good quality community development work is likely to be that water systems are implemented with little regard to “time wasting” participatory practises beyond the basic contracted CAP and CLTS processes. In a more competitive environment the quality of implementation may be a factor in the supply of services. The reality in Timor-Leste at present is that there is not an oversupply of contractors or local WASH NGOs and the local NGOs tend to have strong affiliations with particular INGOs who provide training and regular work and whose reporting requirements are familiar.

This is a very rationalist economic view of the situation and not entirely reflective of a reality where the motivations of staff and mission of organisations are not just about generating income. Roche (2010) indicates that measurement is a solution that INGOs use to provide donors with evidence that development outcomes are being achieved, as promised. In an environment where INGOs compete for funding, measurement and reporting are “pushed down” through bureaucratic structures from donors to INGOs to local NGOs, all with the same apparent rationale of meeting donor requirements. At the implementation end of the chain, local staff members are looking for funding, not to grow a business, but to feed their families and improve their lives. Regardless of the good intentions of donors and INGOs to see money used as efficiently as possible, payment by implementation (coverage) will arguably continue to result in small communities having water systems that are implemented and then fail in relatively short timespans. Lack of genuine community participation is exacerbated by lack of feedback between communities and INGOs. Lack of feedback to INGOs indicates a potential accountability problem, this is discussed further in section 8.13.3.

8.11 Sanitation and hygiene

The responses to survey questions in the pilot village showed that of those who answered the question about who they would discuss a broken water tap with, only one household indicated that they would fix it without discussion with anyone else. Almost the opposite was true for sanitation where only two of the respondents indicated that they would look for assistance in rehabilitating a toilet. Toilets are considered to be a private issue whereas the water system is considered to be a community issue. Toilets as a private issue is understandable as they are built on private land with private resources. This community had undergone the community led total sanitation process (CLTS) which aims to ensure that all members of a community use toilet facilities rather than defecating in the open. If toilet facilities are not being fixed due to lack of resources or interest, this could in fact affect the whole community by reintroducing pathogen contaminated faeces to the environment and thence into the food chain. Similarly the choice not to use hand washing facilities interferes with community hygiene. Both of these choices are demonstrated by residents in their comments on the survey:
About toilets:

“Yes sometimes it surprised me when the toilet is broken. When it is happening we go to the forest.”

“We don’t really like traditional toilet”

“I use my neighbour’s toilet because I am really old (60) now no-one helps me to build my own toilet”

About hand washing:

“Heard about that but we do not do it yet”

The more frequent response was

“Wash hands using a bucket”

This rather relaxed attitude to sanitation and hygiene points to the possibility that CLTS is not an entirely effective process or is not implemented in an entirely effective way. As CLTS is a process designed to encourage behaviour change, and behaviour change requires time and reinforcement, perhaps the relaxed attitude is an indicator of the need for ongoing reinforcement of the lessons of CLTS rather than its implementation as a “one off” triggering activity (Cairncross & Valdmanis 2006). GMFs have a committee position for promoting health and hygiene (PSF). The individuals whom I spoke to regarding this position seemed to consider promotion of new hygiene practices such as strategic hand washing to be a relatively simple case of telling people what to do. This understanding belies the difficulty of creating conditions for behaviour change and indicates again that attention paid to the training and information aspects of WASH may be at a superficial level or may simply not be effective for other reasons.

At the first meeting, which included a lunch that was served by the women, a big deal had been made of everyone using the hand wash station at the front of the house. The wash station was made from a 5L plastic vegetable oil container and a pen, sitting on a wooden platform at the front of the house. On my second visit to the community I noticed that this wash station had been removed. While this is a cheap and mobile technology, there are issues about its ease of use. The ‘tap’ is a fiddly little pen end. In section 3.2.2 it was mentioned that one litre of running water was required for best hand washing results. On this basis the container would need to be refilled at least six times a day for adequate family hygiene. I didn’t see houses with more than one hand wash station which means that they are not placed in the two most convenient locations, being outside the toilet and close to the kitchen. Kitchens tend to be well separated from toilets. If these are the only barriers to good hand hygiene then the solutions may be found in encouraging individuals to consider the most strategic positions for their hand wash stations and in investing in larger containers or mandis along with the provision of taps that could be fitted to the containers (Figure 68).
Given the coercion already mentioned around the use of CLTS in Timor-Leste, the building of the hand wash stations may be an example of ‘insincere mimicry’. Actions that are measured and incentivised by external agents are labelled by Krause (2013) as ‘insincere mimicry’ and their existence creates a gaming behaviour whereby the value of the incentive is calculated by the recipient in terms of a cost-benefit ratio. In this example, the value of the water system (incentive) would be higher than the cost of creating hand wash stations and toilets that may never be used. Even if this is the case then it is still possible that communities will adapt the technologies above to suit their environment as they come to understand the importance of changing behaviours around hand washing and if they are structurally supported to do so with household taps or large spigoted water containers.

8.12 Community Management of Water Systems

Efforts to identify the factors that drive longevity of water systems in rural communities in Timor-Leste have resulted in reports by NGOs and government agencies that have focussed on the concerns and issues around the management and maintenance of water systems by GMFs (Grumbley & Hamel 2010; WaterAid Australia 2010; Willetts 2012). Limitations to successful community water management in Africa have been identified by Harvey and Reed (2007). These limitations include a lack of long-term incentives for individuals to manage the supply of water, the emigration of skilled volunteers from the community, a lack of trust in the committee (usually related to a lack of transparent accounting), funding shortfalls for larger repairs and a lack of external support or communications for GMFs. These issues have all been identified within my observations in Timor-Leste as well.

In a significant review of rural WASH program outcomes in Timor-Leste, Willetts (2012) identified a set of virtuous and vicious cycles (reinforcing feedback loops) in community water management, as shown in Figure 69. The diagram includes trust and satisfaction (as willingness to pay), transparency of accounting, GMF management capacity (as fees spent and availability of parts and skills) and finally service levels.
Figure 69: Virtuous and vicious cycles in management of [rural] water systems.

Interpreting and adapting these cycles to standard system dynamics notation using the styles defined by Sterman (2000), and teasing apart multiple influences into single factors results in a new causal loop diagram which identifies more accurately the direction of causal influences within the feedback loop, as shown in Figure 70. Willetts’ use of the Virtuous and Vicious Cycle diagram (Figure 69) can be seen as a simplified descriptive tool as there are no assertions based upon the interpretation of it. However, redrafting of the virtuous and vicious cycles into an influence diagram gives a more nuanced understanding of cause and effect within even this simplified schema.

Figure 70: Causal Loop diagram of community water supply management and maintenance.
Willets indicates in Figure 69 that transparency of fee collection has an impact on disbursement of funds. Counter to this, in Figure 70 it is presumed that while transparency of accounting will impact on the willingness of community members to pay fees, it doesn’t have a direct impact on the disbursement of available funds, as these are disbursed based on the GMFs capacity to manage the operation and maintenance of the water system. Similarly, in Figure 69 the conduct of operations and maintenance (O&M) appears to be influenced by three contiguous factors – disbursement of funds which then affects availability of skilled technicians and availability of parts. Unpacking this further, Figure 70 makes it clear that while O&M is impacted by these factors, the availability of parts and skilled technicians are not directly affected by disbursement of funds. So while Willetts designation of vicious and virtuous cycles in community water management in Timor-Leste highlights an existing feedback loop, they are slightly inaccurate as an analysis tool for indicating possible points of intervention in the continued functioning of rural water supply systems. In the overall analysis, Willets covers much more scope but highlights the need for GMFs to develop greater capacity in all areas of water management.

The following section looks more deeply at the role of GMFs as perceived by communities, the government and NGOs. It also looks beyond the capacity of GMFs to manage water systems and focuses on the structural requirements of managing a common pool resource. Overall the indications are that while failure of water systems is often blamed on poor community management capacity it is likely that WASH programs are not structured sufficiently well to achieve the desired outcomes of robustness and community behaviour change.

8.12.1 GMFs

Village 1

‘System A’ has a female chefe GMF who has replaced her husband in this position. She is a school teacher and has married into a liurai family which is well respected in the area. Comments from this community about the GMF were positive. The water management regime ensures that water is available several times a day and allows the tanks to fill up in between. Water users indicated that they could and would fix minor pipe issues by themselves, so a small leak might be wrapped with an old rubber inner tube or some palm leaf (Figure 71). They would expect the GMF to fund and fix any more complicated or costly issues such as completely broken pipes that might require a new joint. This GMF has no written set of guidelines and every household indicated that they were happy with the cost and the service provided. The GMF is seen here as being quite separate to other village institutions such as the liurai and their justice/reconciliation activities.
Those households connected to ‘system B’ and hence under a different GMF seemed less happy. They had less access to water, needed to carry it uphill to their homes and were unable to install pour flush toilets due to lack of water. They were so unhappy with pit toilets that the pits were disused and back-filled. Women in this area indicated that they would only attend GMF meetings that were close to home as childcare responsibilities would make longer distances (I have no sense of how far) too difficult.

**Village 2**

The GMF in this village has been elected by the community and the water system is still being built. Costs per household have not yet been decided and the technicians are not trained. In response to questions about possible futures – broken pipes etc.- most residents indicated that they would revert to collecting water from the springs, only with further questioning did they consider that they might fix the problem or request that the GMF do so. While this community has had a water system in the past, only some members have benefitted from it and it isn’t clear who has maintained the system or whether it has simply been robust enough to not require maintenance. The existence of a functional water system prior to the current implementation indicates that there has been some experience within the community of piped water over a period of years rather than a “blank slate”. In most places that I visited or travelled through there was evidence of water pipes that were either being used, or which been used previously.

**Village 3**

Village 3 had no GMF and no current NGO relationships in WASH. This village has had two water system implementations in the past and the legacy of these
are one still functional but unprotected spring fed system and evidence of several individual pipe lines from small springs to households that have used scavenged parts of the other system. This community therefore has experience with water systems and has a nominated (voluntary) technician. Work on the functional system is done as needed and is not directed by a GMF. It appears that responsibility for broader community planning is taken on by the Chefe Aldeia and residents indicated that if money were required for repairs to the system they would provide what was asked.

Village 4

This village has two GMFs – one is based around supply to nine houses using a solar pump. The GMF collects funds and it has $152 but as yet has not needed to deal with any breakdowns. Upon questioning, it is apparent that the GMF/residents are not sure of who would fix the solar pumping system if it breaks down. The residents have no relationship with a pump mechanic and do no regular maintenance to the pump. I asked what they would do if the pump breaks, I was told that they would rely on the NGO who introduced me, to find a mechanic and perhaps to pay some of the cost of fixing the pump. The residents have no idea what costs for this sort of service might be, or if it available. It would seem that without support from an NGO or other agency this system is destined to run unmaintained until it stops. It is unlikely that the community will have the ability to fix either the pump or the solar power system, nor the knowledge and funds to be able to hire a technician for either of these. In Section 9.1.1 I discuss the potential usefulness of making checklists available to communities to assist their understanding of what to expect and how to request further assistance.

The other GMF is facing more immediate issues. The system was built with salvaged pipes and there is a lot of rust in the pipes, the joints are breaking and the intake has been flooded and no longer provides even the most basic of protections. The flow within the system is so low that one tank has been disconnected. Most water users have stopped paying fees to the GMF and the money that has been collected isn’t being used; as one resident mentioned, “The community doesn’t want the GMF to spend money to fix the tank because there is little water”.

In discussion with the Chefe GMF it appeared that the GMF wasn’t able to get the community to agree to spend money on fixing pipes and that the flooding of the intake had been beyond the ability of anyone in the community to fix. This was reported to the NGO who had initially provided materials for the system but no action had been taken to remediate the situation either through training or provision of materials. One resident indicated that they thought that the GMF should continue to conduct small fixes of the pipes despite the lack of available funding to improve the system overall.

Staff at the NGO appeared to blame the village for lack of maintenance to the system, while residents were concerned that staff from the NGO hadn’t been to observe the flooded intake and seemed to be unaware of the problems caused
by the use of salvaged pipes.

Village 5

The views expressed about the GMF in this village were quite varied. No one was inclined to pay water user fees and many claimed to have little or no access to water through the NGO implemented system. Many households were located near springs and quite a few had wells. There was a sense in the overall responses that the GMF should have been responsible for ensuring that the water was equitably distributed through the system but that they were not capable of doing this.

Village 5 was located along the length of the water system (~3km) making it difficult for anyone to know when and where problems occurred.

To explain this further Figure 72 shows a model of four homes (A, B, C, and D) attached to a water system that runs from left to right. Potential issues are identified at points X and Z. Using this diagram to consider which household are affected and how a problem might be identified and remedied if it was located at points X or Z, it can be seen that if a problem occurs at point Z the only household affected is household D.

![Figure 72: Model of a linear water system](image)

If a problem occurs at X then all households are affected. In both of these cases it is not obvious to household D where the problem is. If they are not in communication with household C or B or A then they do not know whether or not they too are affected by whatever the problem is. For D to work this out they would need to walk along the pipes until they discover the cause of the problem. If the problem is at point Z then they will quickly discover and remedy the issue. However if the problem occurs at point X then every household could be inclined to look for the cause of the problem when only household A would actually need to do so.

Effectively there was no way for someone at the bottom of the system (House D) to know if a problem with the water flow was due to an issue that was between them and the next house or if it was a problem at the spring end of the system that the households at that end were likely to fix (or cause). So
resolution of a problem may require a short walk and repair, may require a “do nothing” approach as someone further up would have the same problem and go out to fix it.

Communication along the line would be useful in this case. In an affluent society it could be expected that a couple of phone calls would be sufficient to determine where the problem is located and to agree on someone to remediate it. In Timor-Leste, with much of the rural population living on less than $1 a day, making several phone calls at ~10c per minute (based on tariffs quoted at http://timortelecom.tl ) requires the sacrifice of a significant part of a household’s income. So adopting a ‘wait and see’ approach, or a time consuming walk are both logical ways to respond to a lack of water flow.

From these case studies it appears that communities don’t necessarily expect GMFs to conduct all repairs, and are often quite happy to make small repairs for themselves. It seems to be expected that larger repairs that will incur some cost, such as replacing taps, will be the responsibility of the GMF or of an NGO. Communities definitely expect GMFs to be transparent about the collection and use of fees. In many communities residents showed me their collection books with payments signed off each month (Figure 73).

![Figure 73: GMF water fees receipt book. This resident paid one years’ fees as a lump sum.](image)

Residents of communities are quite capable of making repairs to water systems. However, many are reluctant to spend money on the repairs or to have the GMF spend money for repairs. Therefore the fixes that occur are more in the nature of ensuring that there is a flow of water rather than ensuring that tanks fill and taps are functional. This is perhaps reflective of the need for everyday frugality
and a prioritisation of water flow over ‘ideal’ functionality.

8.12.2 Official role of GMFs

As indicated in section 3.3.2 the Government of Timor-Leste has published guidelines regarding the role of GMFs in managing and maintaining small water systems (GoTL 2010b). The following discussion does not cover the whole list of responsibilities but attempts to make explicit some of the issues arising from the given set expectations.

Maintenance

Maintaining a water system requires access to tools and hardware, time and knowledge. While regular ongoing maintenance may seem easy to explain or teach it should be noted that international and local development workers and volunteers are not necessarily equipped with a range of adult learning strategies appropriate to the context.

Acquiring hardware is also problematic as shops are often long distances away and communities are reluctant to spend money to send the right person (i.e. the person who knows what to purchase and is trusted with community funds) in a timely fashion. It is also possible that GMFs are not aware of where to go to find hardware. I discovered in conversation with Adia that most people in Timor-Leste only go to places that they have been to before, so finding a strange shop in a town or city could be quite daunting. There is no formal postal service to rural areas in Timor-Leste, so utilising the telephone network to have the appropriate parts delivered to the village is also not possible.

Funding

Rural Timorese are already worse off financially than their city counterparts. The majority of rural residents are living on less than US$1 a day (Santos & Florindo 2013). The gap between city and country is exacerbated by the requirement for rural residents to build and subsequently pay for the maintenance of a water system. Residents of Dili are not currently required to pay for their water. It has been shown by Seery (2014) that charging for public services increases existing inequality as a result of differences in the percentage of income demanded. The most vulnerable rural residents are therefore doubly disadvantaged through the same mechanism.

When funds are collected by the GMF there is little access to banking services, and little guidance available on the best way to use the funds to maintain the system. In light of the previous discussion regarding the expectations that residents have of the way that funds will be used this can create significant tension within communities.

Monitoring use of facilities and resolving conflicts

These two points acknowledge that communities need an agreed set of rules and sanctions regarding the use of water systems, but the GMF is often constituted of residents who don’t hold either traditional or elected posts of
influence, and therefore lack the authority to call meetings or to sanction those who are contravening the rules. This situation may be made even more untenable if the contravention is committed by a resident who does have significant power in the community.

**Linking with other GMFs**

It is possible for members of GMFs to link with other GMFs but in the absence of any kind of contact list, it relies on there being a personal connection between members of GMFs in different villages, or some kind of higher level organisation that will bring members of various GMFs together with a purpose of exchanging information, training, or celebrating successes. One organisation of this type has been initiated by an INGO but requires ongoing inputs of funding and training and is currently not self-sustaining. The existing organisation currently responds to information from the boundary rider in regard to failing water systems. There is no apparent plans for a sustainable funding or membership model that could be applied to ensure a professionalised and ongoing support mechanism for GMFs.

**Promoting good hygiene and sanitation**

While water systems are seen as a community wide service, the implementation of toilets and hand washing is at a household level. From my observations it is unlikely that even village leaders such as the *liurai* or the *Chefe Aldeia* have the ability or power to effect change in this area. Implementing sanitation by way of pit toilets is commonly a prerequisite for the implementation of water systems in rural communities. My observations show that the pit toilet and the hand washing stations that go with them are often left unused after a water system has been implemented. On four of the GMFs that I observed the positions that are allocated to women are the positions that work to encourage hygiene practises such as hand washing with soap. In a culture with a significant gender equity gap this may be an indication that hygiene and sanitation are taken less seriously than water supply.

**Liaising with district and sub-district governance and services**

The constitution of GMFs, as noted above, doesn’t always lend itself to incorporation with aspects of governance across the district. The distances and cost of transport or cost of phone calls, make contact with authorities prohibitively expensive for people who are struggling to survive by subsistence farming and the meagre amounts of cash gained through primary agriculture. Governance structures at the district and sub-district levels are also still under construction, leading to a lack of clarity of roles and responsibilities.

### 8.12.3 Common pool resources

Ostrom et al. (1999) defines common pool resources as those where it is difficult to exclude users, and where use of the resource will reduce its availability to other users. Community managed water systems, especially those with communal taps, clearly fit this definition. Communities cannot exclude
members from using water and the use of water by one individual or family impacts on the availability of water for others. This was demonstrated in the Village 5 case study, where water use for gardening created significant access problems for downstream users.

The following discussion looks at the eight design principles put forward by Ostrom (2008) in the context of the data collected in this research with the aim to observe where current practice is coherent with these principles and where it is not. For some of these principles, suggestions for practices that concur with the principle will be made.

**Clearly Defined Boundaries**

The boundaries of the resource system (e.g., irrigation system or fishery) and the individuals or households with rights to harvest resource units are clearly defined.

The ‘resource system’ for this purpose is defined as the spring, spring protection, pipes, tanks, taps, tools and water. In each of the villages observed this was quite straightforward. The households that have the right to access the water system directly after its implementation is also reasonably straightforward as the users are defined as those that the community recognises as beneficiaries, for the most part these are the same households who will have participated in the implementation of the water system through the CAP, CLTS and building processes. Over the lifetime of a water system though, the rights of new residents is less clear. Extending the system to new users is not covered by the GoTL Rural Water Supply Guidelines (GoTL 2010b). Compounding this lack of direction is the need to understand how many households can be adequately provided for from the system as one informant indicated that it was “possible that water installations attract migration to an area, especially in combination with arable land”. GMFs therefore have a responsibility to define the users and the amount of water that users should be able to access. In order to manage the number of users and the quantity of water available to each user, GMFs need information about the capacity and the limitations of the system and the viability of expanding the system over time for increased water usage by residents or increased population (Neely In Press-b).

**Proportional Equivalence between Benefits and Costs**

Rules specifying the amount of resource products that a user is allocated are related to local conditions and to rules requiring labour, materials, and/or money inputs.

There are clear benefits and costs for users of community managed water supplies. The benefits of water supply ideally include having a reliable source of clean water provided close to home. This is compared with the need to walk long distances to collect water from seasonal sources such as springs, creeks and ponds. The costs of water supply include the provision of local resources and labour in the building phase and then the voluntary work of the GMF in the operation and maintenance phase. On top of this, users are generally required
to pay regular fees to the GMF. The user fees in Villages 1, 2, 4 and 5 were set at 25c per month per household. This 25c is not reflective of service levels nor of the maintenance costs of water systems, nor is it chosen by residents as a fair or reasonable cost for water supply. In terms of service levels, residents of Village 1 who had to walk 10 mins downhill to collect water were paying the same fees as residents who could use a hose to fill a tank in their yard and who could therefore also access significantly more water than those who had to carry their water. NGO staff, when asked about maintenance costs over time, were unable to make estimates of the durability or the replacement costs of parts, so the user fees are not directly related to maintenance needs. Residents in Village 4 indicated that the NGO suggested the amount of 25c and they simply agreed. One man in Village 1 indicated that he could and would pay more if it was required. On checking this sentiment with others it seemed that those who had a reliable water supply would be happy to pay more. Those residents whose water supply was not reliable, particularly in Villages 4 and 5, had stopped paying user fees altogether.

On this basis the costs and benefits of water supply are neither “proportionally equivalent” nor equitably distributed, with some users gaining much greater benefit for the same costs. Creating added benefit or value of the water system would require higher service levels to be implemented. This could be done by ensuring that all users have water points that are close to their house and provide plentiful water for household hygiene and sanitation. In some cases this will require pumps or incur other extra costs to create a proportional benefit.

Collective-Choice Arrangements

Most individuals affected by harvesting and protection rules are included in the group who can modify these rules.

The GMF that manages a water system for the users is defined by the Rural Water Supply Guidelines in such a way as to ensure representation of the whole community including a specified ratio of female members (GoTL 2010b). My observations indicated that women tend not to be included in village level business. In the pilot village for example, the first meeting was comprised of men, with women providing food and drinks and sitting separately, out of sight but within hearing distance. The only time a woman was willing to talk with me was when the men were all distracted by drawing a map. In contrast to this, in Village 1 the Chefe GMF was a woman who was a school teacher and had married into a liurai (traditional leadership) family. So women are able to take up leadership positions, but this was the exception, mostly women in the GMFs were in the position of hygiene and sanitation promotor. Women are probably not fully included in decision making within the GMFs but NGOs are already working to incorporate and model gender inclusiveness in order to overcome this barrier.

In a discussion of challenges and successes in the management of common pool resources Ostrom et al. state that “Users need some autonomy to make and enforce their own rules” (Ostrom et al. 1999, p. 280). The Rural Water
Supply Guidelines (GoTL 2010b) indicate that GMFs are responsible for the setting of rules and while they and the implementing NGO provide guidance, it is difficult to know where the balance lies between providing too much or too little external direction. On one hand it seems wrong to assume that GMFs have the capacity and propensity to manage a water system without assistance (Ara 2013) and on the other hand too much assistance can be seen as indoctrination into the development paradigm which can itself create ‘locked-in’ type thinking (Pogodda 2014) and therefore stymie innovation and local solutions.

Given the issues around the need for communities to choose or create their own guidelines perhaps the best way forward is to present a number of management models to communities that they can choose from and adapt as they wish, within the existing legal frameworks. It should also be clear that there is flexibility to change management models with the changing realities of community life (Neely In Press-b).

**Monitoring**

Monitors, who actively audit biophysical conditions and user behaviour, are at least partially accountable to the users and/or are the users themselves.

Water systems implemented in the villages that I visited were used by whole communities but were not designed in a way that would make them easy to monitor by either the GMF or by other community members. In Villages 2, 3 and 4 the tanks with taps were located in very public areas and so it was possible that water collection could be observed by the general community. In the pilot Village hoses were used to deliver water directly to households but this led to arguments amongst the community when there was not enough water available for all residents. In Village 4 and 5, water use was not always visible by the rest of the community, one resident of Village 5 indicated that she had collected as much water as she could store from a nearby tap early in the morning when she wouldn’t be seen. So user behaviour is difficult to monitor.

The status of the water system is also difficult to monitor as tanks are concrete and have no water level indicators while springs may be more than one kilometre away from the village and therefore the pipes that deliver water to the tanks are also not generally visible. Two kinds of problem arise when tanks lack water level indicators. The first problem is that the community is unable to see when a malfunction has occurred that would stop the flow of water through the system. As I observed in Village 3, once the tank is empty the main issue for residents is to collect water from an alternative source and fixing the malfunction is secondary to this. Given that the analysis in section 8.4.1 show that villages have between one and three days water storage, an early warning system could see problems fixed before water becomes scarce. In this way water systems could become reliable in a way that is not currently the case.

The other problem is that in a wet/dry seasonal climate, water flows tend to be lower at the end of the dry season and there may be a need to adjust the amount of water that each person collects in line with reduced environmental flows. If these changes in flow rates are not evident, then individual or
community level adjustments are unlikely to be made. As indicated in the
discussion in section 3.3.4 individuals will adjust their use based on knowledge
of environmental flows or based on ‘what everyone else is doing’ type social
norms (Brucks & Mosler 2011).

A clear visual indicator of the status of the water supply would be coherent with
Ostrom et al’s (1999) guidance for understanding resource status in order to
appropriately manage common pool resources. The difference between the
current situation and a situation with water level indicator is illustrated in Figure
74.

Figure 74: Almost empty water tank in village 3 (above)
The same water tank with the author’s representation of a visual water level indicator (below).
Source: Neely (In Press-b)
As discussed in (Neely In Press-b) locally available materials can be used to manufacture a water level indicator like the one shown in Figure 74 and Figure 75. Oil bottles are common in the villages as are small lengths of bamboo or hose. The cord would need to be acquired from a local town. The indicator could be made from woven palm with a weight.

Figure 75: How a simple water level indicator would work.
Source: adapted from Neely (In Press-b)

A retrofitted water level indicator as shown in Figure 75 does have some potential to allow the introduction of foreign materials or access to small insects and space for the growth of biofilms, any of which could be detrimental to water quality. However, many of the tanks that I observed were either kept open or were regularly opened (involving lifting a heavy concrete block) in order to monitor water levels or to access low water using a bucket – both of these practise involve at least the same risk to water supply as the method indicated above. The consistent disinfection of water, noted previously, also makes the introduction of some contaminants via a retrofitted indicator a less worrisome prospect.

The final four design principles (Ostrom 2008) deal with legal rights and conflict resolution. Information in regard to this was not sought during case study research. There is legislation regarding community managed water systems - Decree-Law No. 4/2004 (GoTL 2010b) – which indicates that ‘traditional
modalities’ should be applied in the case of disputes. Traditional conflict resolution mechanisms were described briefly by the Chefe GMF in Village 1 as consisting of a meeting of the local liurai (heads of sacred houses). Further research into the connection between GMFs, traditional conflict resolution and legal apparatus in Timor-Leste would be of use in assessing the applicability of the final design principles.

8.12.4 Supporting GMFs

“The notion that once built, systems can be simply handed over to communities, and that the systems will continue to function more or less indefinitely, is now well and truly debunked.” (Lockwood & Smits 2011, p. 103)

The role of the boundary rider from the perspective of the NGO is clearly to assist communities to maintain their water systems and to help them gain the skills and knowledge to continue to do so, for several years after water system implementation. It is less clear whether boundary riders have the skills and the organisational influence that are required to act as a trouble-shooter when technology or management systems in communities break down. In casual conversation with boundary riders and communities it became apparent that even when a boundary rider was aware that there was an issue, they weren’t consistently able to assist with solutions. What was not clear was the cause of this inability, it may have been a lack of skills, lack of time, or lack of institutional influence to direct resources.

Given that a boundary rider skilled in community development techniques may be able to see broader patterns of strengths in community water management, this position could be significant in knowledge transfer between communities. My interaction with boundary riders was not enough to understand how well this position is applied in regard to either community development techniques or in a technical support sense. The benefits of better water disinfection regimes and more transparent banking, which are attributed to this position in other countries (Kayser et al. 2014), do not apply in Timor-Leste as boiling of water is already broadly used for drinking water and banking services are only just starting to be available in larger rural towns.

Ongoing support for GMFs seems to fall to boundary riders, SDFs and the federation of GMFs none of whom appear to have clear responsibility and adequate resources to enable them to fully support GMF operations. It has been shown elsewhere that support through country level government agencies is more effective than local government or CSO support (Smits, Rojas & Tamayo 2013). In addition to the institutional capacity of support organisations, Smits, Rojas and Tamayo (2013) indicate that a frequency of support visits of every 4-6 weeks seem to create the best conditions for water service providers to maintain a reliable service.

The evidence presented in this section points to the need for GMFs to be established, trained and supported in ways that are more consistent with a
systems thinking outlook. This would require more flexibility for local solutions to emerge while ensuring that support is ongoing and adequate with a responsive and pro-active (preferably government based) support structure. Managing a common pool resource is different to managing a private resource and some of the issues that currently plague community managed water systems may be avoided through explicit application of common pool management principles.

8.13 NGOs Working in Timor-Leste

8.13.1 Social Networks of WASH Practitioners

The social network analysis in section 8.1 showed a highly connected clique of INGO and government staff in Dili with little connection to sub-district actors. Lack of inclusion of these actors has two impacts, firstly it reduces the ability for feedback from communities to reach decision makers such as heads of INGO WASH programs. Secondly it reduces the ability of the staff who implement and maintain WASH programs to have learning experiences that involve them in 'social learning' where peers are able to scaffold each other and work through issues of importance together.

The WASH INGO network within Timor-Leste is highly connected – NGOs, BESIK and the GoTL connect through the WASH Forum and the Sanitation Working Group, as well as a lot of direct connections with each other that include the expatriate social network and staff movement between organisations.

Problematically for the sector there appears to be very little connection between these decision makers and villages where systems are implemented. This connection is mainly left to individuals in very specific positions; local NGOs implementing WASH projects and the GoTL subdistrict facilitators (SDF) and INGO community development officers (CDO) who are less able to access the NGO WASH networks based in Dili as demonstrated above.

SDFs have a heavy communication and work load and very little by way of resources and support to connect and advise multiple villages in a sub-district as well as coordinating projects by local government and whichever NGOs are working in the area. One informant stated that

“SDFs are not technical so if there’s a tech problem then the government need to find a service provider, either SAS themselves or a local contractor”

while another informant indicated that SDFs have no computers and receive no travel allowance and often have to make do with sub-standard transport. Yet another informant indicated the SDFs were likely to be more effective if their family are important locally as part of the hereditary liurai. This informant gave some examples:
The SDFs, some of them don’t seem to have a lot of influence or a lot of confidence and I’m wondering whether which family and where they are from in the sub-district makes a difference. But the guy who is the SDF in [sub-district], in [suco A] and there was an argument in [suco B] and the water source was in [suco A], and someone was making life difficult and he said “I'll go and talk to him” and he had the family connection. Then we heard another story a couple of years ago about a Sub-district administrator and an old guy wouldn’t let them use a water source and so he went to him as the SDA and he said “No” and he went to him as “community” [and he said “no”] but when he went as a family member he was like “yeah, you can use the water”. So I think the SDFs, if we are looking at factors in their effectiveness, then the status of their family in the sub district matters. And actually [name] in [sub-district], he’s a young guy with heaps of confidence and all that and it would be really interesting to know where that comes from. And there was another guy who was scared of everyone, and the Chefe Suco has a lot of status, so if an SDF is monitoring what a Chefe Suco is doing, then if the Chefe Suco is not doing the right thing, then there’s not much the SDF can do because he doesn’t have the power.

Local NGO staff tend to be better resourced but are constrained in their interaction with villages by productivity and reporting requirements which are devolved to them through several levels of donor and NGO governance/bureaucracy.

The issue here is summed up by Knox, Levick and Woog (2007) who suggest that the person who forms the weak ties between network cliques needs to be capable of meaningful action within both networks. The people who form the ties between the INGO WASH network in Dili and the network of village residents are local NGO staff, SDFs and CDOs. It appears that while these positions can make meaningful contributions within villages they may not be able to make such a meaningful contribution within the Dili based INGO WASH network. The disconnect that is indicated here is revisited in sections 8.13.3 and 9.1.3 as part of a discussion on feedback and accountability between INGOs and communities.

Social Network Analysis takes a ‘snapshot in time’ of the networks being investigated. It is important to remember that the these networks are dynamic – the NGO sector in Timor-Leste sees rapid turnover of expatriate staff, along with changes to funding, and changes to work practises. This means that ego (individual) networks may change over a short period of time as new people interact through training opportunities, consultancies and employment transiency. One example of this is that an individual who had been identified as an Australian based consultant early in the process of SNA, is now employed in a key position in Timor-Leste, replacing a previously interviewed participant and
hence the significance of her professional networks have changed in relevance over the period between 2012 and 2014.

8.13.2 Participatory practices

NGOs use participatory practices including community action planning (CAP) and community water management groups (GMFs). Interviews revealed that participatory practise may be subordinate to the objectives of the development agency or donors. The following comments from interviews highlight this:

An INGO local staff member responding to the question of what would happen during the community action planning process if the community doesn’t identify access to water and sanitation as primary development objectives:

“Sometimes the first time we go to a community they ask, “can we have electricity, can we have good roads, because we can go to the river to collect water everyday” or something like that so [I say] “OK what relation is electricity for our health, if you will feel sick, the kids will get diarrhoea without the electricity, and is it because of the roads the kids will feel the impact of malaria? And what do you use to clean your body, is it electricity or roads or is it with water?” and they say “OK maybe first we have this maybe after we can have everything else” We [the NGO] can’t say “no you should have…” then you can’t get the answer, but just showing how to make decisions and how the community decides for itself.”

This indicates that while the objective of participatory practise is the empowerment of the community to take control of its own development, the reality is that once a community has been identified as “needing” a WASH intervention the community will be encouraged to get on board with the idea. Further interviews indicate that short of an actual refusal to engage with the NGO, the community will be coerced into participating in the way that the NGO feels is appropriate.

A Chefe Aldeia, when asked about the process of getting a water system implemented:

Interviewer:  
**Was this something you really wanted for the Aldeia?**

Chefe Aldeia:  
**Because the community was a long way from water, I went to the Chefe Suco who took it to a community meeting with [local NGO and sub-district facilitator] who went to [the INGO].**

Interviewer:  
**How long afterwards did it take to happen?**

Chefe Aldeia:  
**First we had to work on sanitation and then we got a water system**
Interviewer: *Was this good/fair?*

Chefe Aldeia: *Yes because this was our only choice.*

This example indicates that coercion is further used to ensure that toilets are built before water systems are provided. In other villages there were several community members unhappy that they had been coerced into digging pit toilets when their own objective was to install a pour-flush toilet. At the time of the research the pit toilets had been filled in and water taps were not close enough to their household to make a pour-flush toilet viable. Having said that, there was also evidence in other villages that access to water was not the limiting factor in the decision to build a pour-flush toilet. In one village the Chefe Aldeia requested that I ask people about their toilets purely so that he could then remind them that they should build a toilet. In this village, even where it was possible for water to be piped to household mandis, toilets were not seen as a priority.

![Figure 76: Community building of a water tank as participatory development](image)

These excerpts highlight the tension the NGOs have between the use of genuine participatory practices and the need to reach objective goals as set by donors. Mansuri and Rao (2004) have also noted that the incentives of project implementers may result in outcome driven activities rather than focussing on encouragement for community participation. It could be expected that single focus NGOs would have a more significant problem with responding to community directed development requests than multi-sectoral INGOs. However, this interview with a staff member in a multi-sectoral NGO indicates that they face similar issues due to program structures:

"Ideally we would always, each project would be working together, but sometimes because of the nature of the sector, yeah we work in silos."
And when asked about collaboration between program areas:

“To be honest this is a headache. This is the main topic for discussion internally, because even in this office we have several technical specialists like me… it is so hard because we work in the same suco for example and the livelihoods project they have their own farmers group, they have their own community groups and programs and trainings and in the same suco as well, WASH we have our own groups. So nowadays we realise that it is not good to always create a new group while the number of the population is not that big, but still in some discussions we also find that working with different groups it is sometimes good, because if we keep working with the same groups then sometimes the same people will always get the advantage and the other community members they don’t profit, but sometimes… it’s a dilemma, this is why I said it’s a headache. As much as possible we always use the same group, for the timebeing.”

While participatory practices are generally seen as an ethical and beneficial way to work with communities (Chambers 2008a) both Shepherd (2009) and McGregor (2007) indicate that participatory practices by the development community in Timor-Leste are limited to inviting communities to implement or receive projects rather than to control or design them (Figure 76). This is supported by my observations across the villages visited where residents were aware of the shortcomings of the systems implemented but felt that they weren’t in a position to request additional resources, changes in the implementation or to customise the system for themselves.

The perception of international development as a measureable activity, tends to subvert participatory development to something that is more a manipulated agreement by communities to work with what is offered. Communities cannot assert a right for their needs to be met in the fashion that they determine. A significant difference between community-NGO relationships and community-state relationships is found in the ability of communities to assert their rights with the state, in ways that are not possible with NGOs. Similarly, Ellis cites Tembo (2003) to illustrate the assertion that:

“while development NGOs may believe that they are participatory and empowering and doing what the poor want and need, the reality can be much more organisationally driven. NGO programs can end up as a pale reflection of the state; but possibly without the checks and balances (such as they are) of even a recipient country government’s systems” (Ellis 2010).

Mapping

My second visit to the pilot village was with a small group of university students who worked in pairs to conduct a survey at all of the houses in the village. One
part of the survey was to identify the household on a copy of the map drawn by community participants during the first meeting. It came as a surprise that each of the student groups returned with the same issue regarding maps – almost no-one who was surveyed was able to identify their house on the map, indicating that many residents are unable to read the maps produced in the process of implementing water systems. Similar issues were encountered in other villages as well, indicating that the use of maps in participatory planning processes may be less participatory than the NGOs currently believe. Chambers (2006) gives many examples of the use of participatory mapping but also notes that “Most local people, asked if they can make a map, say no.” Chambers believes that this is not the case and that in fact most “local people” have the ability to make maps, although they may be different to what the development industry is either accustomed to, or finds useful. From my experience with maps in the villages that I visited, it appears that there is a generally held assumption that residents are capable of drawing and understanding maps in the style preferred by the NGOs. While there may be a locally relevant way to make maps, the process that I observed preferreded young literate males who had been exposed to NGO methods, and this was the style of map that was replicated to answer my questions. The NGO style maps were not concerned with who lived in particular places. When I asked for names to put with households shown on the map, in each case there ensued a lot of discussion and some changes to the map as actual residents or heads of households were identified. Given the difficulty that the general population has with reading and understanding maps that have geographic and architectural features but no identifying names for households, I believe that there is scope to improve the mapping process via the use of names or even photographs of the residents during the CAP process. Identifying particular houses by their residents would ensure that it is clear to them at this point where the taps are to be placed in relation to their households or families.

8.13.3 Accountability

In a completely practical sense, there is no way that a subsistence agriculture community living in a remote area of Timor-Leste can hold accountable the NGO who implemented their water system. The only way that it is even remotely possible is that a boundary rider or SDF might listen to their issues, understand them and act to alleviate the situation. These communities are constrained in their ability to hold NGOs accountable for failure by the very nature of the poverty that makes the need for NGO support valid in the first place. If technical work or materials are shoddy, if participation and decision making are coerced rather than genuine or if GMFs do not have the required skills to manage and maintain a water system then the system is likely to fail. Oddly when a water system fails to meet community needs, my observation has been that NGOs seem to blame the community and tend to resist giving assistance with repair, redesign or upgrading of the water system.

As part of a complex adaptive system, accountability to the residents where water systems are implemented would involve NGOs being easy to contact, responsive to problems and clear about responsibility but willing to help with
issues that arise. It would involve NGOs in being part of a networked governance structure (Jones 2011) that is responsive to change and able to adapt to differing contexts and emergent structures. The interdependence of communities, government and NGOs means that NGOs need to remain accountable, not for a set period of time, but until the structures that would make them redundant have emerged. Recognising that accountability is/should be an indefinite responsibility may require WASH programs to be structured differently to work with the uncertainty that arises in any CAS.

NGOs working in WASH and water services are expected to deliver on the program outcomes that donors contract them for. Generally they also try to work with communities in a participative fashion. There is a distinct tension in these two aims as facilitating genuine community participation takes time and expertise that is often unavailable within the local NGOs who implement water systems, while outcomes based implementation drives the building of infrastructure in preference to the building of community capacity. With little accountability to communities, and an enthusiasm for influencing governments through advocacy, it is unsurprising that NGOs ‘pick the low hanging fruit’. Evidence of ‘success’ is necessary to prove the worth of their development models to the governments who fund them and those who host them.
9 Discussion

Looking at WASH in development through the lens of complex adaptive systems theory has involved collecting information about the professional networks of NGO staff and government actors as well as relationships that exist in small villages. It has also involved observing and discussing the lived experiences of residents of small villages in Timor-Leste. The following discussion looks at questions of community management and participation in WASH programs, NGO practises, drivers of development and the way that these areas come together as a complex adaptive system that works for or against the robustness of water systems in development environments.

9.1 Locating the findings within a Complex Adaptive Systems Framework

Reiterating the list of points used to describe a CAS in Chapter 4 we are reminded that:

- **Agents** are a heterogeneous group of individuals
- Each agent acts within its own *freedom* to make decisions, *interact* and *adapt* to its environment
- The actions of the agents result in the *emergence* of new *levels of organisation*
- Understanding CAS means looking at their *different levels*
- Each level of organisation responds to *feedback processes* that act to reduce change or exacerbate it.
- Change drives the process of *co-evolution*
- CAS are capable of *responding*
- CAS are very *sensitive to initial conditions*
- CAS resist change (are resilient).
- CAS are constrained by Basins of Attraction and Phase Space

As a quite novel set of conceptions around the practical aspects of development interventions, these are not ideas that are in mainstream development use for planning, design or evaluation of WASH interventions. However, systems approaches to evaluation are gaining traction, as evidenced by the IDS bulletin ‘Towards Systemic Approaches to Evaluation and Management’ (IDS 2015). The following section applies the data and observations gathered in this research and evaluates the ways in which interventions could be understood within the different aspects of CAS theory identified above.

9.1.1 Freedoms

In Chapter 6 the convergence of freedom, development, diversity and choice were explained. Given that choice and agency are an integral part of development, the processes of development should not involve coercion or
force. If development processes do require coercion or force then individual or collective freedom is reduced. Even beneficial outcomes created under these conditions are unlikely to be maintained without continued coercion. As an example of this, in Village 1, a man who had been coerced into digging a pit toilet as a requirement for having the water system implemented had simply filled it in and left the walls to fall down. Coercion didn’t create the desired behaviour change (sanitary defecation as opposed to open defecation) and left a ‘participant’ quite disgruntled at having to do work that he saw no good reason for. His displeasure was based on wanting a pour-flush toilet, being coerced into building a pit toilet, then not being able to upgrade to a pour-flush toilet because the new water source was not close enough to provide plentiful water.

The processes and the outcomes of WASH implementations can enhance the freedoms of residents and communities in multiple ways. Firstly, by reducing the time spent in water collection activities, which allows individuals time for other activities. Secondly, the process can also enhance freedoms (emancipation) for women as they participate in community forums, see women from NGOs having equal status with their male colleagues and become part of formal management structures (GMFs). Thirdly, freedom from poor health is enhanced by a having a source of water close enough to make hand washing a frequent activity, thereby increasing hygiene in families and communities. Lastly, nutrition and economic freedom can also be enhanced where water supply is plentiful enough for kitchen gardens to be instigated in communities.

If WASH programs are designed and implemented with little participation from the community then there is the possibility that freedoms will be reduced. If communities or individuals are not encouraged to identify their own needs or desires and have a genuine opportunity to direct the use of resources -including their own money and labour- then their freedom is reduced. The agency of ‘recipients’ is diminished when they don’t have the freedom to refuse, to decide to do it differently or to request more resources or support.

Managing WASH programs for greater freedom and diversity would require NGOs to provide more information and options for communities and individuals to tailor water systems and hygiene practices to suit their own situations. This may include (but is not limited to) choice of materials, choice of tap locations, choice of service levels, choice of costs and choice of sanitation technologies. Providing a broad scope for WASH services to be tailored to communities may require additional initial funding and more training for implementation staff, but is likely to create higher satisfaction levels and more robust water services.

One proposed method to enable communities to make decisions and understand their options is the provision of ‘checklist’ for communities to discuss and make choices before engaging with WASH implementation (see Appendix F). While a checklist seems to be antithetical to applying a CAS framework, it can at least delineate the boundaries of what is offered by a WASH implementation agency. The provision of a checklist puts some power over the process back into the hands of the community by ensuring that there is an exchange of information and that communities are faced with real choices about
what is offered, and what is possible, under different circumstances of context and engagement.

Placing the above factors within the framework outlined in Chapter 6, Figure 77 highlights the need to be aware of the use of power within WASH programs. If power is used to coerce or force compliance the counter-productive effects of this have the potential outweigh the positive effects created in the areas of health and nutrition.

![Figure 77 Sub-factors affecting freedom in WASH programs](image)

9.1.2 Emergence

Creating conditions that encourage the emergence of locally relevant development programs is an important aspect of development as a tool for empowerment. Locally relevant development can be achieved through recognition and support for diverse community voices, groups and livelihood strategies. Within WASH programs the techniques used by NGOs to implement rural water supply can either support or undermine emergence within communities.

It is possible for WASH programs to support emergence of locally appropriate development by providing overt knowledge and skills in areas of science, engineering, health and management. The process of WASH implementation also provides demonstrations of the language and methods of development; these may be used by communities in future interactions. WASH programs often support the voices of women and other marginalised groups through the modelling of inclusive interactions within the NGO and within the community. This was demonstrated in regard to gender by one informant while discussing an engineer who is female:

“..especially we see that it’s a really positive thing now that some of them [NGOs] have women as not just their hygiene person but their technical person, and one of the mothers
actually said “you know that’s changed the dreams I have for my daughter” ”

And the engineer herself:

“…and I see not many women engineers and not really enough and we’re really talking about gender (like its 2012!) but we’re still talking about the gender and everything. It feels like my work is not really engineer but social engineer.”

The above example illustrates the potential impact of modelling different social norms within NGOs. Therefore, as the voices of the marginalised are attended to by NGOs, there is an increase in the possibility for patterns of interaction to change and lead to the emergence of new social norms that prioritize women, children and vulnerable members of a community.

WASH programs have the potential to undermine emergence if they are too prescriptive (Neely in press-a). Using a “one size fits all” approach to design and implementation of WASH systems could unduly limit the options that each community has to develop a system with a level of service that the community is capable of supporting. Socially, the same issue applies to the formation of a GMF and the rules that are suggested to the community. By not clarifying that communities can change the management of their water systems, NGOs construct a false sense of the permanence of the GMF structure and leadership as well as the rules of the water system, including fees payable. Over-engineering or over-planning can lead to the ‘titanic effect’ as discussed in section 8.2.

Maintenance of water systems can be premised on local emergence, providing knowledge and information and allowing time for communities to self-organise, consider their options and create their own structures. On the basis that emergence and self-organisation in complex adaptive systems can arise from a small number of simple rules/norms – as demonstrated by agent based modelling (Macal & North 2010) - then nudging a community in the direction of maintaining a water system could be achieved by providing a small extrinsic reward based on the idea that communities will ‘collaborate to compete’. Census benchmarking has started this in Timor-Leste by making available information regarding the status of different suco’s through individual reports and workshops comparing education, water, sanitation, agriculture, housing and poverty levels (GoTL 2010a). Bar-Yam (2004) and Wilkinson and Young (2002) indicate that competition and collaboration occur at different levels and that both are necessary for individual and group ‘survival’ in complex adaptive systems. Given the previous narrative evidence that individuals or families both compete for and collaborate to gain access to water, there is scope to use this to create incentives. Bar-Yam gives an analogy of sports teams

“Teams will improve naturally – in any organization – when they are involved in a competition that is structured to select those teams that are better at cooperation. Winners of a
competition become successful models of behaviour for less successful teams, who emulate their success by learning their strategies and by selecting and trading team members.” (Bar-Yam 2004, p. 83)

If this concept is extended to community groups then encouraging communities to maintain their water systems in order to compete regularly with nearby communities for an appropriate extrinsic reward puts an onus on communities to collaborate internally to maintain their water system. It also means that communities would have impetus to learn from those communities who gain rewards by maintaining a functional system.

Placing the above factors into the framework described in Chapter 6, Figure 78 illustrates the potential for top-down prescriptive planning and rules that are ‘given’ to a community to reduce the overall positive impacts that processes such as community action planning may have.

![Figure 78 Sub factors affecting emergence in WASH programs](image)

9.1.3 Links to other levels of governance

The interdependence of different parts of a CAS implies that in order to understand them it is essential to look at them from different levels of a system (Jones 2011). Part of emergence is the ability of different levels to communicate effectively. In WASH implementation in Timor-Leste a lot of responsibility is taken on by international and local NGOs. The project cycle involves significant communication between NGOs and district government representatives but little communication between community representatives and district governments, as shown in Figure 79.
This strategic communication is seen as essential to enhancing government coordination capacity as the two levels of government are included in planning and information flows. However government departments can also be excluded from information flows if the NGOs choose to do so. As discussed in section 8.1 service clubs and ‘friends of...’ groups may do this through simple omission.

In the situation outlined above, the community is not enabled to form good communications with the sub-district representatives who are supposed to share joint responsibility for the ongoing robustness of water systems once the NGOs have concluded implementation and ‘handed over’ the system.

If district and sub-district administrative offices cannot support the number of water systems being implemented by NGOs then communication issues caused through the above communication structure are exacerbated. It was noted in section 8.13.1 that sub-district facilitators are generally perceived to be under-resourced. Lack of government capacity to support community water systems has led to NGOs intervening to create a civil society based support structure (such as the Federation of GMFs) that further circumvents the role of formal governance structures.
Figure 80 Effects of knowledge and communication networks in WASH programs

Figure 80 illustrates that networks can work either for or against change. An understanding of the nature of the networks that NGOs work within, and the way that these networks change around them, could highlight communication gaps between stakeholder groups. A networked model of WASH implementation would apply SNA, system dynamics or systems thinking techniques to understand the connections between people, organisations and natural resources. In developing this understanding, in conjunction with communities, there is the potential for implicit knowledge and power relationships to be made explicit and for locally appropriate communication and support channels to be encouraged to emerge. This is in line with the theory of change arising from the Triple-S project indicating the importance of creating dialogue and opportunities for knowledge sharing across donors, governments and implementing agencies (Schouten & Moriarty 2013).

9.1.4 Feedback

By evaluating the actions and outcomes of WASH interventions in system dynamics terms it is possible to understand why some interventions result in completely different outcomes to other quite similar interventions. Enacting this type of analyses across a program of interventions hones the information that can be gained about how interventions succeed or fail. Having elucidated at least a partial range of causes for the success or failure of programs from a CAS perspective it is then possible to reconsider the theory of change that is applied to specific contexts and to increase awareness of pitfalls and opportunities that may arise, hence ensuring that resources are applied strategically. The IDS bulletin "Towards Systemic Approaches to Evaluation and Impact" contains papers that indicate the usefulness of recognising the "effects of context interacting with the intervention" (Garcia & Zazueta 2015), and the usefulness of applying a collaborative system dynamics modelling methodology (Grove 2015) in creating an holistic understanding of the impacts of interventions beyond the scope of the log frame or the theory of change.

9.1.5 Co-evolution

The nature of this research as a snapshot in time is unlikely (and not intended) to identify specific processes of coevolution. An attempt to recognise the co-evolution of systems in regard to use of water would ask the question ‘what else
is changing in this village at the same time?’ and ‘how is the availability of water impacting and being impacted by this?’

One example of co-evolving process may be found in the proliferation of vegetable gardens. Without plentiful water vegetable gardens are not possible. Where water is plentiful the money from selling excess vegetables could be used to increase water supply, safety and sanitation. In two villages that I visited the issue of vegetable gardens seemed to be the cause of significant tension within the community:

   Researcher:  Why would someone cut the pipe?

   Response: Because some don’t get water, or they put a stick in the pipe to get more water to vege gardens (upstream).

In other villages it appeared that vegetable gardens were only planted where and when there was plentiful and equitable access to water. There was an expressed desire by many respondents to have a vegetable patch if there was a close and adequate water supply:

   “He’d (Chefe Aldeia) like to see more of the village able to grow vegetables.”

And in another, regarding a women’s gardening group:

   “Extra time on gardens eggplant, tomato, oranges [therefore they] decide together to send to market and split the profits.”

Many residents responded to the idea of having extra water and time by saying that they would grow vegetables. I observed posters in several villages for programs to create more home gardens. It appears, therefore, that gardens and water systems may coevolve with each other. The existence of one provides the necessary materials for the other – water systems provide water (and time) to grow vegetables, vegetable gardens provide extra income to extend water systems.

9.1.6 CAS learn and respond

Communities in Timor-Leste are constantly responding to changes in their environment including changes to their democratic processes, governance, demographics, education, expectations and natural environment as well as changes in the availability of communications technologies, media, electricity, transport, food and money.

Resilient communities will learn and respond to change. Folke et al. (2005) noted that “self-organized local responses for active adaptation to environmental change have emerged among communities and societies that have survived over long periods of time”.

Communities will continue to adapt and respond as their environment changes,
for example the availability of water close to a house is a change that may lead to adaptations by some individuals. If the tap stand is located close to a road then one adaptation is the use of trolleys to transport water, which leads to the capacity to collect more water. This adaptation was observed in Village 2 but although the tap stands in Village 3 and Village 4 were also located on a roadside, no trolleys or carts were observed in use.

The processes of water system implementation can support learning and response when implementing agencies ensure that information, skills, knowledge and support are available to the community. The flipside of this is shown in Village 5 where some of the residents worked to implement a water system and are now finding that they cannot extract water from it. Their response to this is likely to have a lasting influence on the ways in which the residents of the village choose participate in future development programs.

Jones (2011) discusses community adaptation in terms of social capital and self-organisation, linking this with access to education and the potential for autonomous institutions to be formed within national legislative frameworks. GMFs that manage a robust water system are learning and adapting to new conditions. Managing WASH implementation programs so that communities learn and self-organise around the desire to maintain a water system requires a vision that is shared by the community. However, robust water supply should only be a part of a broader vision of the life that is desired by community members in the pursuit of social justice (Kilgore 1999).

9.1.7 Sensitivity to initial conditions

During WASH implementations Community Action Planning (CAP) processes do some justice to understanding where a community is at from its own perspective. However there is scope to look much more broadly at community strengths and needs, as well as diverse ways to co-deliver outcomes that communities want. Many communities in Timor-Leste have experience with water systems from the past, it seems that few villages are ‘greenfield’ in terms of experience with tanks and pipes and taps. Utilizing the existing knowledge of the community is important in two ways; first it acknowledges that communities have skills, strengths and knowledge that are valuable in their own right and secondly it reminds the staff of NGOs that each situation is unique and needs to be treated as such.

In terms of the robustness of water systems observed within this research, there is a link between the initial conditions and the outcomes. In the Villages 1 & 3 where the initial conditions were that springs were very difficult to access, it seems that the water infrastructure was better maintained. In Village 5 where water was available from close springs or wells the system wasn’t well maintained and was also apparently co-opted by a few families. Understanding the differences in initial conditions of water stress can lead to more informed strategies for working with communities as they are, rather than an ‘ideal’ of a community.
In using a ‘one size fits all’ approach to development programs, sensitivity to initial conditions can be overlooked by NGOs. From discussions with NGO staff, when initial conditions are observed by NGOs, sometimes it is simply to ensure that the project is “doable” in the sense of not needing to deal with complicated land or water rights, multiple user groups, or even particularly difficult terrain or difficult technical requirements. Choosing the ‘low hanging fruit’ (as described to me by the Timor-Leste country head of one NGO) extends the reach and coverage of water systems but neglects to work with communities who may have the highest levels of need and who are likely therefore to be most invested in finding ways to maintain a new water system. The lead engineer of an NGO indicated that

“Communities with water sources nearby are pretty much ‘done’, those that are left are on the boundaries of sucos, or the water sources are quite remote from the houses”

During a discussion with the implementing team of another NGO, the group indicated that if the flow from a single spring seemed inadequate to the needs of a community then they “wouldn’t work in that community” and a “new location would be chosen by the Chefe Aldeia, Chefe Suco, SAS and NGO”.

From the above examples it can be seen that the reasons why NGOs look at initial conditions influences what they look at and what they do with that information. When NGOs look at the initial conditions of a village in terms of the problems that are likely to arise then it is possible that the villages that are most in need of assistance, because of the issues that they face, may be the last to be helped. If these observations are generalizable then the systems thinking archetype of “success breeds success” (Sterman 2000) means that the most vulnerable communities are the least likely to enter into a reinforcing loop of positive development outcomes. In other words, they remain in a poverty trap as described by Neely (2015) whereby the lack of improved access to one resource makes access to other resources also difficult. So a lack of access to water reduces wellbeing as does a lack of access to hygiene or nutrition, whereas increasing access to any one of these factors has the likelihood of a reinforcing effect where increased wellbeing will translate to actions that create further increases in wellbeing (Figure 81).
9.1.8 Resilience/Resistance

Resilience in the CAS literature is related to the way that a CAS moves and returns to an area of phase space around a specific attractor. Folke (2006, p. 259) notes that:

"resilience is not only about being persistent or robust to disturbance. It is also about the opportunities that disturbance opens up in terms of recombination of evolved structures and processes, renewal of the system and emergence of new trajectories" and that "It does not imply that resilience is always a good thing. It may prove very difficult to transform a resilient system from the current state into a more desirable one".

This implies that resistance is in fact the negatively construed flip-side of resilience.

Resilience, in the sense that it is used in development practise, as the ability to bounce back from, overcome or adapt to change – usually acute or chronic difficulties – can be seen as an accumulation of capital. The Torrens Resilience Institute (2013) specifies issues in household resilience as being related to health, community connectedness, physical environment, finances including insurance and access to services. These factors correlate well with human, social, economic and cultural capital (Bourdieu 1986) which are part of the mix in ensuring individual, household or community resilience to shocks. The idea of community resilience, as opposed to individual resilience, is contested (Portes & Landolt 2000). However, in the small communities that I investigated the interdependence of families and the close knit familial relationships encourages me to accept that shocks that would test the resilience of an individual or family,
would in fact be felt across whole communities and hence the resilience of their response is also likely to be community wide. The social networks of relationships and sacred houses discussed in section 8.3.1 can form a significant aspect of both individual and community resilience as it is the basis of social capital for individuals and the community.

Ostensibly the implementation of a new water system in a community should lead to better outcomes for all residents. It is possible though for WASH interventions to create a situation where communities become less resilient. The ability to maintain and fix a water system forms part of the new resilience of the community. If mending and maintaining the water system is not within the capability of the community, then resilience can be overwhelmed and the response to a malfunction consists of reverting to collecting water from unimproved sources. This lack of resilience in the face of water systems breaking down could be caused by lack of tools, lack of skills, lack of money/spare parts, lack of time, lack of management ability or lack of social cohesion. However, lack of maintenance should not be seen as synonymous with lack of capacity. Lack of water system maintenance could also be the effect of a resilient system averting change.

If the resilience of a community is based on its accumulation of capitals (social, cultural and economic) then the potential for heightened resilience exists in any water system implementation. If a WASH implementation achieves the intended outcomes of making safe water more accessible and good sanitation practices the norm, then the desired flow on effects on health and education, in particular, should result in increased cultural and economic capital and hence increased resilience in the face of external shocks.

If a community commits resources to a WASH program then they require ongoing support in case the project creates detrimental impacts or in case the project outcomes are short lived and especially if previous alternative lifestyles have been forgone (e.g. a family sold the horse that carried the water but then the taps ran dry). Folke et al. (2005) noted that adaptive capacity is maintained through flexible institutions and overlapping capabilities. Therefore, creating and maintaining redundancy within a community managed water supply requires that no single individual is the only repository of a particular skill set or knowledge set. Responsibility, on the other hand may be invested with a specific individual. Ensuring that communities understand the actual costs they may be expected to incur in maintaining, extending or replacing a water system allows for appropriate financial and physical management. This way communities can take responsibility for ensuring that the economic capital will be available when it is required, or understand when the issues is beyond their resources and quickly call on other resources.

Being adaptive means having a range of possible responses to acute or chronic stressors. Ensuring that communities are well versed in their options for responding to water system malfunctions and/or GMF dysfunction is important in ensuring that they can respond appropriately and flexibly as the situation requires.
“As resilience declines, it takes a progressively smaller external event to cause a catastrophe. The process is a cumulative one in which sequences of shocks and stresses punctuate the trends, and the inability to replenish coping resources propels a region and its people to increasing criticality” (Folke et al. 2005)

Communities may be resilient against the changes that are being implemented, even when there is apparent agreement with the aims of a WASH program. Knowing this opens up scope to ask questions about the issues that are experienced, in ways that don’t blame a community for being resistant to change.

9.1.9 Changing attractors

Similarly to taking a ‘social norms’ inventory and developing a theory of change, the CAS framework can be used to explicitly (although only ever partially) describe the current and desired states of a community. In being able to describe the initial attractors or phase states of the community and in carefully assessing the desired end points in concert with the community, it is possible for both the NGO and the community to observe and understand changes that occur.

In the case of a WASH program there are often multiple changes that INGOs aim to achieve even before any staff have visited a community, as per Table 16, which is informed by interviews with staff from INGOs. While the aim of INGOs is generally to make the desired attractors explicit and to engage the community in also wanting and working towards the same attractors, much of the actual community engagement is dependent on good performance of the community action planning (CAP) process and CLTS processes.

The existence of attractors implies the existence of both the possibility of change and resistance to change. Moving a system away from an attractor is not a straightforward task. Acknowledging the lack of linear pathways and predictability in WASH processes indicates that a closer look at theories of change is warranted. If a theory of change appears quite simplistic or rigid and involves no feedback or learning loops then there is a good chance that it is neither accurate nor useful as it would disregard the complexity of communities and community level interventions. Some applications of theory of change suffer from this shortcoming (Vogel 2012). However, the use of theories of change as described by Funnell and Rogers (2011) explicitly acknowledges the complexity inherent in community development and notes that unintended consequences are part of the milieu. So it would appear that theories of change can be placed along a scale from rigid and linear to flexible interlinked and iterative. Vogel (2012) also suggests that theories of change should be seen as processes rather than just outcomes otherwise they risk becoming a bureaucratic box ticking exercise.
Table 16: Typical set of attractors for a community before a WASH intervention in Timor-Leste and the attractors that INGOs aim to move communities to.

<table>
<thead>
<tr>
<th>Initial Attractor/state</th>
<th>Desired Attractor/state</th>
<th>How change is pursued</th>
</tr>
</thead>
<tbody>
<tr>
<td>Open Defecation</td>
<td>Open Defecation Free Sanitary Defecation</td>
<td>CLTS is a commonly used in Timor-Leste, as is the building of toilets as a prerequisite for the implementation of water systems</td>
</tr>
<tr>
<td>Lacking adequate close water supply</td>
<td>Access to adequate close water supply</td>
<td>Community building of water supply as planned and funded by NGOs Includes CAP process</td>
</tr>
<tr>
<td>Prone to diarrhoeal disease</td>
<td>Free from diarrhoeal disease</td>
<td>CLTS education highlights routes of transmission of pathogens and gut parasites with the aim to trigger sanitary behaviours by community members</td>
</tr>
<tr>
<td>Poorly nourished</td>
<td>Well nourished</td>
<td>Time for economic activities to provide food and medical access, also reduced transmission of pathogens and gut parasites.</td>
</tr>
<tr>
<td>Poorly educated</td>
<td>Educated</td>
<td>Time for children to access school via reduction in water collection activities</td>
</tr>
<tr>
<td>Masculine domination of the public sphere</td>
<td>Equal opportunities for engagement in the public sphere for women, men and young people</td>
<td>Inclusion of women in water management committees and decisions. Gender equality modelling within CAP process</td>
</tr>
<tr>
<td>Vulnerable poor</td>
<td>Resilient poor</td>
<td>More time to engage in activities that will increase economic, social and cultural capital.</td>
</tr>
<tr>
<td>Lack of consideration of accessibility needs</td>
<td>Considerate and aware of different abilities and mobilities, especially in the building of infrastructure.</td>
<td>Accessible design and disability awareness education within CAP process.</td>
</tr>
<tr>
<td>Small group of (usually) male elders with power over the community</td>
<td>Whole of community engages with each other to determine its future together</td>
<td>Modelling of power sharing through CAP process</td>
</tr>
<tr>
<td>Some skills in water system maintenance</td>
<td>Skilled at water system maintenance and management</td>
<td>Training of GMF in management, financial and technical skills</td>
</tr>
<tr>
<td>Not inclined to wash hands after toilets, before food preparation or after dealing with children’s faeces</td>
<td>Hand washing practices that meet required hygiene standards for good health.</td>
<td>Inclusion of health facilitator position in GMF and reliance on CLTS process to trigger sanitation and hygiene behaviours.</td>
</tr>
</tbody>
</table>
Vogel's understanding of theory of change applied in an ideal sense shows correlation with the perspectives arising from complex adaptive systems theory, she warns that:

“To support a better fit between programme and context, it may be that chosen interventions are not technically the most efficient or effective, but are justified as the most appropriate for influencing change within the social, political and environmental realities of their particular context.” (Vogel 2012, p. 4)

The above statement conflates efficiency and effectiveness with time and cost. I would argue that a program that follows Vogel’s suggestions for good practice with theory of change would be effective, efficient and appropriate whilst perhaps costing more and taking longer than a program that ‘ticks all the boxes’ but may lack long term positive impacts. An appropriate theory of change and development process as per Vogel (2012) could lead to change in community attractors.

Theory of change processes are not the only way for development activities to assist communities in moving between attractors. However, a good theory of change uses explicit processes with scope to include the broader understanding of communities and change that are significant to a CAS perspective.

Uncertainty is a defining characteristic of complex adaptive systems. It is not possible to fully know the outcome of an action before the action is taken in a complex adaptive system. In recognising that a plan is merely a guideline and that it should be constantly adapted to changing situations it is important to allow that good projects may be emergent projects. As Jones puts it “light and flexible systems around ex ante analysis are needed to facilitate responsive, appropriate interventions” (2011, p. 30). This doesn’t mean that planning isn’t useful, it merely means that development isn’t a linear process with known action-reaction responses and shouldn't be treated as such.
10 Contributions and Conclusion

This research journey has been quite exploratory; it has looked to understand the nature and applications of systems thinking within the WASH sector of development. Contributions to academic knowledge, practical knowledge and community awareness have been made. Formal, discoverable contributions in each of these areas are listed in section 10.1. Finally, section 10.2 brings together the threads and themes of this research in a summary of the most significant points of learning and some further research that has the potential to benefit the users of small rural water systems in Timor-Leste and across the globe.

10.1 Contributions

This research has been contextualized within a complex adaptive systems framework and explicitly recognises that there is no action or set of actions that can guarantee the continued supply of water in rural villages. The understanding gained from this research contributes, in quite specific ways, to the knowledge of development theory and to useful practical actions that can be taken within Timor-Leste and within the WASH sector globally.

The methods of data collection have relied upon significant levels of input by staff at NGOs and by residents of small rural communities in Timor-Leste. Both of these groups were fully informed about the nature of the research and encouraged to comment on the research process and findings during the course of the project. It became evident over the course of this research that the methods applied are participatory research methods. A clear part of that participation for the researcher is in “giving back” to communities. This is achieved through addressing questions that are relevant to communities and which enable communities to produce their own knowledge and hence create social change (Diver & Higgins 2014). For rural communities in Timor-Leste the research has involved many individuals reflecting on their water use, the management of their water system and on their relationships both within their community and externally. While these reflections may or may not have influenced the way that communities perceive themselves or their water systems and GMFs over the long term, at the time of data collection it was evident that at least some individuals appreciated the efforts of the researcher in trying to understand the everyday lives of residents. On this basis I was taught how to prepare and weave palm leaves, sort coffee beans for market and was invited to community celebrations, meals and a school graduation. Ensuring that research results are available and accessible to academia, industry and communities is an important part of participatory research. Formal written feedback to communities is included in Appendix F and was provided in Tetun during the community feedback process in June and July, 2015.
The other specific group of participants in this research were the practitioners - staff of NGOs and government departments. The process of creating social network maps and influence diagrams are not well known within the development community so part of the research involved explaining these techniques to participants. One practitioner commented that the questioning and reflection aspects of this research enabled them to articulate thoughts about development that they would rarely have any other opportunity to discuss. Another participant indicated that the use of both social network and influence diagrams was useful in visualising complex situations. Formal written feedback to NGOs is constituted as a report based on the themes found within this thesis including: managing water systems as a common pool resource; using system dynamics to describe WASH issues; WASH as a complex adaptive system. This report is not included in the appendices but will be lodged with a DOI at Australian Policy Online.

Academic engagement in the form of publishable work - peer reviewed journal articles and conference papers are a typical expectation of any doctoral candidate (Lovitts 2007, p. 31). I have fulfilled this expectation and listed those publications, alongside the other contributions, in Appendix G.

This thesis has contributed to a small body of theory, (Elwert & Bierschenk 1988; Howe 2010; Rihani 2002a; Rihani 2002b; Rihani 2005; Rihani & Geyer 2001; Ulrich 2010) popular development and grey literature (Barder 2013; Ramalingam 2013; Ramalingam et al. 2008) that looks to make explicit the link between complex adaptive systems theory and a sociological understanding of international community development. The framework proposed in Chapter 6, as illustrated through the use of influence diagrams, has been a useful aid to exploring the drivers of successful development in water service delivery programs in Timor-Leste. This work exposed some of the assumptions that are made within the WASH sector about the value of water supply and provides a method that can be applied to further question our assumptions within development programs. It has shown that the current structure and funding of the WASH sector works against the use of participatory practices and creates a situation where gains in access to water and sanitation tend to be short-lived. On the same basis, there is a tendency by NGOs to avoid working with technically or socially difficult community cases and so the WASH sector gains ‘quick wins’ but many of the hardest to reach communities are neglected.
10.2 Conclusions

The literature review of social theories aimed to determine whether CAS theory was commensurate with international community development theories and sociology. The findings were not only that there is a high level of commensurability between these fields but that using a CAS framework extends the concepts of freedom and choice in development by recognising that poverty imposes a form of orderliness or constraint on the lives of those who live it. Development as a means of reducing poverty therefore requires an increase in complexity (decrease in order) that may be evidenced by increased freedom, choice, diversity or the emergence of higher level social structures. Hence the application of predominantly technical approaches to development – providing material goods that achieve a concrete and measurable objective – which do not provide scope for increased agency are unlikely to shape beneficial development outcomes in the long term.

The use of CAS theory as a framework for understanding issues around sustainability of water systems in rural Timor-Leste opened three streams of inquiry that characterise the strength of this approach and the significance of this work:

- social networks of NGOs in the WASH sector
- social networks and water management in rural communities
- system dynamics modelling based on participative observation and narratives of community residents

The first stream of inquiry was an observation of the sociocentric networks of participants in WASH sector activities across Australia and Timor-Leste. Whilst this research was centred on a single Australian-based NGO with a local office and local partner NGOs in Timor-Leste, it also encompassed WASH projects implemented by four different INGOs in Timor-Leste. Outcomes of social network analysis of this information pointed to strong connections between organisations and individuals within the WASH sector in Dili. It also showed a lack of connection to villages and a lack of input and oversight by sub-district facilitators (SDFs) who are expected to take over responsibility for the long term robustness of the water systems implemented. This research has shown that finding a way to expand or bridge the Dili based WASH network to include SDFs and community leaders may be a necessary step in the emergence of a locally capable and connected WASH workforce.

The second stream of inquiry was a series of case studies in rural villages in Timor-Leste. From these case studies a significant body of data was collected and analysed using thematic analysis and social network analysis. The results of these analyses showed that villages have internal networks which appear to be dominated by the structure of the uma lisan (sacred house). External networks mostly appear to be built on family relationships or (in some cases) friendships initiated during education experiences. It is rare for residents of rural villages to encounter a stranger, therefore the social networks that exist tend to be made of strong ties and have very few weak ties. While this points to
difficulty in dissemination of new information and innovation into the network – especially in the absence of local media – there is a good likelihood of transmission of knowledge once that information has reached the village.

Noting parallels with the business networks that Wilkinson and Young (2002) discuss it became clear that the more work an NGO does in an area the more they are trusted and welcomed as part of the network of a community. In particular the follow-up support that is provided by boundary riders and the federation of GMFs was found to contribute to the longer term inclusion of NGOs within a dynamic social network. As a part of the network of rural communities, NGOs can be seen as co-creators of that network, and as such they are part of the set of behaviours and attitudes and interactions that determine the attractors (eventually the status quo) that each system settles towards. In the same sense that Giddens (1993) noted that the individual creates society and society creates the individual, it is clear that each part of the rural network shapes the network and the network shapes them. Together the future actions of the network are co-produced by the existing individuals and organisations. As NGOs create situations of increasing mobility and network connections and communication (all increased freedoms) they will unconsciously increase the complexity of the environment for each resident. This increased complexity can take a system to the “edge of chaos” where innovation, adaptation and shifts between attractors are most likely to occur and be sustained.

At the same time however, NGOs may unwittingly create a barrier to the emergence of ties between villages and government officials as the NGOs effectively take over the government’s responsibility, leaving little scope for government agents to create the long term trust and relationships that are required for effective governance. This research found that the replacement of government services by NGOs is problematic in two ways, the first is that NGOs have less accountability mechanisms than governments, the second is that NGOs generally do not plan to maintain a long term presence in communities. Therefore, when NGOs exit a community they may leave a significant gap in community support and management networks. Ensuring that WASH programs and communications are well integrated with government departments and government staff would help to avoid this issue.

The third stream of inquiry was the use of case studies and system dynamics modelling to understand the drivers behind the robustness of water systems. The results of this research show that the proximity and volume of water that is accessible by residents has a significant influence on the amount of water used in the household. Furthermore residents have an order of priorities for water use in the household that is dependent on the ease of access, as shown in Figure 70.

This analysis established that small community managed water systems can be considered as common pool resources. Therefore, applying the management principles of good design, as per Ostrom (2008), would have positive impacts on the robustness of water systems. Four specific outcomes of applying the
Design principles are as follows.

Firstly, the inclusion of visible water level indicators on tanks would help to ensure that the management of water in the case of broken pipes or reduced environmental flows would involve timely repair or agreed community reductions in water use respectively. Secondly, ensure strategies are in place for expanding the volume of water delivery as communities grow or as residents want to use water for an extended range of activities. Thirdly, the benefits of water supply in Timor-Leste are currently centred on the reduction of labour for collecting water for household use as opposed to increased water quality. While the implementation of village tap stands achieves a substantial reduction in the labour of carrying water, these benefits would be increased significantly by the implementation of individual household taps. Increasing service levels would see households using higher volumes of water for hygiene which is likely to have a beneficial impact in the reduction of diarrhoeal diseases (Cairncross & Valdmanis 2006). Lastly, there is no apparent connection between the level of benefit provided by a water system and the cost to households of accessing the water system. The introduction of options for variable service levels related to a sliding scale of fees would allow residents and GMFs to determine what service level is desired and what it is worth. Increasing options like this would act as a driver of increased choice and complexity, and hence development, within communities.

Overall, this research has found that using systems thinking techniques within a CAS framework can help to explicate the ‘failure’ and the ‘success’ of water systems as a function of technical, social cultural and structural contexts of communities. The drivers of development currently promote the increasing reach of WASH programs with little concern for the ongoing functionality of existing and new water systems. The criterion against which local NGOs are assessed and remunerated – number of systems implemented - is in direct tension with the time consuming participatory practices and quality implementation that are required for robust outcomes. This research demonstrates that investing more effort into enabling increased community participation, and promoting community and individual decision making regarding the allocation of resources at all stages of the project cycle, will promote agency and diversity in ways that are currently neglected in favour of reach or coverage (Figure 82).
CAS theory does not provide a ‘silver bullet’ for development, nor does it provide a better way to manage WASH programs, but it does provide a framework for development workers and researchers to ask the right questions about relationships, freedom and choice. It reminds us that each step in development should be a step away from the orderliness and constraint imposed by poverty. Development pathways are unpredictable and uncertain, CAS theory does not change that, but it does lead us to look at one step at a time rather than trying to plan the effects of a whole avalanche.
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Appendices

Appendix A: Village householder (semi-structured) interview questions

Where did you get your water from today?
How much water was collected for your household today?
Who collects the water?
How long does it take to collect water?
What do you use the water for?
Where do you wash your clothes and take showers?
What do you do if there is no water at the tap? e.g. pipes are broken or blocked
Do you pay the GMF?
How much?
What does the GMF do with the money collected?
Where do you collect water if the tap is broken?
How long does it take to collect water from the alternative source?
How many people live in your household?

For the network map:
Is there anyone else in the village that the (head of household both male and female) are related to?
Explain the relationships – parents, siblings, children, adopted
Which Uma Lisan is they a part of?
Appendix B: Stories to talk about water, with women.

There is a village in the hills where Maria and the other women must walk 1hr to collect water. They are always tired because they get up early to get water for their families and they work hard all day in their homes and gardens. Maria and the other women would like to have taps in the village so that they would only have to go a little way to get water. What can they do to get pipes and taps in the village?

When the village got pipes and taps Maria was very happy. What do you think Maria and the other women would do with their extra time and with the extra water that they had? Do you think there would be anything that could make them sad about the new easy way of get water?

In the village where Maria lives every family had to pay a little money to the GMF to make sure that the technician could buy extra parts to fix the taps if they broke. One time Maria didn’t have enough money to pay the fee. What could she do?

One year it was a very long dry season and there was very little water in the taps, not enough for everyone to use for all the things that they do. The women started to fight with each other about who got the most water. What can they do to make everyone happy again?

Eventually there was no water in the taps, so Maria and the other women went to the spring to get drinking water. Their families got very sick…. What should Maria do?

When the rain came again and the taps should have water, the taps were all broken and Maria and the other women still had to walk to the spring. They found that they were happy when everyone walked together and there was no more fighting. What should Maria do now?
Appendix C: Pilot Village Survey Questions

Name of person being interviewed
Position (if any) of person being interviewed
Age of person being interviewed
Person’s spouse’s name
Position (if any) of person’s spouse
Mark house on map….. Which water tap do you use? (mark on map)
1. Does the water tap nearest your house turn on?
2. Does the water stop running completely when you turn the tap off?
3. If part of the tap or tap stand is broken, who would you speak to about getting it repaired?
4. Why?
5. Do you ever still collect water from the river?
5a. If yes, Why?
6. Is there anyone, who would come to talk to you about getting a tap repaired? Who? Why?
6a. Who?
6b. Why
7. Do you know about community meetings to discuss the water system?
8. Do you attend community meetings about the water system?
8a. If yes, do you talk about the issues that matter to you?
9. Is there anyone else that you might talk to about the water system or about water?
9a. Who?
10. Does your house have a toilet that can be used? Yes / NO If yes tick which of the following apply:
   • Pit toilet
   • local materials
   • concrete pan
   • ceramic pan
   • Pour flush
11. If you wanted to repair your toilet who would you talk to about it?
11a. Why?
12. If you wanted to improve your toilet who would you talk to about it?
12a. Why?
13. Do you ever use a toilet other than your own?
13a. Where?
13b. Is this linked to particular occasions?
14. Do you have a tap that can be used for handwashing?
14a. Describe
15. When did you first learn about the importance of handwashing?
15a. Who from?
16. Who do you talk with about handwashing and hygiene?
17. Is there anything that you particularly like about having:
17a. A water system with public tap stands?
17b. A toilet
17c. A handwashing facility
18. Is there anything that you particularly DO NOT like about having:
18a. A water system with public tap stands?
18b. A toilet
18c. A handwashing facility
19. Has anything happened because of the village water system or the toilets that you were surprised about or didn't expect?
20. Complete checklist of stakeholders.
Appendix D: Checklist of stakeholders

From the following list, please say if you would ever talk with any of these people about the water system or toilets or hygiene or something else, or if you don't know this person or wouldn't talk to them for some other reason.

<table>
<thead>
<tr>
<th>Person</th>
<th>Water system</th>
<th>Toilets and sanitation</th>
<th>Handwashing and hygiene</th>
<th>Other, if specific, what topic?</th>
<th>I never talk to this person (why?)</th>
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<tr>
<td>Your mother</td>
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<td>Your father</td>
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<td>Your husband or wife</td>
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<td>Your children</td>
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<td>Grandchildren</td>
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<td>Chefe de Suku/Chafa de Kibira</td>
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<td>Council of Elders</td>
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<td>Natural leader</td>
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<td>Local Leader</td>
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<td>Traditionel leader</td>
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<td>A local teacher</td>
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<td>Health worker/SISGA</td>
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<td>Local police</td>
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<td>GMF Chair</td>
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<td>GMF secretary</td>
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<td>GMF treasurer</td>
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<td>GMF technician</td>
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<td>GMF PSF</td>
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<td>District Administrator (or staff)</td>
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<td>Sub District Administrator (or staff)</td>
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<td>SAS dentis technical officer</td>
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<td>CSWDO</td>
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<td>SDF</td>
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<td>HTL Field coordinator</td>
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<td>HTL technician</td>
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<td>HTL sanitation officer</td>
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<td>HTL Health promotion officer</td>
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<td>Water aid technician</td>
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<td>WA Community motivator</td>
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<td>WA health educator</td>
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<td>WA sanitation supervisor</td>
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<td>Water Aid boundary rider</td>
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<td>WA Field support</td>
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<td>WA water resources officer</td>
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Appendix E: Ethics approval

Memorandum

To: Dr Phil Conors
   School of International and Political Studies
   G
   cc: Ms Kate Neely

From: Deakin University Human Research Ethics Committee (DUHREC)

Date: 14 February, 2012

Subject: 2012-010

Developing a Systems Understanding of Relief, Rehabilitation and Development (RRD) in Communities Affected by Natural Disasters

Please quote this project number in all future communications

The application for this project was considered at the DU-HREC meeting held on 13/02/2012.

Approval has been given for Ms Kate Neely, under the supervision of Dr Phil Conors, School of International and Political Studies, to undertake this project from 13/02/2012 to 13/02/2013.

The approval given by the Deakin University Human Research Ethics Committee is given only for the project and for the period as stated in the approval. It is your responsibility to contact the Human Research Ethics Unit immediately should any of the following occur:

• Serious or unexpected adverse effects on the participants
• Any proposed changes in the protocol, including extensions of time.
• Any events which might affect the continuing ethical acceptability of the project.
• The project is discontinued before the expected date of completion.
• Modifications are requested by other HRECs.

In addition you will be required to report on the progress of your project at least once every year and at the conclusion of the project. Failure to report as required will result in suspension of your approval to proceed with the project.

DUHREC may need to audit this project as part of the requirements for monitoring set out in the National Statement on Ethical Conduct in Human Research (2007).

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Appendix F: Report to Communities

Report to communities in Timor-Leste
By Kate Neely

First I would like to say thank you to those of you who shared your homes, your stories and your experiences with me. I couldn’t translate my whole thesis so I would like to provide you with a summary of my findings instead:

1. It is very important for communities to have choices and make decisions about what happens, how it happens and how money is used. When you have choices, things will change and sometimes this will be uncomfortable as there will be new and different ways to do things. Sometimes the changes will challenge your culture and your customs. It is very important to think and talk together about what customs are important and which ones it might be ok to change so that your children have more choices for their future.

2. It is easier for communities where families live close together to manage their water systems. If a community has many different families or umalisan that don’t have traditional connections then it might be harder to manage a water system. In this case you might consider some different management strategies. For example instead of having volunteers you could pay for a technician to make sure that all the taps are working and the pipes and the spring protection are ok. Or you could use a roster system so that the same people don’t have to do the work all the time. Or you could agree to change the GMF every year.

3. The technicians who maintain the water system, and the GMF, don’t always know what to do if something breaks, or where to get new parts or which parts and tools they will need. It is difficult to go and buy new parts if you haven’t been to the shop before. Making a phone call to the NGO the SDF or ABBS is expensive and transport to Liquica or Dili can also be expensive. The fees collected by the GMF could be used to pay for phone calls or travel. The people at ABBS, like Jamito, will be able to help you buy new parts if your water system is broken.

4. Lots of water systems stop working after about three years. But some of them last for more than 20 years. If you have time, look at the systems in neighboring communities that have lasted a long time and the systems that work well and see if you can learn from the communities that use them, about what makes them successful.
Here are some ideas from my research:

1. Water Level Indicators

At the moment sometimes when the pipes break nobody knows they are broken until there is no water left in the tank(s). It would be easier to know when there is a problem with a water system if you put a water level indicator in the tanks, then you would be able to see if the tank is filling up or not. Make sure that the plastic bottles are really clean, the indicator will need something a little bit heavy tied to it.

2. Wash stations

We all know that we should wash our hands with soap so that there are no germs on our hands that we can accidentally pass on to other people, but it is really hard to wash our hands with soap as often as we should. It might be easier if there was water near the toilet and near the kitchen, in containers that are easy to use. If you have a mandi, it’s pretty easy. If you don’t have a mandi then a big container with a proper tap and some soap and a cloth beside it is a good idea. The more everyone washes their hands the less people will get sick. It’s a really difficult habit to get into — maybe communities could have a meeting with everyone to talk about different ideas to remind us to wash our hands every time we go to the toilet.
3. Toilets
Some people I met have built a toilet that they don’t use and some people haven’t built a toilet at all. I think that most people know that when you shit on the ground it can allow diseases to spread to other people, even if you are not sick. This is because some people get sick more easily than others. The pit toilets are a bit scary, especially at night. Can you think of ways to make them less scary so that everyone will use them? Can you have a torch or a light that makes them easier to use at night? During the day, what would make it better?

4. Toilets
Do you know that when you have used your pit toilet for a year you can cover the hole with dirt and then 6 months later you can plant a banana tree on it and it will grow really well. You can just keep moving the toilet around.

5. Checklist for working with NGOs
In some places in Timor-Leste, it is difficult to get information and it can be hard to know what to ask people from NGOs and the government when they come to ask you if you want a water system. Here is a checklist of ideas and questions to consider at different stages of a water system being implemented. Some of these questions might work for other projects that NGOs and the government offer as well.
Checklist for communities

Know what you need and want before planning activities with the NGO:

☐ Have you talked to women and men from a nearby village that has a water system about what happened and the good and bad impacts when they had a system implemented?
☐ Work out how much water you use each day – try and include water that you carry home and water that you use at the source so that you know what you need.
☐ Do you want just enough water for drinking and cooking or do you want enough for washing and gardens as well?
☐ Are you prepared to provide extra work, materials or money to get more water or more tanks for storage?

Make sure that you have looked at different options before building a water system:

☐ Does every person in the village know where their nearest tap will be? Can they point to the spot?
☐ Is every person in the village OK with the distance to the taps? It is much easier to collect water if the tap is right beside a road, not down a hill. It is even better if it is close enough to use a hose so that a mandi or drum can be filled at the house.
☐ If a tap has to be located downhill from your house, have you thought about using a pump to move the water uphill?
☐ Is anyone planning to use a hose to bring water to their home?
☐ Do you want a clothes washing space at the tap?
Do you want to build a shower or two at the tap? How would you keep it clean?

If you have a shower or a clothes washing station where should the used water go?
Can you make a garden to use the waste water?
Have you talked about what might go wrong?

Make sure everyone knows what will happen after the system is built and make sure you can contact someone if you need help or if something unexpected happens. Check the following list before the inauguration of the system:

- Is there a way for everyone to see how full the tank is?
- Have at least three people been to the shop where you can buy new taps and pipes?
- Do you have a list of how much new parts cost?
- Do you have names and phone numbers written down for the following people?
  - NGO office in Dili — director, boundary rider, engineer, sanitation officer
  - Local NGO office or the person who led your system building
  - ABB5 (federation of GMFs)
  - Local sub-district facilitator (SDF)
  - Local DNSAS officer
- Do at least three people have access to the GMF records and funds and tools?
- If your water system has a pump do you have the name and phone number for a pump technician?
- Is it ok for the GMF to use funds to make important phone calls and to travel to buy spare parts or tools?
- Have you got a bank account for the funds? Would a bank account be practical?
- Does your kiosk sell soap and toilet paper? Is it affordable?
- Sometimes after the water system is built, you will find that you want different people to be on the GMF. Does everyone understand that as a community you can
change the rules of the GMF and different people can take up the positions if you agree that it is a good idea?

☐ Do at least three people know how to fix minor problems?
☐ Do you know how to change or extend the water system if you need to?
☐ Have you checked that all the women are happy with the taps and with washing stations?
☐ Can the elderly and the disabled access the taps?
☐ Have you taught the kids NOT to play with the taps and pipes?
☐ Is anyone planning to use a hose to bring water to their house? If so, is that going to be ok?
☐ Does everyone have really convenient to use hand washing stations for after the toilet and before cooking?

If you think this is a useful checklist please share it with other communities who could use it.

Important Names and Phone Numbers

Name: ___________________________ Phone: __________________

Organisation: ___________________________

Name: ___________________________ Phone: __________________

Organisation: ___________________________

Name: ___________________________ Phone: __________________

Organisation: ___________________________

Name: ___________________________ Phone: __________________

Organisation: ___________________________

Name: ___________________________ Phone: __________________

Organisation: ___________________________

Name: ___________________________ Phone: __________________

Organisation: ___________________________
Appendix G: Formal contribution to the academy, practitioners and community

<table>
<thead>
<tr>
<th>Purpose</th>
<th>Forum</th>
<th>Title</th>
<th>Status and Date</th>
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<tr>
<td></td>
<td>Development: Power, Resilience and Change</td>
<td>Understanding WASH through Complex Adaptive Systems Theory</td>
<td>Peer reviewed paper and presentation July 2013</td>
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<tr>
<td>Practitioner &amp; Academic</td>
<td>NGO</td>
<td>Complex Systems and Rural Water Supply</td>
<td>Convenor of international discussion group in Rural Water Supply Network 2013 - current</td>
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<td><a href="http://www.rural-water-supply.net">http://www.rural-water-supply.net</a></td>
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<td>Community</td>
<td>Swinburne University Media Student Project</td>
<td>East Timor Documentary Part 5 <a href="http://tinyurl.com/SwinTV">http://tinyurl.com/SwinTV</a></td>
<td>SWINTV documentary 2014</td>
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<tr>
<td>Academic &amp; Practitioner</td>
<td>Development in Practice</td>
<td>Complex Adaptive Systems as a Valid Framework for Understanding Community Level Development</td>
<td>Peer reviewed journal paper, accepted for publication 28/02/2015</td>
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<td>Academic</td>
<td>Deakin University Exit Seminar</td>
<td>A complex adaptive systems understanding of water projects in international development.</td>
<td>Presentation February 2015</td>
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<td>Academic &amp; Practitioner</td>
<td>5th ACFID University Network Conference</td>
<td>Assessing the equity of access to rural water systems in Timor-Leste</td>
<td>Presentation June 4-5 2015</td>
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<tr>
<td>Academic</td>
<td>Timor-Leste: The Local, the Regional and</td>
<td>Water Supply in Rural Aldeia. Why Residents Need to Make Choices About Service Level</td>
<td>Presentation 9-10 July 2015</td>
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<td>Peer/Report Details</td>
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<td>Academic</td>
<td>38th WEDC International Conference, Loughborough UK</td>
<td>Peer reviewed paper and presentation 27 -31 July 2015 (accepted)</td>
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<td>Governance &amp; Practitioner</td>
<td>TL WASH forum</td>
<td>Workshop/report June/July 2015</td>
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<td>Community</td>
<td>Long visits to aldeias.</td>
<td>Community feedback and discussion, written report to Chefe Aldeia &amp; Chefe Suco June/July 2015</td>
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<td>Practitioner</td>
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<td>Report submitted in Australia and Timor-Leste August 2015</td>
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