Traps and Transformations of Grenadian Water Management

by

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AUTHOR'S DECLARATION

I hereby declare that I am the sole author of this thesis. This is a true copy of the thesis, including any required final revisions, as accepted by my examiners.

I understand that my thesis may be made electronically available to the public.

Abstract

The adaptive cycle metaphor provides insight into how and why social-ecological systems change. Literature on 'resilience thinking' has built upon this foundation and further developed the concepts of resilience, adaptation, and transformation to describe social-ecological system behavior. The resilience-thinking literature also describes systems that do not change, even when such change is desirable, as being in a trapped state. However, relatively little research has explored why such systems are trapped and how to free them. This thesis is the product of doctoral research which resolves how to identify, evaluate, and free a system caught in a maladaptive system trap. The study setting is water management in Grenada, a small island developing state in the southeastern Caribbean. Four research questions guide this study: (1) To what extent is Grenadian water management in a trap?, (2) To what extent is Grenadian water management transformable?, (3) Do current and recent interventions effectively foster or utilize transformability?, and (4) Which interventions should be pursued to facilitate transformation of water management in Grenada?. The study is informed by literature on social-ecological systems and integrated water resources management.

Methodologically, the study is an explanatory single-case study of water management in Grenada, conducted from 2012 to 2013. The study utilizes data from semi-structured interviews (n=19), a questionnaire (n=180), a document review (n>200), and observation. The general strategy was to evaluate attempts to transform Grenadian water management within the 3-phase transformation framework described in the resilience-thinking literature. 'Points of failure' in transformation are defined as the cause(s) of a trap, and interventions to relieve the points of failure are proposed.

Results indicate Grenadian water management is in a rigidity trap, although it exhibits some capacity to transform. A key point of failure of attempts to transform the Grenadian water sector into an integrated and holistic management system has been an inability to seize windows of opportunity to pass key legislation. I conclude the primary cause for this failure is poor fit among the problem, as perceived by various stakeholders, the proposed solution prescribed by water sector reform proponents, and political reality. In addition, reform proponents focus on advocating for reform to water sector professionals and do little to broker passage of legislation politically. Finally, reform proponents also assume legislation will be effectively implemented, which is not certain.

Contributions specific to the Grenadian setting include a post-mortem on why efforts to reform the water sector have failed, described above. Five recommendations are made for future

interventions to foster transformation of Grenadian water management: (1) engage residents as part of a vision to create political pressure for proposed solutions, (2) frame the problem with substantial resident input and focus, (3) craft solutions which take advantage of political realities such as funding restrictions, (4) anticipate and prepare for crises, and (5) enlist one or more people or organizations to serve as brokers. Empirical contributions include support for the three-streams framework of seizing windows of opportunity as fundamental to explain transformation of social-ecological systems. The primary conceptual contribution is the development of resilience thinking to illuminate ways to free trapped systems. I begin by providing a nomenclature to quantify and describe traps, which includes the type of trap, the degree of persistence and undesirability of the trap, and recent changes in these properties. Then, I develop a framework to assess transformability of a given system based on the existing 3-phase framework of transformation. When applied empirically, this framework illuminates points of failure of transformation, which I define as the cause of a given trap. Once identified, specific strategies can be devised to foster transformation and to break free of a trap.

Acknowledgements

A wise friend once told me over quaint campfire and a wee dram[1] on the Garden Island Expedition, "at the end of true perseverance, you will find a humble man." This quotation, and my subsequent journey to produce this work, frames my approach to these acknowledgements.

I am honored and privileged to have had Dr. Brent Doberstein and Dr. Bruce Mitchell as academic advisers. They each exhibited patience in guiding a willing physical scientist on a serendipitous foray into social science, and the wisdom to know when to let me swim on my own. In addition, they provided candid and timely advice; prompt, insightful reviews of drafts; and continue to provide a model of excellence and integrity which I aspire to achieve. I also extend my sincere gratitude to Dr. Paul Kay and Dr. Larry Swatuk, who served graciously on my research committee and provided important guidance, support, and travel assistance.

I am further indebted to the University of Waterloo. Financial awards provided by the university made my research possible. I am further grateful to the fine professionals of the university for their professionalism. Dr. Jody Decker at Wilfrid Laurier University stands out as particularly influential; many teachers have changed *what* I think, but she changed *how* I think.

I also acknowledge a vital role played by my wife, Jeni, who for some sadistic reason did not talk me out of taking this path even though she knew what ~~I was~~ we were getting into.[2] It turns out that marrying a doctor was a good idea in unexpected ways; her council on academic matters has been invaluable. She also selflessly carried the majority of household duties, and two children, during my studies. Finally, I credit my wife with insisting I acknowledge the key contribution to my productivity made by the 1,146 Red Bulls I consumed while working toward this dissertation.

Jim Nicholas and Dr. Greg Cronin deserve recognition for mentoring, continued friendship, and for providing letters for my application package. Jim is particularly memorable as my greatest supervisor and for luring me to Michigan, partially on the condition of letting me hunt his property. Greg stands out for his efforts as my master's thesis adviser, and for our rich conversations about Haiti, hockey, and how the boat managed to run aground and why the sail won't come down.

Cumulatively, my parents contributed heavily to my accomplishments, for establishing a solid foundation on which to build my life and making sacrifices to send me to college. Not all are this fortunate. On the topic of family, I close by recognizing my good fortune to live with Jeff and Jo-Ann Merriman while in Waterloo, who welcomed me as a loved member of their family.

[1] The dram was not' wee,' nor the campfire 'quaint,' but the conversation was sincere.
[2] She claims to have tried, and that I would not listen to passionate, rational arguments.

Dedication

To my lovely wife, Jeni, and our two children, Darwin and Rex. Having you in my life makes this dissertation my fourth greatest triumph.

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Chapter 1
Introduction

The past 150 years of economic growth around the globe have powered an unprecedented improvement in living conditions for most people. Advancements in disciplines such as engineering, economics, and public health have helped create a world with previously unimaginable access to resources and wealth, while extending global average life expectancy to nearly 70 years of age (World Bank 2011). For example, in 2010, 87% of the world's population met the WHO/UNICEF definition of having access to 'improved' sources of drinking water (World Health Organization and UNICEF 2010). Advancements in public health and medicine have neutralized diseases such as influenza, polio, and smallpox that once caused untold pain, suffering, and death throughout the world. The scale and pace of wealth and economic growth in the 21st century is unprecedented. In an economic sense, these advancements are due to a spectacular and accelerating division of labor (Smith 1776 [1976]; Sachs 2005) made possible by the confluence of conditions favorable to the globalization of goods and services.

However, a serious problem exists. Living conditions have been slow to improve for many people, particularly those in less developed countries (LDCs). This phenomenon is nothing new, since inequitable access to resources has likely existed from the beginning of humankind. Thinkers as diverse as Thomas Malthus and Karl Marx famously grappled with many of the issues seen today. Countless accounts of poverty and inequitable resource distribution exist in the literature and many have stimulated social and political movements.

Independent of the academic and political hand wringing over the causes of inequitable distribution of resources, the consequences are stark. A dramatic disparity exists in the distribution of wealth among and within nations. Davies et al. (2008) report that the richest 2% of individuals control over half of global wealth, while the bottom 50% of individuals cumulatively control barely 1% of global wealth. While 87% of the world's population has access to improved sources of drinking water, the 13% that does not represents over 800 million people. And 39% of the world's population, over 2.6 billion people, lack access to basic sanitation (World Health Organization and UNICEF 2010).

Paradoxically, this disparity persists even as vast resources flow from more developed countries (MDCs) to LDCs to improve living conditions. Over $120 billion of development assistance money now flows to LDCs *annually* (Deutscher 2010). Most of this aid is channeled through aid agencies

often criticized for inefficiency and waste (Easterly and Pfutze 2008) and ineffectiveness (Easterly 2006). Some authors acknowledge difficulties with giving foreign aid but champion present and future global efforts such as the Millennium Development Project (Sachs 2005). But others have gone so far as to claim that foreign development assistance does harm and should be abandoned (Moyo 2009). At the very least, the debate over foreign aid underscores the notion that assisting the developing world is a complex issue fraught with difficulties.

Development problems in LDCs are often challenging for a number of reasons. The actors often see the same problem differently from their respective positions. The contrasting viewpoints of Sachs (2005), Easterly (2006), and Moyo (2009) are one illustration of this reality. Some may deny a problem exists at all (Simon 1996) or try to undermine others trying to act (Inhofe 2012). When the actors cannot agree that a problem exists, or on exactly what the problem is, coordinated efforts to improve the issue can be elusive. Furthermore, even when actors can agree on a specific problem, solutions may not exist in an ideal form, and alternatives may be unknown or may not yet exist. Choices are usually not between 'right' and 'wrong'; many times the best that can be hoped for is *better*. Rittel and Weber (1973) coined the term 'wicked problem' in the planning literature to describe this type of situation.

The wicked nature of many development problems and the growing angst with the status quo of foreign assistance points to a need to approach old problems differently and from fresh perspectives. Indeed, the current condition persists despite the cumulative contributions of many smart and talented people and vast investment of resources. If the solution is to apply greater effort in the same ways, development would likely not still be a problem. It is my contention that the solution likely lies in approaching the same problems in different ways and in ways customized for each setting.

1.1 Defining the Study

The study is designed to flow schematically in an hourglass form, illustrated in Figure 1.1. The downward flow represents study design; the upward flow represents interpretation of data collected, answering the problem statement, and ultimately making a contribution to knowledge.

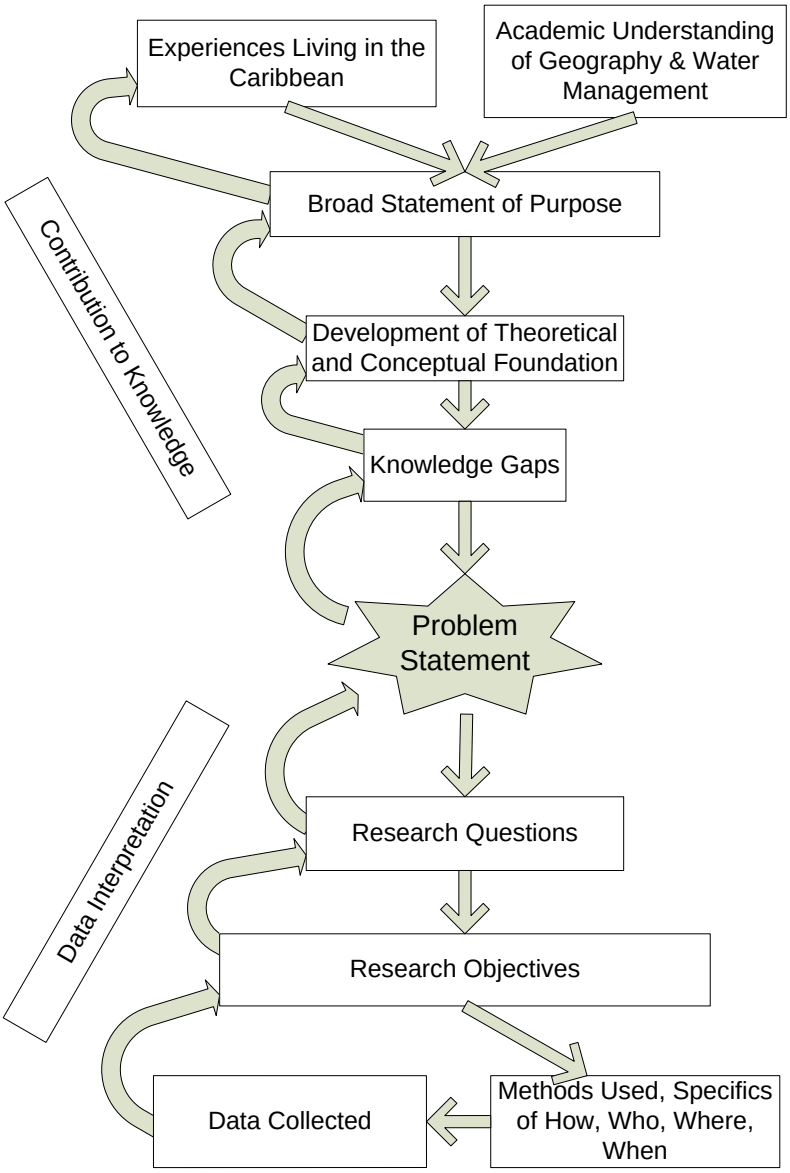


Figure 1.1. Schematic of research design, featuring the roles of data interpretation and contribution to knowledge.

1.1.1 Statement of Purpose and Scope

The purpose of this study is to determine actions most likely to stimulate transformation of Grenadian water management. The scope is defined geographically to include the main island of Grenada. Additionally, the term **water management** refers to the management of the freshwater resource; supply of potable water to residents, industry, and agriculture; and recognizes linkages to other stakeholders at a wide range of scales. The term 'transformation' is defined in Section 2.2.1.

1.1.2 Problem Statement

The problem pursued in this study is, *How do traps and transformability affect progress of Grenadian water management?* Progress is defined relative to resident wellbeing, as discussed in Section 4.1. Answering this question is intended to fill knowledge gaps, address the statement of purpose, and facilitate a change in the experience of living in the Caribbean depicted in Figure 1.1. This question is informed by academic literature as described in Chapter 2, particularly literature on social-ecological systems (SES[3]), resilience thinking, and integrated water resources management (IWRM). This problem statement is crafted to ensure the study is relevant to resident wellbeing, but retains a focus on traps and transformability of Grenadian water management.

1.1.3 Research Questions and Objectives

The study is further designed with four research questions and seven objectives, summarized in Table 1.1. Once answered, the objectives should answer each research question. Likewise, answers to the four research questions should solve the problem statement. The full study design is depicted in Figure 1.2.

Table 1.1. Summary of the research questions and objectives.

Research question #1: To what extent is Grenadian water management in a trap?

Objective #1A: To create a literature based evaluation framework to assess traps

Objective #1B: To apply the evaluation framework to Grenadian water management

Research question #2: To what extent is Grenadian water management transformable?

Objective #2A: To create a literature based evaluation framework to assess transformability of water systems

Objective #2B: To apply the evaluation framework to Grenadian water management

Research question #3: Do current and recent interventions effectively foster or utilize transformability?

Objective #3: To determine if a lack of transformability is inhibiting efforts to improve Grenadian water management

Research question #4: Which interventions should be pursued to facilitate transformation of water management in Grenada?

Objective #4A: To identify which aspects of the system are the key points preventing change

Objective #4B: To determine the most effective ways to relieve, or marginalize, the key points preventing change

[3] Social-ecological systems is a term used to acknowledge the interdependence of social systems and ecological systems and that neither type of system can be understood in isolation.

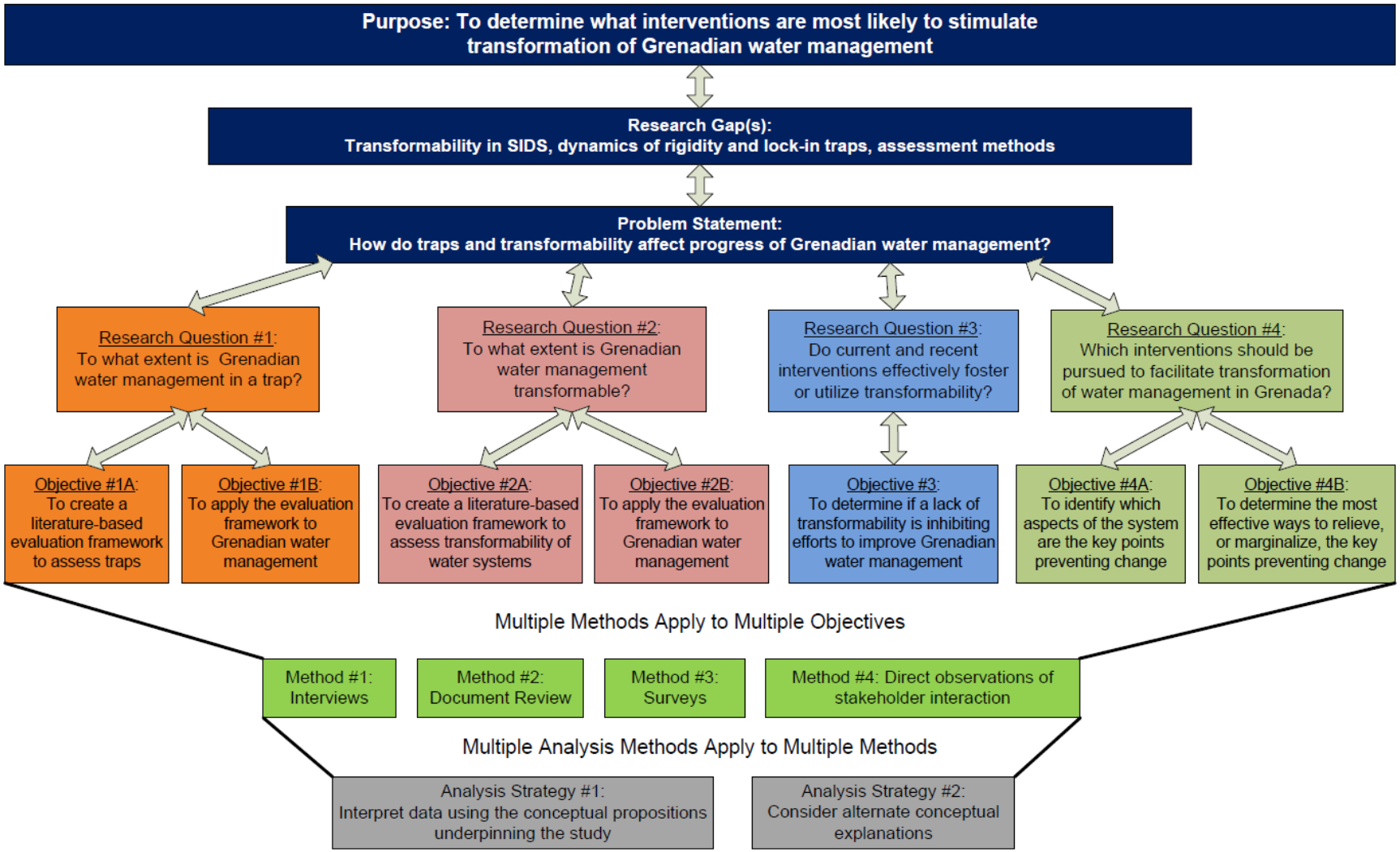


Figure 1.2. Schematic structure of study, featuring linkages among research components.

1.2 Study Area

Selection of a manageable and well-defined study area and specific problem is important to develop insight relative to the conceptual knowledge gaps in the academic literature. Large systems quickly become unwieldy and difficult to study. For example, trying to explain the dysfunction of the United States congressional system from an SES perspective would likely be untenable. An ideal study location is one with definite boundaries, is small, but is similar enough to other contexts that its study may serve as a model for larger systems.

Small island developing states (SIDS) may present a uniquely manageable opportunity to study the dynamics of social change, particularly with regard to water management. Population sizes and land areas are commonly small and easier to approach than those in continental settings. Additionally, SIDS typically have better defined boundaries. In a literal sense, the boundaries are well defined as shoreline, which usually reduces or eliminates overlapping jurisdictions over a common fresh water resource and simplifies the approach to water management. In a broader geographical context, the remoteness of SIDS tends to dampen outside influences. However, it is acknowledged that SIDS are not simply small, manageable, LDCs. They have unique attributes and the setting of each SIDS must be carefully considered before extrapolating judgments to other settings.

Water resource management on the island of Grenada (pronounced 'gri-**ney**-duh') was chosen as a single case study for several reasons. First, the small island setting provides a manageable sized system to study with well-defined boundaries, both politically, and in terms of fresh water resources. Second, this island experiences many of the same difficulties facing other small island states throughout the world, particularly concerning water resource management. Third, similar to other LDC settings, relatively large amounts of foreign aid are routinely targeted at improving water supply and management in Grenada. Fourth, I resided in Grenada for most of the past 7 years, working in the Department of Public Health at a local university, and have accumulated a breadth of knowledge of the island and access to key persons in the water sector that would be difficult to duplicate elsewhere in the timeframe of a PhD project. Finally, as discussed further in Chapter 3, conducting a single case study rather than a multi-case study enables a more in-depth analysis. This strength admittedly comes at the price of the breadth of analysis afforded in a multi-case study approach.

The nation of Grenada is located between the Atlantic Ocean and Caribbean Sea, at the southern end of the Windward Islands (Figure 1.3). Politically, the nation of Grenada consists of three populated islands, the islands of Grenada, Carriacou, and Petit Martinique. The latter two islands are

sparsely populated, do not have water distribution infrastructure, and rely 100% on rainwater harvesting to meet water needs. This study does not consider the outlying islands.

Figure 1.3. Map of Grenada. Figure adapted from images in The World Factbook, published by the US Central Intelligence Agency, accessed on 15 March 2012 at https://www.cia.gov/library/publications/the-world-factbook/geos/gj.html.

1.2.1 Geography of Grenada

Grenada is classified as an upper-middle income country by the World Bank with a per capita income of $7,710 US, measured in terms of 2009 purchasing power parity (World Bank 2011). The nation has a population of approximately 110,000, almost entirely on the main island of Grenada. As of 2012, there is a net migration of people moving away from Grenada, reflected in an emigration rate of 3.3 migrants per 1,000 population per year (Central Intelligence Agency 2012). Despite emigration, the birth rate (16.6 per 1000 people) is relatively large compared to the death rate (8.0 per 1000 people) and Grenada experiences modest population growth of 0.5% annually.

The island of Grenada is approximately 30 km (19 mi.) in length, north to south, and 15 km (9 mi.) in width, from east to west, with a total land area of approximately 286 km^2. The island is volcanic in origin and mountainous, rising to an elevation of 840 m (2,760 ft.; Caribbean Conservation Association 1991). Similar to other small, volcanic islands, the mountainous island terrain forms many long, narrow watersheds (Figure 1.4). The island is located on the 12^{th} parallel North and has a tropical climate, moderated by northeast trade winds and year-round seawater temperatures of 27-30° C.

Figure 1.4. Watersheds of Grenada. Figure created using the Grenada Water Information System, May 7, 2012. http://www.cariwin.gd/webmap/app/db/index.php.

Precipitation on the island varies over space and time. The nearly constant trade winds blow warm moist air over the island from the east, resulting in large amounts of orographic precipitation in the interior of the island (Figure 1.5). However, the island experiences distinct dry (January – May) and wet (June – December) seasons (Figure 1.6). This seasonal variability is driven by the annual north and south migration of the North Atlantic high pressure cell. During the wet season months, this

high pressure zone migrates northward, causing the Inter-Tropical Convergence Zone to migrate northward and over the Caribbean. This results in a convergence and uplifting of surface winds over the Caribbean, which drives precipitation during this time of year. During the dry season, the opposite situation occurs. The North Atlantic high pressure cell, and therefore the Inter-Tropical Convergence Zone, migrate southward, causing lower-tropospheric divergence over the Caribbean and subsidence of surface winds, which greatly reduces precipitation during this time of year (Stephenson, Chen, and Taylor 2008, p. 87).

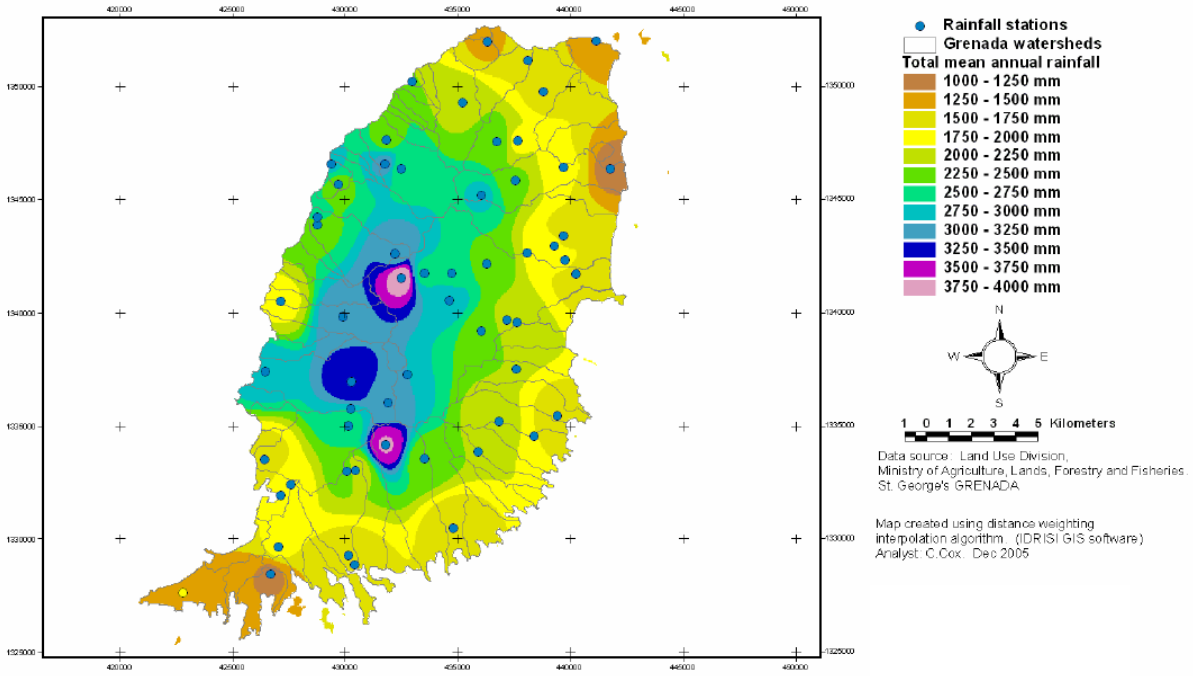


Figure 1.5. Average annual precipitation in Grenada. Figure adapted from CEHI (2006b).

Interannual variability in precipitation is also significant and responds strongly to the El Niño Southern Oscillation (ENSO). During an ENSO event, the North Atlantic high pressure cell strengthens and expands toward the equator, causing higher sea-level air pressure and lower surface water temperatures over the Caribbean. The effect of these developments is for a decrease in precipitation over the Caribbean during ENSO events, although the full relationship is considerably more complex than presented here (Giannini, Kushnir, and Cane 2000). Droughts in Grenada correlate with ENSO-intensified dry seasons and represent the times the water supply is most stressed with regard to producing sufficient water to supply the nation.

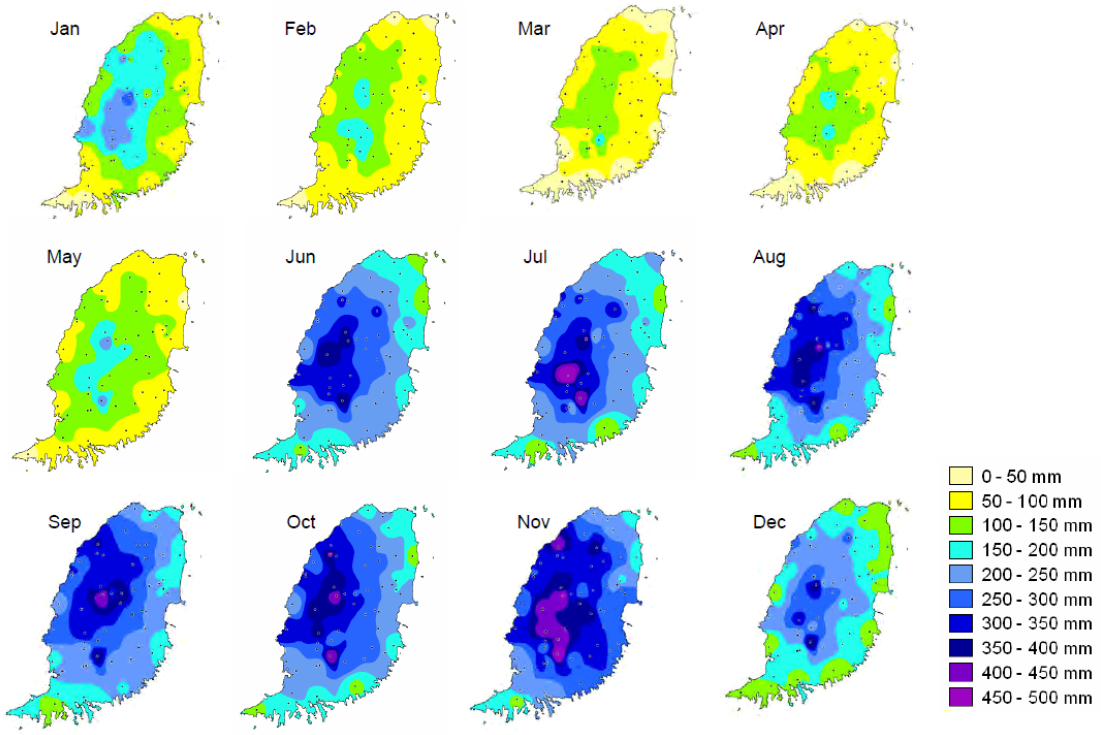


Figure 1.6. Average monthly precipitation in Grenada. Figure adapted from CEHI (2006b).

1.2.2 Water Management Challenges and Solutions

Fundamentally, Grenada has an abundance of freshwater resources. Although reliable estimates of per capita water supply do not exist, a tropical rainforest exists within 10 kilometers (6 miles) of every residence. Nonetheless, water management in Grenada faces many challenges and water shortages continue to exist.

Water is generally supplied to residents through a system of diverting source water from high-elevation streams to treatment plants and then distributing treated water to residents at lower elevations. A distinct advantage of this system is that it utilizes gravity to distribute water and greatly reduces the need for costly pumping. However, the rugged terrain also reduces opportunities for easy diversion or distribution of water from one watershed to another. As a result, the water supply system uses 33 relatively small water treatment plants, most of which use surface water from small streams, and a water distribution system with limited ability to move water from watersheds with excess water resources to watersheds in need of greater water supply.

Seasonal water shortages in Grenada result from a combination of factors. Some water treatment plants are particularly vulnerable to dramatic seasonal fluctuations in source water. The Caribbean Environmental Health Institute (CEHI; 2006a) identified five treatment plants that collect water from catchments with greater dry-season potential evapotranspiration (PET) than dry-season

rainfall. Stated another way, if actual evapotranspiration (ET) is at or near PET in these catchments, any water flowing in the stream must originate from groundwater storage. This contributes to vulnerability to water shortages during drought conditions.

Additionally, difficulties in diverting water around the island make areas with high populations vulnerable to dry season shortages. On balance, Grenada has vast freshwater resources. But the bulk of the population is located in the southwest corner of the island. The lack of ability to divert sufficient water from other watersheds often contributes to seasonal water shortages. In some cases, shortages occur despite the presence of abundant water resources a few kilometers away.

All of these problems could be relieved if sufficient water could be stored from wet season to dry season. Unfortunately, options for water storage are limited. In concept, a large dam could be constructed to store water from wet season to dry season. Even if this were a cost-effective solution, the rugged terrain precludes easy distribution of water from any central location to other parts of the island. Another option is to construct many moderate size dams to store water and supply water treatment plants around the island. However, this option is not considered in the water authority's current 5-year plan (NAWASA 2009). Large storage tanks could also be constructed throughout the island to store potable water for times of shortage. Large storage tanks are used in some parts of the island, but expansion of their use is not presently under consideration.

An added challenge posed by poor water storage options is that sediment-laden water is frequently flushed into streams, and into water intakes, after significant rainfall events. Most water treatment plants lack the ability to let heavy sediment loads settle from water being treated. In these cases, the plant operators choose between closing the treatment plant until the source water clears, which causes a supply disruption to residents, and supplying sediment-laden water to the distribution system. However, only two of the 20+ treatment plants that utilize surface water in Grenada are staffed outside of normal business hours. If the rainfall occurs during these non-staffed times, sediment-laden water flows through the unstaffed water treatment plants and enters the distribution system.

Finally, the mountainous terrain and deficiencies in the water distribution system cause difficulty in maintaining consistent water pressure. Spikes in water pressure can rupture household fixtures and cause frequent breaks in the distribution system. This can further exacerbate water quality and quantity problems.

Technical solutions exist to overcome supply problems, both at the resident and water authority levels. Residents can, and many do, store rain or piped water in plastic water tanks or cisterns under

their homes. The water authority could utilize additional streams or establish intakes and treatment plants farther downstream than presently located to expand source water supply. Use of groundwater also could be expanded. Water use could be reduced; leakage could be reduced in the water distribution network, or policies to promote water use efficiency and conservation could be implemented.

The current state of water supply in Grenada is a product of the existing water management system. Technical solutions to management challenges have been implemented to varying degrees and water supply has improved in recent decades.[4] Nevertheless, solvable supply shortages persist. The fundamental issue is likely not a lack of water or technical solutions; the fundamental issue is that existing water resources and technical solutions are insufficiently managed.

Shortcomings of Grenadian water management have been recognized, and domestic and international efforts to transform the water sector into a holistic and integrated management system are ongoing. Despite these efforts, change remains elusive. This dissertation describes a research effort to explain why Grenadian water management resists change. Furthermore, this research assesses strengths and weaknesses in current intervention efforts and prescribes interventions likely to stimulate transformation of Grenadian water management.[5] Beyond the case, this research contributes a generalizable nomenclature to quantify and describe traps. It also advances the concepts of resilience thinking and provides a generalizable strategy of seeking out and alleviating points of failure in transformation to free trapped systems.

1.3 Description of Dissertation Organization

This thesis utilizes a traditional structure, similar to that used in most scientific journals and as discussed in Yin (2009, Kindle location 3540). First, the study problem is defined and background information is presented. Relevant literature is then discussed, followed by presentation of the research design and study methodology and the results of data collection. An analysis of the results is

[4] Data to document trends in the frequency and severity of water supply shortages does not exist. To judge these parameters, I relied on observation, document, interview, and questionnaire data. Similarly, no long-term (>10 years) records of streamflow exist and almost no streamflow data exist at all. No water demand forecasts have been made. Overall population is relatively stable (Section 1.2.1), but trends in urbanization are difficult to discern until data from the 2009 census are published (results from the 2000 census were not published until 2009). All of these data would be useful to develop a quantitative assessment of trends in water shortages.

[5] As stated in Section 1.1.2, the problem statement guiding this study is crafted to retain relevance to resident well being, but a focus on the SES concepts of traps and transformability. In particular, recommendations made in this study are intended to help Grenadian water management overcome any traps and to enable it to transform, but do not address the 'best' type of system Grenadian water management should transform into.

then presented, followed by the study conclusions and implications. Accordingly, the remaining chapters of this thesis are:

Chapter 2 – Literature Review,

Chapter 3 – Research Design and Methodology,

Chapter 4 – Grenadian Water Management System,

Chapter 5 – Traps and Transformations,

Chapter 6 – Breaking the Rigidity Trap, and

Chapter 7 – Conclusion.

Chapter 2
Literature Review

This chapter provides a discussion and evaluation of academic literature relevant to this study as well as context for the position of this study with respect to current scientific knowledge. Within this discussion, research gaps and opportunities for contributions to the literature are identified. In particular, I argue that a synergy exists among the concepts of transformability, MS traps, and IWRM, but such synergy should be validated through research of real SESs. I have structured the chapter in five sections as follows:

- The first section presents the conceptual framework of resilience thinking, which guides the design and interpretation of the study.
- The second section builds upon the discussion of resilience thinking and focuses specifically on transformation of SES. In this section, I scrutinize current research and delineate research gaps relevant to this study.
- The third section presents a parallel discussion on MS traps in SESs, and also scrutinizes current research and delineates research gaps.
- The fourth section presents a discussion of the literature on IWRM. The recent attempt to implement IWRM in Grenada is arguably the best example identified in this study to illustrate the dynamics of transformation and MS traps. The discussion of the academic literature on the normative principles of IWRM and the difficulties with implementing them in an operational sense serves as a basis for discussing the study results.
- The fifth and final section summarizes the key findings of the literature review and draws conclusions. Discussion focuses on how these three literatures connect to frame this study and highlight how knowledge gaps will be filled.

I do not discuss all potentially relevant literature to this study. In the presence of the expansive and fragmented academic literature and in an environment of finite resources, I decided to review a subset of the relevant literature. Furthermore, the literature discussed in this chapter is a subset of all the literature considered in preparing this study.

2.1 Conceptual Framework

I use the term *conceptual framework* to denote the set of principles with which I "analyze, understand, and prescribe" actions to resolve dilemmas specific to my case. In contrast, I consider the term *theoretical framework* to denote a set of principles to "describe, explain and predict" at a nearly-

universal level (Mitchell 2008, p. 141-2). For example, Charles Darwin's theory of natural selection can be applied to describe, explain, and predict the evolution of life forms the world over. However, there is no nearly universal principle to describe, explain, and predict persistent, wicked problems such as how to bring about change in a society. These problems often involve learning through trial and error and lateral thinking to approach the issue from multiple angles until something works. A more reasonable, and still useful, target is to aim to analyze, understand, and prescribe solutions for these cases. Basic principles and generalizations can serve as reference points to navigate wicked, persistent problems and I refer to these guideposts as a conceptual framework.

2.1.1 Resilience and Resilience Thinking

The fundamental goal of the study is to illuminate ways to foster resilience in Grenadian water management. In this sense, I tentatively describe resilience as ability of a system to 'absorb shocks' when disturbed. The study helps identify strategies to make Grenadian water management better able to overcome shocks such as drought, infrastructure failures, and funding shortfalls, and still deliver high quality water service to users.

Literature on social-ecological systems provides considerable commentary on how to conceptualize resilience. Holling (1973) introduced the concept of stability domains to describe the extent to which one type of system, an ecosystem, could be disturbed while still being 'able to get back' to its original form. Holling also introduced the concept of thresholds as being the 'tipping point,' or the point at which a disturbed ecosystem would "flip" (p. 9) to a different form. These concepts were used to explain why abrupt, dramatic, and often permanent changes in ecosystems occurred following disturbances that had previously caused modest and reversible changes to system behavior. Examples in the SES literatures of such 'flipping behavior' include insect outbreaks in forest ecosystems (Ludwig, Jones, and Holling 1978), eutrophication of lakes (Scheffer et al. 1993; Carpenter and Cottingham 1997), and societal collapses and processes of social collapse and renewal (Homer-Dixon 2006).

Scheffer et al. (1993) and Gunderson (2000) used a 'ball-in-cup' heuristic to describe the concept of stability domains, thresholds and 'flipping behavior' of ecological systems (Figure 1.2). In the ball-in-cup illustration, the ball is defined to be the state of a given SES, and the cup is defined to be a stability domain. At equilibrium, the ball rests at the bottom of the 'cup.' If the ball is disturbed, signified by pushing the ball away from the equilibrium point, it will normally return to the bottom of the cup. However, if the ball is pushed 'too far,' it will cross a threshold and trigger rapid and turbulent change, and move toward a new equilibrium in a new stability domain. In this analogy, the

term **resilience** is defined as the capacity for a system to absorb disturbance and remain in the same cup, or stability domain.

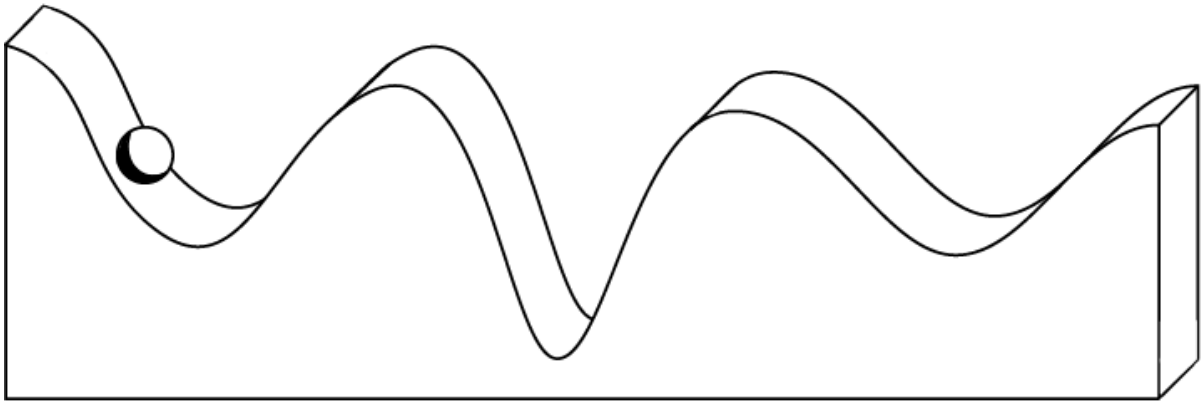


Figure 2.1. Ball in cup heuristic used to describe social-ecological resilience. The state of the system is represented as a ball, the valleys, or cups, are defined to be alternative stability domains. Figure redrawn from images in Carpenter and Gunderson (2001, p. 454).

The adaptive cycle (Holling 1986) and panarchy (Holling 2001) explain key aspects of resilience. The **adaptive cycle** is a metaphor to describe the dynamics of SES change (see Walker and Salt 2006, p. 31-36). Within the social-ecological systems literature, systems are observed to pass through four distinct phases that form a cycle. The four phases are growth and exploitation (r), conservation (K), release (Ω), and reorganization (α). Holling (1986) first presented the adaptive cycle graphically as a 'sideways figure 8' with a Y-axis of potential and X-axis of connectedness (Figure 2.2). Later representations include a Z-axis of resilience (Figure 2.3; Holling 2001). Holling (2001, p. 394) provides crucial definitions for these axes. The **potential axis**[6] is defined as determining the limits of what is possible, or as the options for the future. The **connectedness axis** is defined as "the degree to which a system can control its own destiny." Finally, the **resilience axis** is defined as "how vulnerable the system is to unexpected disturbances and surprises" (Holling 2001, p. 394) and is essentially a measure of how well the system is able to stay in 'one cup,' as depicted in Gunderson (2000). Walker et al. (2004) point out the adaptive cycle does not mean systems always cycle through these stages in sequence and many permutations of system behavior are possible. The

[6] Terminology for the Y-axis of the adaptive cycle has been variable in the literature. Holling (2001) described the Y-axis using both "potential" and "wealth." In describing lock-in traps, Allison and Hobbs (2004) used the term "potential" as well as the terms "capacity" and "capital" to illustrate the dynamics of trapped systems. The terms capital and wealth are perhaps used to emphasize the accumulation of resources or to provide better integration of the adaptive cycle analogy to other disciplines as discussed in Abel, Cumming, and Anderies (2006, p. 3). Gunderson, Holling, and Allen (2010, p. 436) provide a table similar to Table 2.1 that provides both terms, "capital/potential." All of these terms are consistent with the meaning of the axis, as defined in Holling (2001), which is to determine the limits of what is possible, or the options for the future. I choose to use the term *potential* because it is most common in the literature.

concept of panarchy (Figure 2.4; Gunderson and Holling 2002), defined below, was developed to illustrate that adaptive cycles exist at many scales, both within a SES and among SESs. Many of these adaptive cycles interact and can profoundly influence the stability of any given system, enhancing or reducing resilience.

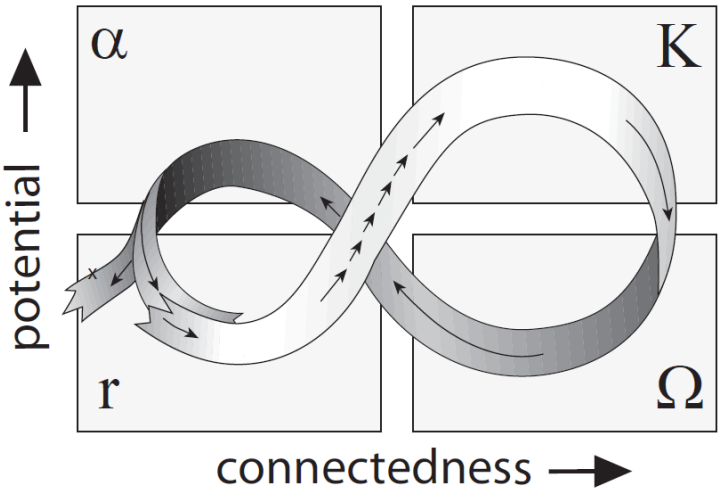


Figure 2.2. 2-D representation of the adaptive cycle with axes of potential and connectedness. Modified from *Panarchy* edited by Lance H. Gunderson and C.S Holling. Copyright © 2002 Island Press. Reproduced by permission of Island Press, Washington, DC.

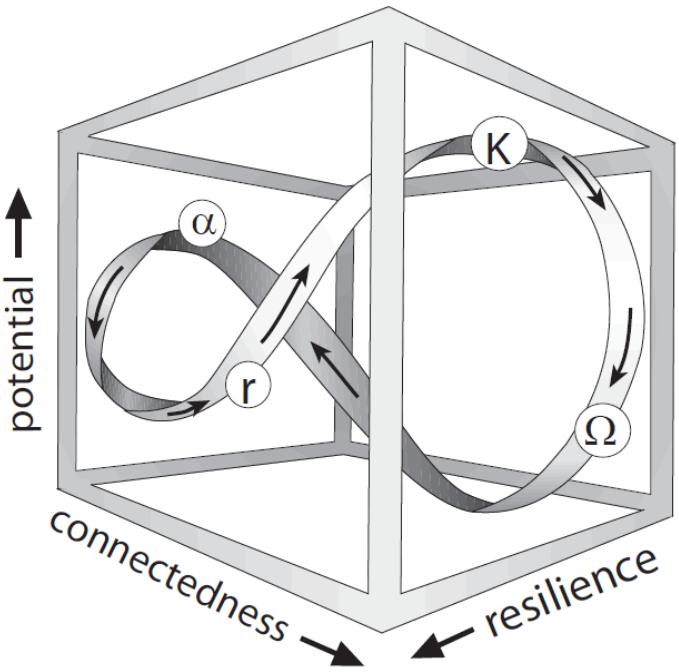


Figure 2.3. 3-D representation of the adaptive cycle with axes of potential, connectedness, and resilience. Modified from *Panarchy* edited by Lance H. Gunderson and C.S Holling. Copyright © 2002 Island Press. Reproduced by permission of Island Press, Washington, DC.

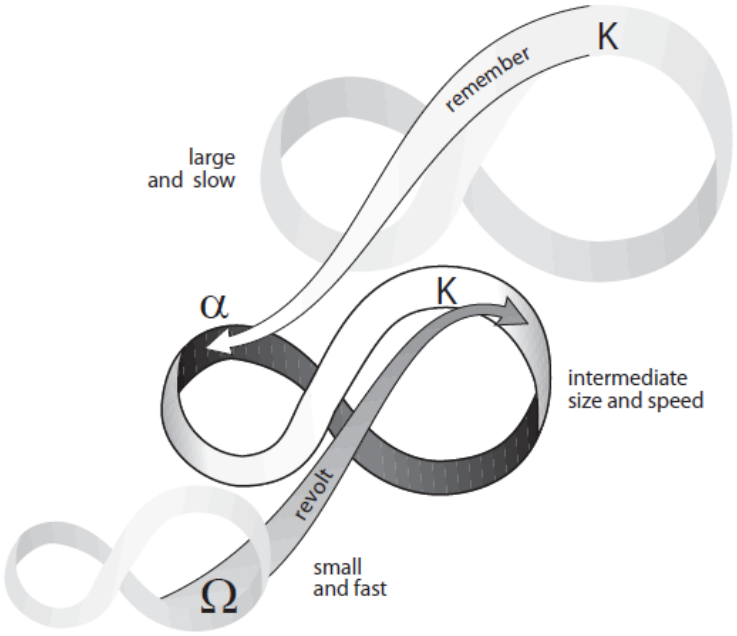


Figure 2.4. Graphical representation of the panarchy metaphor. From *Panarchy*, edited by Lance H. Gunderson and C.S Holling. Copyright © 2002 Island Press. Reproduced by permission of Island Press, Washington, DC.

Unfortunately, it is easier to define what resilience is than to explain how to get it. To help fill this gap, resilience thinking has emerged in academic literature as a metaconcept[7] which describes how to foster resilience. **Resilience thinking** describes the full range of factors that affect change in SESs, and is governed not only by resilience, but also by adaptability and transformability (Figure 2.5; Walker et al. 2004; Walker and Salt 2006). [8]

Walker et al. (2004) further described resilience as having four key aspects: latitude, precariousness, resistance, and panarchy. **Latitude** is the amount a system can be changed before crossing a threshold into a new stability domain. This can be thought of as the width of the cup. **Resistance** is the difficulty of moving the system and can be thought of as the steepness of the cup. **Precariousness** is how close the system is to a threshold and can be thought of as how close the ball is to the top of a cup. **Panarchy** is a metaphor for the effect of influences from other scales on the system and can prevent, or cause, the system to cross thresholds.

[7] A metaconcept is defined herein as a concept devised to analyze another concept.
[8] Walker and Salt (2006) provide the earliest use of the term 'resilience thinking' in the literature. Use of this term to describe how adaptability, resilience, and transformability work in concert to affect social-ecological systems has grown increasingly common, although its application remains inconsistent. Notably, Gunderson, Holling, and Allen (2010, p. 423) acknowledged use of this term to "capture a coherent set of notions that together produce a framework for conceptualizing and explaining how systems of humans and nature behave."

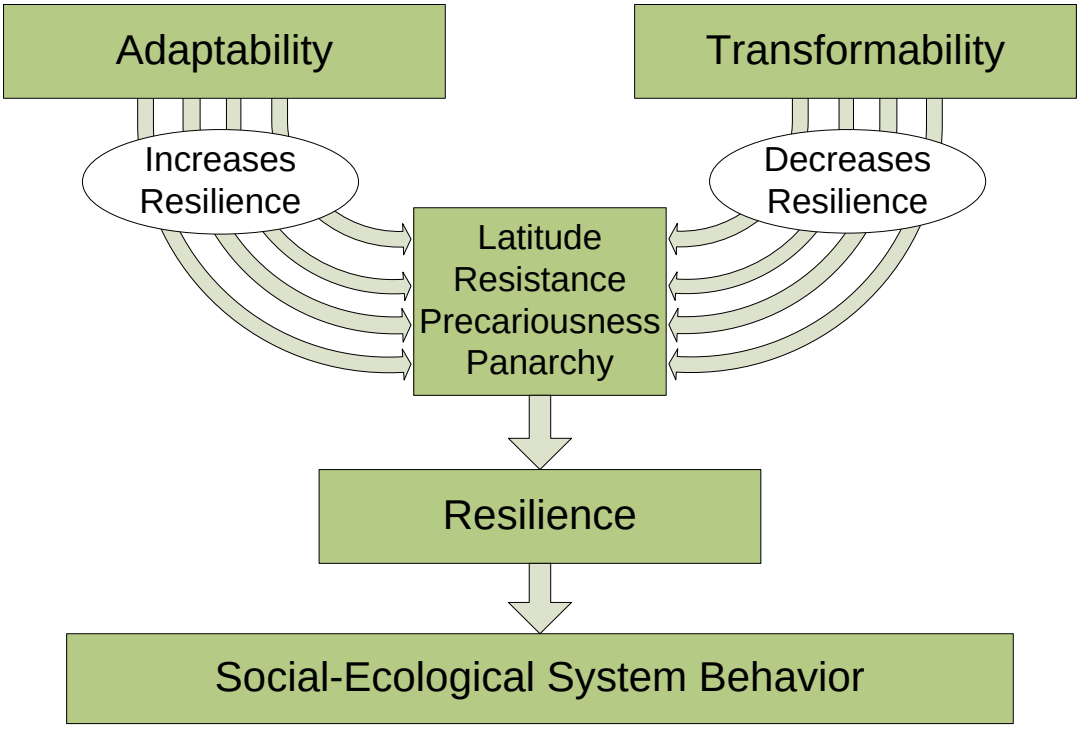


Figure 2.5. Depiction of how adaptability, transformability, and resilience act to affect social-ecological system behavior in the resilience-thinking framework.

Resilience and adaptability are closely related in that resilience is the capacity of a system to remain in one stability domain, or 'cup,' while **adaptability** is defined as "the capacity of the actors in a system to manage the system's resilience" (Walker and Salt 2006, p. 119).[9] In practice, adaptability is achieved by manipulating the four key properties of resilience to prevent the system from falling into a different stability domain, or 'cup.' In a natural resource management context, management actions can attempt to purposefully move a system away from a threshold or prevent it from moving toward a threshold. Management actions can also manipulate the position of the thresholds, or alter the shape of the cup. For example, to avoid social disruption in response to climate change, managers could choose to encourage cultivation of new crops that may be better adapted than current crops to future climatic conditions. In effect, this would 'widen the cup' and increase the latitude that the system can be pushed before crossing into an undesirable stability domain, in this

[9] Many terms with the root word 'adapt' exist within the social-ecological systems literature. At least 13 such words are used throughout this thesis. In many cases, the proliferation of 'adapt words' is grammatical in nature (e.g., adapt, adapting, and adapted; adaptive and adaptiveness). In other cases, confusion results from inconsistent use in the literature (e.g. adaptability and adaptive capacity). Where appropriate, I confront the confusion directly, define the meaning of each term, and omit further use of particularly confusing 'adapt terms' (e.g. adaptive capacity, see Section 2.1.1). Ultimately, my use of these terms is a reflection of the social-ecological systems literature.

case to social disruption. Other management decisions could be targeted at improving the healthcare system to provide some social resistance to future disease conditions. Management efforts can also be taken to identify situations in which the system is precariously close to existing thresholds and to move the system farther away from those thresholds. For example, if unprecedented tropical storms are expected in the future because of climate change, management actions could be targeted at preparing for such storms. Finally, the concept of panarchy can be utilized to affect the stability of a given SES, as described below.

Walker and Salt (2006, p. 119) state explicitly that the concept of adaptability is equivalent to adaptive capacity. The distinction between adaptability and adaptive capacity elsewhere in the literature is subtle and often avoided. Some authors avoid using both terms in the same publication (Walker et al. 2004; Walker and Salt 2006), others equate the two terms outright (Holling 2001, p. 394), and The Resilience Alliance offers subtly distinctive definitions for both in a glossary of terms posted on its web page (http://www.resalliance.org/608.php). For the purposes of the current discussion, the two are treated as equals, and the term adaptability is preferred to avoid confusion between the terms adaptive capacity and adaptive cycle.

Transformability is the capacity of a system to 'reinvent itself' when the form of the current system is deemed untenable. Walker and Salt (2006, p. 62) define it as "the capacity to create a fundamentally new system when ecological, social, economic, and political conditions make the existing system untenable." It is the ability to recognize when the system is better off *not* remaining in the same cup, to identify or create a better cup to move to and then to move there. In the ball-and-cup heuristic, resilience and adaptability were focused on keeping the ball in a stability domain. Transformability does the opposite; it focuses on moving the ball to a new domain.

2.1.2 Traps

Empirical observations of SESs following the idealized trajectory provided by the adaptive cycle framework are limited. In fact, SESs often *do not* follow the trajectory indicated by the adaptive cycle. These non-conforming systems have been termed maladaptive (Gunderson and Holling 2002) and described as being in a pathological state (Allison and Hobbs 2004). Relatively little research exists to explain the reasons and consequences for maladaptive system behavior. In some cases, influences through panarchy or fundamental failures in the SES prevent progression through the adaptive cycle and result in a non-desirable and stubbornly persistent 'trapped' state (Allison and Hobbs 2004; Abel, Cumming, and Anderies 2006; Bunce et al. 2009). The existence of a poverty trap and a rigidity trap was discussed briefly in Gunderson and Holling (2002, p. 95-98). A lock-in trap was later described by Allison and Hobbs (2004), who also hypothesized the existence of one more

as-yet unobserved maladaptive system. This fourth trap, was later termed an isolation trap (Table 2.1; Gunderson, Holling, and Allen 2010).

Table 2.1. The eight positions a system may occur within the adaptive cycle, if system potential, connectedness, and resilience are each assigned a 'high' and 'low' value. Table adapted from Allison and Hobbs (2004).

	Potential	Connectedness	Resilience	Description in Literature
K (Conservation)	High	High	Low	Holling 1986
Ω (Release)	Low	High	Low	Holling 1986
α (Reorganization)	High	Low	High	Holling 1986
r (Exploitation)	Low	Low	High	Holling 1986
Rigidity trap	High	High	High	Gunderson and Holling 2002
Lock-in trap	Low	High	High	Allison and Hobbs 2004
Poverty trap	Low	Low	Low	Gunderson and Holling 2002
Isolation trap	High	Low	Low	Gunderson, Holling, and Allen 2010

Both rigidity and lock-in traps occur when a system is maintained in the K phase of the adaptive cycle for a prolonged period. However, not all systems that persist in the K phase will fall into one of these traps, or are even undesirable. In fact, corporations go to great lengths to maintain high levels of production characteristic of the K phase, while mitigating the likelihood of a large, corporation-wide breakdown (Gunderson and Holling 2002, p. 95). Corporations achieve this state by maintaining many small adaptive cycles within the company, such as a research and development division, designed to produce variability and creativity. Lockheed-Martin's famed 'skunkworks' project is one such example (Gunderson and Holling 2002). Variability is managed internally and corporation-wide rigidity is avoided. The corporation can anticipate or respond more quickly to market changes and maintain the productivity of being in a K phase without experiencing the risk of a dramatic breakdown. In essence, what separates a 'bad' K phase from a 'good' K phase is adaptability and transformability occurring at smaller scales within the panarchy (Gunderson and Holling 2002, p. 402). A rigidity trap results when a system in the K phase is made or becomes increasingly rigid over time. Panarchy influences often contribute to rigidity by preventing breakdown and change of a system. If the resources available within the system for rebuilding a new future system are slowly lost over time, a lock-in trap results (Allison and Hobbs 2004). Nations run by corrupt dictatorships often fit this description. When these dictatorships eventually fall, a nation may be left with little to rebuild with (Laurance 2004).

Poverty traps, in the context of maladaptive systems, occur when a SES has low connectedness, potential, and resilience (Table 2.1; Holling 2001). These conditions may come about in different ways. If the breakdown experienced in the Ω phase of the adaptive cycle is sufficiently severe to prevent the reorganization of capital, or destroys most or all the capital in a system so that there is nothing left to reorganize, then a poverty trap results. The poverty trap condition is also, perhaps, a logical continuation of rigidity and lock-in traps. The result of a lock-in trap is a system with low potential (or wealth), high connectedness, and high resilience. If a lock-in trap continues for an extended period, the loss in potential (or wealth) can be extreme and undermine system connectedness, the degree to which a system controls its own destiny. The resulting system is low in connectedness and potential (or wealth) and high in resilience. However, when the conditions that perpetuate the lock-in trap change and resilience is reduced, a poverty trap results.

2.1.3 Alternative Approaches

I recognize academic perspectives other than resilience thinking could be used to inform this study. Some, such as governance (Gelcich et al. 2010), diffusion of innovation (Rogers 2003), and policy transfer (Mukhtarov 2007), provide broad frameworks to approach problems or even to define ideal solutions to strive for in working through problems. Many more, such as psychological empowerment (Menon 1999), critical consciousness (Freire 2005), and community-based social marketing (McKenzie-Mohr 2000), provide tools useful to sort through difficult aspects of problems. Resilience thinking complements, overlaps, and perhaps restates some of these other options and its use should not be considered mutually exclusive with other approaches. For example, the application of resilience to sustainable development is documented in widely cited publications authored by most of the key authors in the resilience field (e.g., Folke, Carpenter, Elmqvist, Gunderson, Holling, Walker et al. 2002). Ultimately, each approach has distinct advantages and disadvantages. I chose resilience thinking for the conceptual framework of this study because it offers a set of principles useful to analyze, understand, and prescribe actions to resolve complex social issues, yet is accommodating of insight from other perspectives. Literatures and approaches that inform, complement, or provide alternatives to resilience thinking are discussed as appropriate.

2.2 Transformability

The concept of transformation of social systems is not new to the academic literature. Thomas Kuhn's celebrated text on the structure of scientific revolutions dates to the early 1960s (Kuhn 1962) and other examples date to the early 20th century or even before (Hildreth 1853; Ellwood 1905). Within the literature on resilience, use of the terms *transformation*, used to describe a fundamental change in

a SES system, and *transformability*, used to describe the potential for such change, is relatively recent. Early works considered observed ecological transformations. Examples include observations of ecosystem transition from grass- to woody-dominated rangelands (Walker et al. 1981; Walker, Langridge, and McFarlane 1997) and from clear lakes to turbid lakes (Scheffer et al. 1993; Carpenter and Cottingham 1997). Gunderson (2000) utilized the ball-in-cup heuristic to describe the behavior of SESs and illustrate transformation as the movement of a system from one cup to another (Figure 2.1). Below, I focus on the development of the concept of transformability within the resilience-thinking literature, provide discussion about gaps in knowledge, and identify ways to fill those gaps in the current study.

2.2.1 What is Transformability?

Academic attempts to explain transformation within the SES framework are a relatively recent development. The landmark 'panarchy publications' of C.S. (Buzz) Holling and Lance Gunderson (Holling 2001; Gunderson and Holling 2002) built upon previous work and greatly advanced the academic understanding of SES behavior, notably by presenting the concept of panarchy for the first time. These publications advanced the conceptualization of transformation beyond 'cup to cup' movements. Both publications explained transformation as a response to conditions such as loss of diversity within an SES, a change in the surrounding environment, and disturbance. However, the two 'panarchy publications' left many unanswered questions. For example, neither publication provided a *definition* for transformation or explained how it relates to other key concepts in resilience thinking. The widely cited publication of Folke et al. (2002) also provided a description of transformability, but similarly did not define the term. In 2004, Brian Walker et al. published a paper aptly titled, *Resilience, Adaptability, and Transformability in Social-Ecological Systems* that provided the first explicit definition for transformability. Walker et al. (2004) also clarified the relationship between transformability and other key concepts in resilience thinking (Figure 2.2). Two years later, Brian Walker co-authored a book titled, *Resilience Thinking* (Walker and Salt 2006) that elaborated on the points presented in his 2004 publication and provided extensive case-study support.

The definition of transformability provided by Walker et al. (2004, p. 62) is "the capacity to create a fundamentally new system when ecological, economic, social and political conditions make the existing system untenable." In terms of the Gunderson (2000) 'ball in cup' analogy, transformability is the ability to recognize when the system is best served by moving to a different cup and then moving to that new cup.

The Walker definition remains the most widely cited definition in the SES literature by a wide margin, although other variants occasionally appear (Table 2.2). For example, Chapin et al. (2009, p.

241) defines transformation as a "fundamental change in a social–ecological system resulting in different controls over system properties, new ways of making a living and often changes in scales of crucial feedbacks." To date (2012), no other publications in the academic literature have adopted this definition. Folke et al. (2011, p. 724) essentially rephrase the first half of the Walker definition and retain its second half: "The capacity to create untried beginnings from which to evolve a fundamentally new way of living when existing ecological, economic, and social conditions make the current system untenable." Folke et al. (2011) was authored by 22 individuals, including most of the key authors in the resilience-thinking field, notably Brian Walker. The Folke et al. (2011) definition is also used in Westley et al. (2011). The significance of the change in wording between the 2004 Walker definition and the 2011 Folke definition is not discussed in the literature, nor did Westley et al. (2011) indicate a reason for using the Folke definition. As of 2012, the Walker et al. (2004) definition remained in the glossary of terms maintained on the Resilience Alliance website (http://www.resalliance.org/) and is the definition used in this study. Some authors (Moore and Westley 2011; Schoon et al. 2011) have endorsed the notion that transformation is simply a larger version of adaptation. Nuances in the distinction between the terms 'transformation' and 'adaptation' are discussed further in a following subsection.

Table 2.2. Summary of definitions for 'transformation' from the resilience-thinking literature.

Selected Publication from the Literature on Resilience Thinking	Google Scholar Citations, Sept. 2012	Definition of Transformation	Description of How Transformation Occurs
Holling 2001	1,095	None given	As part of the adaptive cycle
Gunderson and Holling 2002	2,116	None given	As part of the adaptive cycle
Folke et al. 2002	897	None given	A response to a large system shock
Walker et al. 2004	901	**First explicit definition of transformability**	Not Provided
Olsson, Folke, and Hahn 2004	232	Complies with Walker et al. (2004)	**First explicit conceptual framework to describe transformability**
Walker and Salt 2006	584	From Walker et al. (2004)	Not Provided
Gunderson and Light 2006	75	None Given	3-phase framework is inferred (Olsson, Folke, and Hahn 2004)

Selected Publication from the Literature on Resilience Thinking	Google Scholar Citations, Sept. 2012	Definition of Transformation	Description of How Transformation Occurs
Olsson et al. 2006	279	None Given	3-phase framework (Olsson, Folke, and Hahn 2004)
Anderies, Walker and Kinzig 2006	119	From Walker et al. (2004)	Not Provided
Walker et al. 2006	305	From Walker et al. (2004)	Not Provided
Folke 2006	804	From Walker et al. (2004)	Not Provided
Gunderson et al. 2006	62	From Walker et al. (2004)	Not Provided
Olsson et al. 2008	82	None given	Not Provided
Chapin et al. 2009	79	**Provides a new definition**	3-phase framework (Olsson, Folke, and Hahn 2004)
Folke et al. 2010	83	From Walker et al. (2004)	3-phase framework (Olsson, Folke, and Hahn 2004)
Gelcich et al. 2010	41	From Walker et al. (2004)	3-phase framework (Olsson, Folke, and Hahn 2004)

Finally, I highlight one nuance in my use of the term transformation. In common, non-technical language, transformation describes any large change in appearance or structure. This type of transformation is often brought about by abrupt, unexpected shocks to the system and the new form that emerges is anything but intentional. The unexpected, unintentional type of transformation referred to in common language is precisely what resource managers try to avoid. As mentioned earlier, resilience thinking is a metaconcept to explain and illuminate how to foster resilience. In the resilience thinking sense, transformation is a tool to steer a system away from the 'large, unintentional transformation.' It is a relatively orderly and intentional transition to a more desirable state.

2.2.1.1 Transformability and Resilience

Transformability is also a fundamental component of resilience thinking, but acts to *weaken resilience*. In the ball in cup analogy, transformability is the ability of the system to move to a different cup. In this respect, transformability and resilience are opposed. In a practical sense, it may help to consider resilience as something that is not always good. For example, being stuck in a dead-end job may be a resilient situation, but in this case resilience is ‘bad.’ When an opportunity arises to move to a better job, transformation is ‘good’ in that it improves the overall situation.

2.2.1.2 Transformability and Adaptability

To understand the relationship between resilience and adaptability, it is important to recognize the precise meaning of adaptability. Adaptability is one component of resilience thinking, and is defined in Section 2.2.1 as "the capacity of the actors in a system to manage the system's resilience" (Walker and Salt 2006, p. 119). In the ball in cup analogy, adaptability is the capacity to manipulate the shape of the cup to prevent the system from falling into a different cup.

Adaptability operates through similar mechanisms as transformability, but has an opposite function. Both adaptability and transformability change the resilience of a system by manipulating the four key characteristics of resilience: resistance, precariousness, latitude, and panarchy. However, adaptability acts to *strengthen* resilience whereas transformability acts to *weaken* resilience. In the ball in cup heuristic, adaptability is the ability to manipulate the shape of the cup to move the ball away from thresholds, and transformability is the ability to manipulate the shape of the cup to move the ball over thresholds.

Other views on the distinction between adaptability and transformability have been expressed in the resilience-thinking literature. Some authors describe transformation as simply being a larger form of adaptation (Moore and Westley 2011; Schoon et al. 2011). Issues of scale and panarchy also serve to complicate the distinction between adaptation and transformation. Schoon et al. (2011) contend that transformability and adaptability are two ends of the same continuum and their difference depends on the scale of interest and perspective used. To paraphrase their discussion, one person's adaptability is another's transformability. To illustrate the importance of scale and panarchy, Folke et al. (2010) stress that adaptation and transformation commonly occur simultaneously at different levels within the same panarchy. Consider a panarchy linking a community, the local water authority, and employees within the water authority. Presume the water authority recognizes a need to protect the community better from disinfection byproducts in the water supply. The water authority could reassign some of its engineers to focus on reducing disinfection byproducts. Thus, adaptability at the community level, expressed as a marginally decreased health risk, actually depends on transformability at the water-authority employee level, expressed as a fundamentally new job function for specific employees. Folke et al. (2010) refer to this concept as multiscale resilience.

To summarize, my interpretation of the resilience-thinking literature is that transformability is the ability to move a system to a different stability domain, while adaptability is the ability to manipulate a system to remain within the same stability domain. The two concepts work in concert via panarchy linkages, but the degree to which they operate by similar mechanisms remains unclear in the literature. The crucial distinction, however, is that the two terms indicate actions in opposite

directions; one stabilizes a system, the other destabilizes a system. This study is underpinned by the understanding of resilience thinking described above.

2.2.2 The Transformation Process

The landmark 'panarchy publications' of Holling (2001) and Gunderson and Holling (2002) provided a dramatic advance in the conceptual understanding of resilience thinking. Unfortunately, these and other early works provided limited guidance on the nature of transformation, indicating that it simply occurs as part of the adaptive cycle or in response to a large shock to the system (Folke, Carpenter, Elmqvist, Gunderson, Holling, and Walker 2002). Olsson, Folke, and Hahn (2004) provided the first framework in the SES literature to explain transformation as a deliberative process, not a simple reaction to external shock. The Olsson, Folk, and Hahn framework consists of three phases and utilizes a window of opportunity (Figure 2.6). The first phase is preparation for transformation, followed by seizing a window of opportunity. The second phase is navigating the transition and the third phase is stabilizing the new regime.

Subsequent resilience-thinking literature on transformability has either endorsed or inferred acceptance of the Olsson 3-phase framework, particularly to describe purposeful transitions from one natural resource management practice to another (Table 2.2). Some literature provides valuable insight into specific aspects of transformation but does not directly interpret it within the context of the 3-phase transformation framework. Nevertheless, these insights are relevant and can be applied to one or more of the three phases. Therefore, I utilize the Olsson 3-phase framework to frame discussion of the process of transformation.

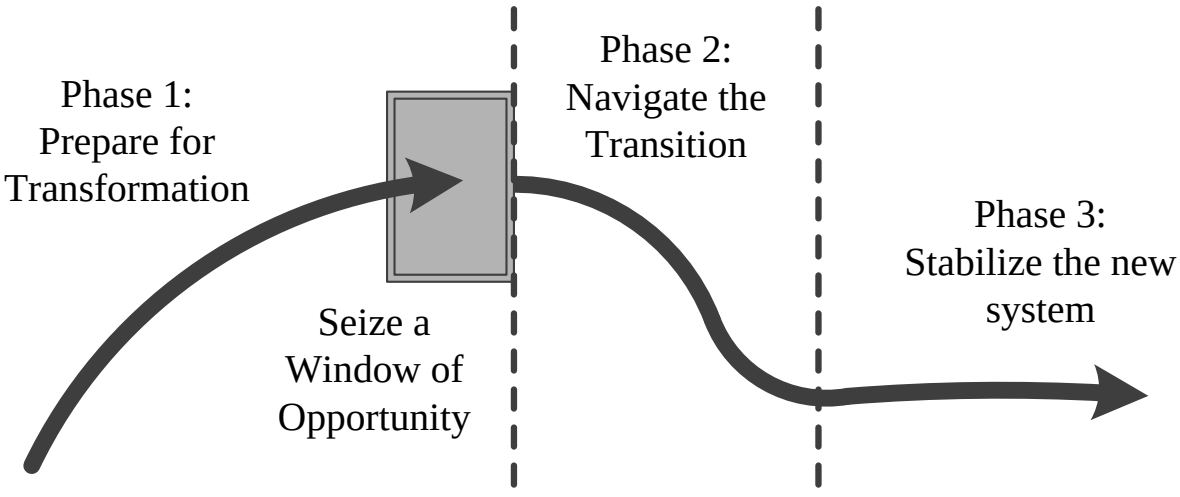


Figure 2.6. The 3-phase framework of social-ecological system transformation. Phases 1 and 2 are linked by seizing a window of opportunity. Figure adapted from Olsson et al. (2010).

2.2.2.1 Preparing for Transformation: Networks and Bridging Organizations

Early works based on case studies of transformation made basic observations of 'essential ingredients' for successful preparation for transformation. First, establishing a common acknowledgement among stakeholders of the need for transformation, or at least a willingness to go along with it appears to be important (Gunderson 1999; Anderies, Walker, and Kinzig 2006; Olsson et al. 2006). Second, these same authors cite a loose agreement on how to facilitate the transformation as being key and acknowledge both these points present a challenge to resource managers.

Two basic views have emerged in the literature to explain how a system proceeds through the first phase of transformation. The first of these views I interpret as the **'networks and bridging organizations perspective;'** the second is provided by the **'three-streams framework,'** (Kingdon 1995 [2003]), which I discuss in the next section. The former is essentially a collection of observations and hypotheses regarding factors that usher a system through the first phase of transformation, while the latter is a far more structured 'framework' to describe the same. It is not clear to what degree these literatures are complementary, or mutually exclusive, and both have occasionally been discussed in the same publication (Olsson, Folke, and Hahn 2004; Olsson et al. 2006).

Figure 2.7 provides my interpretation of the 'networks and bridging organizations perspective,' based on synthesis of available literature. Olsson et al. (2006, n.p.) described networks and bridging organizations as "critical factors for transforming social-ecological systems" and provided commentary on how these factors interact. In this context, the term **social network** refers to the linkages and ties among system **actors**. Actors can refer to any entity, a government agency, private party, or other stakeholder that directly influences the SES of interest[10] (Gunderson et al. 2006). The key function of these networks is to foster learning and trust within the system.

The exact form of the social network in Figure 2.7 is variable, although to foster learning and trust effectively within the system the network must be inclusive of diverse viewpoints and knowledge and safe for the members to communicate freely. This is particularly relevant to the degree of formality in the network, a point expanded upon below.

[10] The term 'stakeholder' denotes all entities with an interest in the system. The term 'actor' denotes stakeholders that may affect the system.

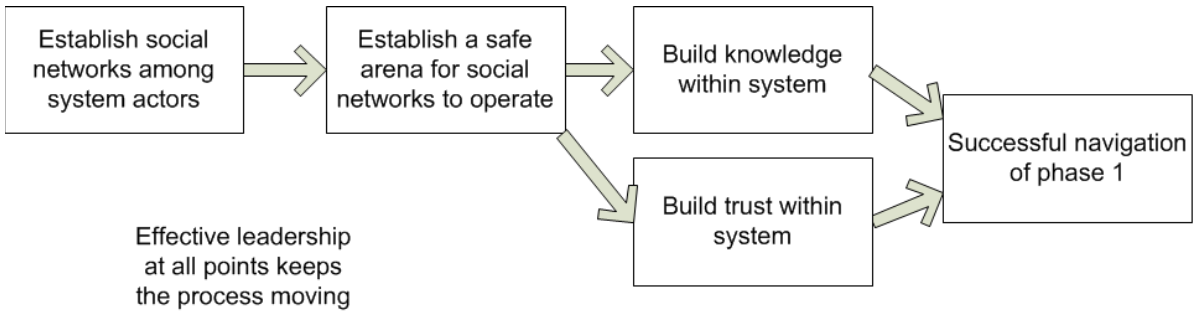


Figure 2.7. The 'networks and bridging organizations perspective' to describe critical factors of preparing the system for transformation.

The literature repeatedly discusses three forms of successful social networks with varying degrees of formality: epistemic networks (Gunderson et al. 2006), shadow networks (Gunderson 1999), and bridging organizations (Olsson et al. 2007). **Epistemic networks** are groups that enable the exchange of information and ideas among members with contrasting viewpoints (Olsson et al. 2006). The term **shadow network** refers to a group that exists informally and is politically independent, removed from regulation and implementation (Gunderson 1999; Olsson et al. 2006). The benefit of the informal nature of these groups is the members are freer to exchange information, think about creative solutions, and consider a wider variety of options since members are not necessarily under the direct scrutiny of their employers (Olsson et al. 2006). **Bridging organizations** are formal in nature and emerge on an ad hoc basis as a means to bridge actors across multiple scales (Folke et al. 2005; Gunderson et al. 2006). From these descriptions, it can be inferred that these classifications are not necessarily mutually exclusive and may work together. For example, a shadow network is distinctive in its informal nature and could be considered a type of epistemic network. In addition, bridging organizations commonly provide a venue for epistemic networks to operate through activities such as workshops. **Information networks** is another term used in the resilience-thinking literature to refer to these networks in general terms (Pelling and Manuel-Navarrete 2011) and a significant literature specific to networks also expands on these concepts beyond what is represented here.

Case studies of attempts to transform resource management regimes illustrate the value of networks to navigate transformative change. Olsson et al. (2006) reviewed five case studies of attempted transformations in water management and found that suitable networks were established among stakeholders in the Kristianstads Vattenrike catchment in Sweden and the Everglades in the United States, and were instrumental in the successful transformation to adaptive management regimes. Gunderson (1999) cites stakeholder networks as being instrumental in multiple transformations of Everglades management systems. In contrast, attempts to transform management

of the Northern Highlands Lake District in Wisconsin and the Mae Nam Ping Basin in Thailand highlight stakeholder networks which did not develop and transformation of a management system did not occur (Olsson et al. 2006).

A critical aspect of the social networks described above is that they must have a safe arena to operate in (Olsson, Folke, and Hahn 2004). This characteristic has been described as a crucible (Gunderson et al. 2006) and an incubator of new management approaches (Folke et al. 2005). From a logistical perspective, members of these networks may need more free time to participate and opportunities to interact. In addition, the groups themselves may need financial support as well as management help to support routine operations. The more formal varieties of networks, particularly bridging organizations, tend to excel in this regard (Biggs, Westley, and Carpenter 2010). However, several authors have noted that informal networks tend to be more successful arenas for promoting innovative approaches to management (Gunderson 1999; Folke et al. 2005; Pahl-Wostl et al. 2007). These authors have observed that actors are more likely to leave entrenched positions and think together when removed from the scrutiny of the public, employing agencies, and constituencies, as well as the need for political maneuvering.

Many authors have stressed the role of leadership in fostering the formation and maintenance of the social networks described above (Folke 2006; Gunderson and Light 2006; Olsson et al. 2006). Gunderson et al. (2006, n.p.) describe leadership as the "the oil that keeps the network lubricated." If leadership breaks down, problems tend to arise throughout the transformation process. For example, in their case study of water management in the Goulburn-Broken Catchment of southeast Australia, Olsson et al. (2006) describe how misguided political leadership prevented transformation by championing adaptation strategies rather than pursuing transformation of the system. Gunderson et al. (2006) observed that a lack of regional leadership was also a likely impediment to transformation in the North Highland Lakes District in northern Wisconsin.

While there is agreement on the importance of having a leader emerge to shepherd the system through the process of transformation, less agreement exists about the characteristics of that leader. Drawing on the organizational science literature, some authors have evaluated transformational leadership through the academic lens of social entrepreneurship (Biggs, Westley, and Carpenter 2010; Olsson, Bodin, and Folke 2010). Olsson, Bodin, and Folke (2010) discussed successful social entrepreneurship. These authors report the literature has been more effective at explaining the success of an entrepreneur based on the social connections around the entrepreneur than based on characteristics of the entrepreneur.

Drawing further from the literature on social networks, Olsson, Bodin, and Folke (2010) describe the leaders who enhance transformability as having diverse and strong panarchy connections to other levels. The ability of actors to precipitate change is a function of their connectedness and their ability to take advantage of that connectedness. This finding is consistent with broader literature. For example, Malcolm Gladwell's *The Tipping Point* describes key tipping actors as having many diverse and loose connections to facilitate information flow as well as strong connections that foster the trust of other actors (Gladwell 2000).

Pelling and Manuel-Navarrete (2011) evaluated connections within networks to gain a better picture of the environment in which a policy entrepreneur[11] for transformation is likely to succeed. Their work discussed unsuccessful attempts to transform water management in two separate cities in Mexico. They observe that close connections between an actor and family and friends can make an actor rigid in the context of cooperating with diverse management concerns. A more ideal situation is to have more equality between the bonds that hold an actor in place and the bonds to other stakeholders and a commitment to the greater good. This conclusion, in turn, is reminiscent of the observation of Gunderson (1999) that if resilience or flexibility among actors is low, it is simply not possible to transform the system and manage adaptively.

System-wide learning is a product of the social networks described above, when operated in an appropriate arena for discourse (Gunderson et al. 2006; van der Brugge and van Raak 2007). System actors learn to reframe problems, view issues from others' perspectives, and explore avenues of cooperation (Biggs, Westley, and Carpenter 2010). Trust among actors can be built, sense-making and innovation can occur, collaboration can emerge, and conflict can be avoided (Olsson, Folke, and Hahn 2004; Olsson et al. 2006). New ways of managing natural resources can emerge and an opportunity for successful transformation emerges. One common tactic among case studies of successful transformations in water management is promotion of scenario building exercises among stakeholder groups (Folke et al. 2005; Olsson et al. 2006). Scenario building is widely recognized as an important tool for creating change (Maas and Maas 2009; Bishop and Strong 2010). One reason for its effectiveness in contributing to systemic change may lie in its ability to strengthen ties and trust within the system, and build common knowledge and leadership within the system. As noted in the following sections, scenario building also aids managers to navigate the uncertain transition phase of transformation.

[11]The term 'champion' also occurs in the literature to describe people instrumental in changing a system.

2.2.2.2 Preparing for Transformation: The Three-Streams Framework

Application of the three-streams framework to the resilience-thinking framework was first proposed by Olsson et al. (2006), who adapted the concepts from Kingdon (1995 [2003]). This framework describes three 'families of processes,' which Kingdon (1995 [2003], p. 87) terms the three 'streams' of problem, solution,[12] and politics. At special times, these three streams come together (Figure 2.8) to allow a system to pass through a window of opportunity for transformation. Joining the three streams and seizing windows of opportunity are discussed in detail in the following section, 2.2.2.3.

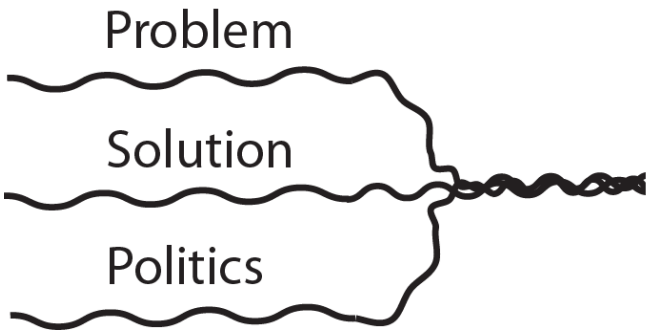


Figure 2.8. Graphical depiction of joining the three streams of problem, solution, and politics.

Kingdon's 1995 work is a revised edition of a textbook first published in 1984 (Kingdon 1984). Kingdon (1984), in turn, draws from an earlier work titled, *A garbage can model of organizational choice* (Cohen, March, and Olsen 1972). These earlier authors described four streams[13] in developing a 'garbage can model' to explain organizational choice in university settings, but it is also applicable in certain contexts such as public policy making.

The garbage can model contrasts sharply with rational problem solving in explaining how organizations act to solve problems. In rational problem solving, problems are first identified, then alternative solutions are considered, and finally the best alternative is chosen and acted on (Marston et al. 2003). The opposite occurs in the garbage can model of organizational choice. In the garbage can model, people define solutions which benefit them in some way and then search for a problem to which to attach their solution. Kingdon (1995 [2003], p. 86) describes the garbage can model as:

[12] Kingdon (1995 [2003]) used the term 'policy' rather than 'solution' on p. 87, but also used the term 'solution' in other passages. Olsson et al. (2006) used the term 'solution' to describe this stream, nomenclature which I retain here.

[13] The four streams described by Cohen, March, and Olsen (1972) are problems, solutions, participants, and choice opportunities.

> People do not set about to solve problems [in the garbage can model]. More often, solutions search for problems... Nor do they go through a prescribed logical routine: defining the problem, canvassing the possible solutions, evaluating the alternatives in terms of their ability to solve the problem at the least cost.

Whether or not a given solution is acted upon depends on joining a proposed solution to a recognized problem and generating political support for action, collectively referred to as joining the three streams of problem, solution, and politics (Kingdon 1995 [2003]; Olsson et al. 2006).

Kingdon (1995 [2003]) considers the garbage can model applicable to organizations characterized as: (a) 'organized anarchies,' which feature poorly defined or conflicting problems; (b) having membership without solid understanding of how the organization operates; and (c) having imprecise participation in making decisions, for example by whichever people who happen to attend a given meeting. In other words, cases of transformation in water management are often well suited to the garbage can model. Mucciaroni (1992) provides a critique of the garbage can model and a recent edited book examines the garbage can model in considerable depth (Lomi and Harrison 2012), with contribution from the authors of the seminal 1972 publication (Cohen, March, and Olsen 2012).

In the problem stream, perceptions, power, and crisis govern how and why attention is given to one problem rather than another. People inevitably perceive aspects of any issue differently, depending largely on how they are affected. For example, raising taxes is likely to be perceived negatively by those who will pay more and positively by people who benefit from government programs enhanced by the tax increase. Power relations further determine why attention is paid to one problem rather than another. Stakeholders with power have a disproportionately strong influence on which problems are addressed. Crises often elevate certain conditions to 'problem status' and create political incentive to address them. Kingdon (1995 [2003]) discusses budget crises as an unusual, but important, type of crisis. Budget crises can constrain or promote the chance for a given condition to be defined as a problem (Kingdon 1995 [2003]). For example, during a budget crisis, issues perceived to be expensive to address are likely to be ignored regardless of merit. However, issues perceived as a way to save money may quickly be defined as a problem worth solving.

The solution stream has been described as a 'primeval soup' of proposals, containing a wide range of potential solutions for any given problem. In the words of Kingdon (1995 [2003]):

> ... ideas are floated, bills introduced, speeches made; proposals are drafted, then amended in response to reaction and floated again. Ideas confront one another ... and combine with one another in various ways. The "soup" changes not only through the appearance of wholly new elements, but even more by the recombination of previously existing elements. ...as in a natural

> selection system... Some ideas survive and prosper; some proposals are taken more seriously than others.

Solutions are advocated by **policy entrepreneurs**, people who invest in a given policy in hopes of a future return such as career advancement, job security, or the satisfaction of seeing the advancement of a policy with which they agree. Usually, the solution stream is prone to inertia and resistant to promoting new ideas. Policy entrepreneurs engage in 'softening up' the system by sensitizing key actors to the merit of their pet solutions. 'Softening up,' described in Kingdon (1995 [2003]), is time consuming and difficult, but enables proposals to gain political traction. From Kingdon (1995 [2003], p. 128):

> It takes a long time to educate people. And then once you get them educated, you have to build up some power to do something. Educating people is very time consuming and energy consuming.

and:

> A proposal... has to go through a gestational period. It takes a number of years.

Eventually, perhaps years later and through processes of persuasion and diffusion, a solution may gain an audience and reach a tipping point to gain widespread recognition. Then, when a window of opportunity presents itself, a path has been paved to advance the given solution.

The political stream comprises factors dictating which solutions gain political support. Key factors include the political mood of a country or organization, lobbying efforts, elections, the ideology of the ruling political party, and turnover of persons with decision-making power (Kingdon 1995 [2003]). Consensus building in the political stream is achieved through bargaining and building political coalitions. As Kingdon (1995 [2003], p. 159-160) states, "Joining the coalition occurs not because one has simply been persuaded of the virtue of that course of action, but because one fears that failure to join would result in exclusion from the benefits of participation."

A crucial aspect of Kingdon's three-streams framework is the complementary roles of advocacy and brokering. **Advocacy** denotes general actions intended to persuade others to accept the merit or need for a policy or idea. **Brokerage** is a distinct set of actions that join the three streams. Kingdon (1995 [2003], p. 183) describes these activities (emphasis added):

> ...calling attention to the special role entrepreneurs play in joining the streams highlights two rather different types of activity. *Advocacy* is involved, but so is *brokerage*. (Policy) entrepreneurs advocate their proposals, as in the softening up process in the policy stream, but they also act as brokers, negotiating among people and making critical couplings. Sometimes, the two activities are combined in a single person; at other times, entrepreneurs specialize, as in the instance of one pushing from an extreme position and another negotiating the compromises. This emphasis on

> coupling shifts our focus from invention, or the origin and pushing of an idea, to brokerage. ...Inventors are less important than entrepreneurs.

In the three-streams framework, the essence of preparing the system for transformation is advancing the streams through advocacy so that policy entrepreneurs may join them via brokerage when a window of opportunity arises. The role of brokerage is of primary importance to the following section. Finally, my use of these terms is limited to the definition described here and does not reflect the relatively large academic literature dedicated to advocacy and brokerage.

2.2.2.3 Windows of Opportunity

Windows of opportunity link the first two phases in the transformation framework (Olsson, Folke, and Hahn 2004). Huitema and Meijerink (2010, n.p.) summarize Kingdon's view of windows of opportunity as "particular moments in time (for instance an election or disaster) that offer opportunities for policy entrepreneurs to launch and gain support for new policy proposals." In terms of the Olsson 3-phase framework of transformation, **windows of opportunity** are the times when policy entrepreneurs can join the three streams and propel the system from the first phase, into the second phase.

Before continuing with a description of how windows of opportunity are seized, I recognize two important limitations of this discussion. First, relatively little of the transformation literature has considered how windows of opportunity are seized. In particular, the transformation literature on networks and bridging organizations provides insight to *what factors* are important in transformation, but says little about *how* windows are seized. Within the transformation literature, the three-streams framework (Kingdon 1995 [2003]) is, by a wide margin, the most explicit framework used to describe how windows are seized; nevertheless, it is not widely utilized (Table 2.3). As a result, my discussion is 'Kingdon 1995 heavy.' Second, an abundance of applicable frameworks, theories, and approaches exists outside the relatively narrowly defined 'transformation literature.' Two examples are the advocacy coalition framework (Sabatier 1987) and punctuated equilibrium theory (Baumgartner and Jones 1991), both of which have been used to assess processes of change in social-ecological systems. I attempt to note the existence of many of these approaches and acknowledge their potential application to the 3-phase transformation framework. Furthermore, delineations between literatures are often poorly defined and overlap, which required 'judgment calls' to include specific publications in this discussion. For example, in building Table 2.3, I slightly stretched the boundaries of 'transformation literature' and considered some publications that could be considered 'transitions

literature'[14] and 'social innovation literature.'[15] In general, however, the scope of my discussion is limited to frameworks, theories, and approaches which have been applied explicitly to the 3-phase transformation framework (Olsson, Folke, and Hahn 2004).

Table 2.3. Citation of Kingdon (1995), and discussion of brokerage and the three-streams framework in transformation literature.

Publication	Kingdon (1995)	Brokerage	Three-Streams
Olsson Folke and Hahn (2004)	**Cited prominently**	Not explicitly discussed	**Mentions the three streams, their importance can be inferred**
Anderes, Walker, and Kinzig (2006)	Not cited	Not explicitly discussed	Not explicitly discussed
Olsson et al. (2006)	**Cited prominently**	Not explicitly discussed	**Discussed explicitly and considered with regard to case study research**
Gunderson et al. (2006)	Not cited	Not explicitly discussed	Not explicitly discussed
Gunderson and Light (2006)	Not cited	Not explicitly discussed	Not explicitly discussed
Olsson et al. (2007)	**Cited prominently**	Discussed as a key to developing networks, not for joining the 3 streams	Not explicitly discussed
Gelcich et al. (2010)	Not cited	Not explicitly discussed	Not explicitly discussed
Olsson, Bodin, and Folke (2010)	Not cited	Defined and discussed as a key in developing networks, not for joining the 3 streams	Not explicitly discussed

[14] These publications were part of a 2010 special feature of *Ecology & Society*, titled *Realizing Water Transitions: The Role of Policy Entrepreneurs in Water Policy Change.* I include these publications in Table 2.2 to recognize more recent work utilizing the Kingdon three-streams framework and because the publishing journal, *Ecology & Society*, is operated by the Resilience Alliance and is associated with much of the literature discussed throughout this chapter.

[15] Some publications in Table 2.3 could be considered to be 'social innovation literature.' Moore and Westley (2011) describe social innovations as being similar to social-ecological system transformation. I include these publications in Table 2.3 because they are particularly insightful to critical aspects of SES transformation.

Publication	Kingdon (1995)	Brokerage	Three-Streams
Huitema and Meijerink (2010)*	**Cited prominently**	**Explicitly discussed**	**Explicitly discussed**
Font and Subirats (2010)*	**Cited prominently**	Not explicitly discussed	**Discussed explicitly and considered with regard to case study research**
Werners, Matczak, and Flachner (2010)*	**Cited prominently**	Not explicitly discussed	**Discussed explicitly and considered with regard to case study research**
Meijerink and Huitema (2010)*	**Cited prominently**	**Explicitly discussed**	**Explicitly discussed**
Pelling and Manuel-Navarrete (2011)	Not cited	Not explicitly discussed	Not explicitly discussed
Westley et al. (2011)	Not cited	Discussed as a key to developing networks, not for joining the 3 streams	Not explicitly discussed
Schoon et al. (2011)	Not cited	Not explicitly discussed	Not explicitly discussed
Moore and Westley (2011)	Not cited	Discussed as a key to developing networks, not for joining the 3 streams	Not explicitly discussed
Armitage, Marschke, and van Tuyen (2011)	Not cited	Not explicitly discussed	Not explicitly discussed

* These papers were part of a special feature of *Ecology & Society* titled, *Realizing Water Transitions: The Role of Policy Entrepreneurs in Water Policy Change.*

With regard to the three-streams framework, policy entrepreneurs join the three streams by generating political support to implement a given proposal to address a recognized problem. The tactics used to join the streams is described in Kingdon (1995 [2003]) as brokerage. Without brokering, political action is unlikely. Political maneuvering, deal making, and bargaining are aspects of brokering. However, Kingdon (1995 [2003]) dedicates much text to the topic of anticipating crises and planning for windows of opportunity as a crucial aspect of brokering.

Windows of opportunity usually open briefly and policy entrepreneurs must typically act quickly to join the three streams. Policy entrepreneurs can act faster and more effectively when a window opens if they prepare far in advance (Kingdon 1995 [2003]). Among other tasks, policy entrepreneurs can develop strategies and proposals to take advantage of likely problems, form political alliances, and anticipate opportunities to spring into action. The goal is to be positioned in advance to propose a solution viewed as appropriate and politically attractive when the window of opportunity opens. Waiting until the window opens to develop proposals and build alliances is a poor strategy for success.

Fortunately, Kingdon (1995 [2003]) states many windows of opportunity occur predictably and provides examples of windows opened by political elections, budget cycles, and expiration of legislation. Furthermore, Kingdon discusses many windows as being predictable in form. Anticipating the timing and form of a window of opportunity will help policy entrepreneurs structure and prioritize preparations to seize the moment of crisis when it comes. To illustrate this point, Kingdon (1995 [2003], p. 181-182) provided comments of an anonymous bureaucrat discussing prospects for legislation promoting energy conservation:

> I think... there should be a little group in a back room that is laying plans right now for how to handle the next Arab oil embargo. You want to be in a position to take advantage of times like that. [It] does not present itself too often, and you want to be ready to propose changes at the point that the opportunity does come along.

The greater the variety of crises policy entrepreneurs prepare for, the greater the chance they will be able to seize the next window of opportunity, whatever it looks like.

When policy entrepreneurs join the three streams, the window of opportunity is considered seized. Seizing a window of opportunity is critical to transformation, but does not guarantee it. Seizing a window only advances the system to the second phase in the Olsson 3-phase framework. Unless policy entrepreneurs execute later phases of transformation properly, transformation may stall or the final form of the system may morph undesirably. For example, Wilder (2010, n.p.) describes a situation in Mexico where, "legal modifications to the national water law that emphasize integrated watershed planning and local participation were approved in 2004 but have never been formally implemented." Furthermore, in discussing transformations in governance of Chilean marine coastal resources, Gelcich (2010, p. 16,795) explicitly reminds the reader that transformation involves more than seizing a window of opportunity such as passing key legislation: "legislation enabled a national-scale transformation in governance... However, achieving this transformation was more complex than simply changing legislation."

2.2.2.4 Navigating the Transition

Olsson et al. (2006) utilize the analogy of negotiating rapids in a canoe to illustrate the challenges of preparing for and navigating SES transformations. It is possible for a canoeist to prepare for running a section of rapids. The canoeist can develop skills to maneuver the boat, choose to enter the rapids in a favorable spot, and anticipate where corrective strokes may be required. In the end, however, the canoeist must execute the right moves at the right time to emerge at the bottom of the rapids in a desirable state. In this analogy, even the best preparations can prove fruitless if the wrong moves are made in the turbulent and rapidly changing arena of the transition phase.

The experience of water management in the 1990s of the Goulburn-Broken Catchment in southeast Australia illustrates the importance of navigating the transition phase correctly (Olsson et al. 2006). An impending crisis in this catchment stimulated progress toward a fundamental change in water management for this system. The preparation phase of transformation was well executed and the stage was set for transformation to a more desirable system state. However, a critical mistake was to support and enable landowners to *adapt* to deteriorating conditions in the catchment rather than to support policy to *transform* the SES to a different and more desirable form. The effect of this decision was to derail transformation of the system, with substantial negative consequences. More than a decade after the missed opportunity described by Olsson et al. (2006), Walker et al. (2009) argue that water management in the catchment is still in need of transformation, and is in a poor position to do so. In the analogy described above, water managers entered the rapids properly, but missed the opportunity to navigate to safer water. The canoe struck a rock, capsized, and exited the rapids keel side up as it remained as of 2009.

In general, relatively little resilience-thinking literature has discussed the transition phase of transformation. Olsson et al. (2006) attribute this gap to the unpredictable and turbulent nature of the transition phase; transition is not something that is planned, it is navigated. Some authors point to relevant literature on other academic topics as providing insight, notably on the literature on transition management (van der Brugge and van Raak 2007), and sociotechnical transitions (Folke et al. 2010).

2.2.2.5 Building Resilience of the New Regime

Literature on the 3-phase transformation framework offers little about the final phase of transformation, other than to acknowledge its existence (Folke et al. 2005; Folke et al. 2010; Gelcich et al. 2010). Olsson et al. (2010) argue that the key to a new and more desirable resource management regime is to establish itself in a network of collaborators and carve out a new, collective niche. Chapin et al. (2009) echo this point and add two more strategies to build resilience of a new regime:

(1) to enhance stewardship in the new system and (2) to support the involvement of key individuals in social networks for problem solving.

2.2.3 Lessons Learned and Next Steps

The transformation literature is limited in some important ways. In terms of geographical scope, only a handful of publications apply the concept of SES transformation in developing world settings, where transformations are arguably needed the most to address urgent humanitarian issues (Gelcich et al. 2010; Pelling and Manuel-Navarrete 2011). To my knowledge, only two publications exist that have attempted to evaluate a SIDS for the presence of adaptive cycles: Bunce et al. (2009) on the semi-autonomous island of Rodrigues in the Indian Ocean and Found and Berbés-Blázquez (2012) in the Caribbean.

One important gap in the transformation literature is a method for determining and describing the extent of transformability. It is intuitive that not all systems are equally 'transformable' or 'not transformable,' yet no method to quantify or describe this exists. If such a method existed, it would be easier to determine which systems are close to transforming and which systems are 'hopeless.' We could better judge the effectiveness of interventions, and it would be easier to draw attention to the specific point(s) of breakdown in transformation of trapped systems.

The resilience-thinking approach to transformability is a relatively young and small niche in the literature, but provides a widely applicable and convenient framework to guide research and interpret future study. Most notably, tremendous opportunity exists to fill gaps using literature from dozens of other topics. To date, this strategy has been utilized to some extent, with the most successful attempts drawing heavily from the literature on social networks and especially governance. Additional application of these and other complementary literatures, verified with research specific to resilience thinking, is likely to be a ‘low-hanging fruit’ for future research. Further discussion on the scope of potentially useful literatures and their relevance in this study is provided at the end of Section 2.3.6.

Some aspects of the case study are designed to advance the literature on transformation. First, the study is designed to document multiple transformative events and evaluate the appropriateness of the Olsson 3-phase transformation framework and the way by which windows of opportunity are seized. This study is also designed to evaluate the significance and characteristics of policy entrepreneurs and windows of opportunity. Finally, this study is designed to evaluate synergies in considering transformation and traps together. This last point is discussed further at the end of the section on MS traps.

2.3 Maladaptive System Traps

Resilience of SESs is usually described in a positive light, as something to manage for or to value (Holling 1973; Gunderson and Holling 2002; Falkenmark and Rockström 2008). In this context, resilience indicates the ability of a system to adapt to change and persist, 'in one cup' in the Gunderson (2000) ball-in-cup analogy. However, a system can be *too resilient* and not change enough, even when it becomes advantageous to do so. One example is the large bureaucracy of the former Soviet Union that was infamously rigid and resistive to change long after it was clear that change was needed.

The elegance of the resilience-thinking framework can be misleading when interpreting real-world systems. The literature has had mixed success when explaining the behavior of real-world SESs. For example, Allison and Hobbs (2004) report remarkable success in the progression of the western Australian agricultural sector through adaptive cycles. They were able to identify two full iterations of the adaptive cycle. Similarly, Found and Berbés-Blázquez (2012) effectively used resilience thinking concepts to explain the 500-year persistence of sugarcane plantation landscapes in the Caribbean. These authors identified adaptive cycles at multiple levels of a social-ecological system and attributed resilience at the plantation landscape level to two transformations of how those plantations were operated, which permitted the plantation landscape to persist. In contrast to these relative successes, the experience of Abel, Cumming, and Anderies (2006) was not as clear cut. They studied social-ecological systems in Zimbabwe and Australia and found that the adaptive cycle process exists, but usually not in an ideal form and is often visible only in hindsight. They did, however, find the adaptive cycle useful in explaining system changes. Furthermore, Bunce et al. (2009) expressed frustration at not being able to identify *any* adaptive cycle behavior in their study of recovery from a SES collapse on Rodrigues Island in the Indian Ocean.

Fortunately, a subset of the resilience-thinking literature has discussed the tendency of some systems to become 'too resilient' and not follow the classic adaptive cycle trajectory of breakdown, reorganization, and regrowth. These systems are described as maladaptive and their persistent, rigid states as traps.

2.3.1 What are Maladaptive System Traps?

The literature on resilience thinking first recognized the significance of systems that *do not* change over time as prescribed by the adaptive cycle framework approximately 10 years ago (Holling 2001; Gunderson and Holling 2002). Such systems were described as being maladaptive (Holling 2001) or

pathological (Allison and Hobbs 2004), reflecting their divergence from the adaptive cycle, and as being in a 'trapped' state, reflecting their failure to change over time.

The literature provides little in the way of a definition, or even a consistently used term, to describe systems that fail to conform to the adaptive cycle. To provide a basis for studying these systems, I provide a term here and define it in the following paragraph. First, I combine descriptions in the literature of these systems as 'maladaptive' and 'trapped' to form the term maladaptive system trap (MS trap). To my knowledge, this term has not been used in the literature prior to this study. Past studies commonly refer to specific types of traps, but authors generally avoid referring to the general state of maladaptive systems as 'trapped.'

Second, based on a thorough review of the literature on maladaptive and trapped systems, I observed three fundamental traits common to all maladaptive systems discussed in the literature. These systems are considered both 'trapped' and 'bad,' in that they persist when it is better for the system to change. Furthermore, description of these systems as trapped and bad is relative (see Section 2.3.2). Therefore, I define a **maladaptive system trap** as a persistent and undesirable state, acknowledging that both 'persistent' and 'undesirable' are relative terms.

As discussed in Section 2.1.1, the adaptive cycle framework consists of three axes: potential, connectedness, and resilience (Figure 2.3). A system can occupy eight positions with regard to 'high' and 'low' levels of these three properties (2^3). The adaptive cycle describes four of these positions. The remaining four positions are occupied only by 'maladaptive' systems in a 'trapped' state. Each of these positions defines a distinct MS trap (Table 2.1). Holling (2001) and Gunderson and Holling (2002) recognized two types of MS traps: a rigidity trap and a poverty trap. Allison and Hobbs (2004) later recognized lock-in traps and proposed the existence of a fourth maladaptive system, recently described as an isolation trap by Gunderson, Holling, and Allen (2010).

A **rigidity trap** is defined as a system position consisting of high potential, high connectedness, and high resilience. This trap was first recognized by Holling (2001) and Gunderson and Holling (2002) and is essentially a K-phase system that fails to lose resilience and proceed through the release phase of the adaptive cycle. Rigidity traps are often held in place through panarchy linkages that prevent change at the scale of interest. Such systems are highly productive, but lack flexibility to adapt when conditions change. Rather than collapsing as a 'normal' K-phase system would, something prevents the system from failing, usually through panarchy linkages. One highly visible example of this is government actions in the United States to bail out a banking system that is 'too big to fail.' An example from the resilience-thinking literature is the managing of the Maine lobster fishery as a monoculture of lobsters as described in Steneck et al. (2011). This system is highly

lucrative, so lucrative that there is great resistance to changing the management approach to foster a more diversified system. Since money is the underlying motivating factor that perpetuates the trap, Steneck et al. coin the term *gilded trap* to describe the situation, but it is essentially a rigidity trap. Pelling and Manuel-Navarrete (2011) describe rigidity traps in two Mexican municipalities maintained largely by the structures of power within the system and their ability to manipulate the discourse and prevent conscientization, the psychological process of becoming aware of reality (Freire 2005).

A **lock-in trap** is defined as a system with low potential, high connectedness, and high resilience (Allison and Hobbs 2004). This condition results when a system caught in a rigidity trap loses potential. This trap was first discussed in the resilience-thinking literature by Allison and Hobbs (2004) to describe the situation in a western Australia agricultural region in which management is 'mining' the ecological resource for agricultural gains. In this case, agricultural management decisions were deeply entrenched and caused the land to become less able to support agriculture. However, as the land became less able to produce, the pressure to produce at a high level continued or even increased. This pressure further entrenched the existing land management practices and accelerated degradation of the land. Ultimately, the land was nearly totally depleted and a new and very stable and undesirable situation emerged, characterized by low productivity, diversity, and options. These authors coined the term 'lock-in' to reflect a similar situation in the economics literature, in which 'lock-in' describes an industry with high 'sunk-costs' leading it to deplete the resource it depends on. Examples of this phenomenon are often not described explicitly as being lock-in traps but serve as excellent references. Notable examples are Uzbekistan water management as described by Schlüter and Herrfahrdt-Pähle (2011) and 'the tragedy of the commons' described in Garrett Harden's celebrated essay (Hardin 1968).

Both poverty traps and isolation traps are defined, in part, as systems with low resilience. There is an apparent contradiction between being 'trapped' while also being defined as having 'low resilience' that has not been confronted directly in the literature. In explaining this apparent paradox, I first draw attention to the working definition of MS trap described above, as a 'persistent and undesirable state.' The word 'state' is used to denote the distinct position in the adaptive cycle framework with regard to connectedness, potential, and resilience (Table 2.1). The word 'persistent' is used to denote that the *state of the system* persists over time and is not meant to describe a system that persists over time. In this context, the *state of a trapped system* can be defined as having 'low resilience,' resulting in a system that constantly changes form, but is unable to stabilize on any one form or change its position with regard to the adaptive cycle framework.

A **poverty trap** is defined as a system with low potential, low connectedness, and low resilience. This trap was first recognized by Holling (2001) and Gunderson and Holling (2002) and is essentially a system that emerges from the release phase of the adaptive cycle with no resources, no ability to reach out and gather resources, and little or no hope for revitalization. Systems in a poverty trap are erratic in their precise form, but very stable with regard to possessing low potential, connectedness, and resilience. This point is illustrated in the case study presented by Bunce et al. (2009). They observed a system that experienced a collapse, but rather than staging a recovery the system continued in what the authors described as being "stuck in post collapse recovery" (p. 223), in downward spirals without new structure emerging. The downward spirals have existed for over 100 years, through many generations, leadership changes, and intervention efforts. Nevertheless, the dire situation facing the system of having low potential, connectedness, and resilience persists. Holling (2001) provides another ecological example of a system caught in a poverty trap, an overgrazed grassland savanna system that flips into a stable situation characterized by an eroded landscape with sparse vegetation. The eroded land depletes the ability for the soil to support vegetation, while the lack of vegetation promotes further erosion of the soil. Other examples have been documented. For example, Enfors and Gordon (2008) describe the frustrating rigidity of mechanisms that hold a dryland system in Tanzania in a poverty trap. Gunderson et al. (2006) describe the management system in the Wisconsin north highlands lake district as approaching a poverty trap, with connections within the system being too weak to mobilize resources or spread innovation.

An **isolation trap** is defined as a system with high potential, low connectedness, and low resilience. Systems fitting this description are rare and only two publications in the resilience-thinking literature mention this type of trap. Allison and Hobbs (2004) noted the space for such a trap in the adaptive cycle analogy and hypothesized its existence. Later, Gunderson, Holling, and Allen (2010) coined the term isolation trap to denote isolated populations of plants or animals that are considered to be 'threatened' or 'endangered.' These systems have the capacity to grow into larger populations and persist, but are not resilient to disturbance. Their lack of resilience persists because of their isolation. I propose that isolation traps are less 'trapped' than other maladaptive systems and are prone to changing form and losing potential, thus morphing into poverty traps. An example of this is an isolated and endangered population that, because of its low resilience, experiences a disturbance and goes extinct.

2.3.1.1 Variability within the Literature

Considerable variability exists within the resilience-thinking literature regarding MS traps. Carpenter and Brock (2008) provide a subtly different definition for a poverty trap as a system with low

connectedness, low resilience, and *an unrealized potential for change*. The last portion of this definition contradicts definitions provided in prior literature (Gunderson and Holling 2002; Allison and Hobbs 2004) and later literature has defined such a system as being in an isolation trap (Gunderson, Holling, and Allen 2010). Carpenter and Brock (2008) also define a rigidity trap as having low potential, high connectedness, and high resilience. This view contradicts the previously accepted definition of a rigidity trap (Holling 2001; Gunderson and Holling 2002) and in fact is precisely the definition given elsewhere in the literature for a lock-in trap (Allison and Hobbs 2004; Gunderson, Holling, and Allen 2010). Carpenter and Brock (2008) also appear to have misrepresented Allison and Hobbs (2004) as describing the western Australia agriculture system as being in a rigidity trap rather than a lock-in trap.

Alternate visions of MS traps also appear in other publications. Biggs, Westley, and Carpenter (2010, n.p.) refer to a poverty trap as being "stuck in the α phase" and a rigidity trap as being "stuck in the K phase" of the adaptive cycle. These explanations may be thought of as over simplifications and contradict the definitions for rigidity and poverty traps described above. Olsson, Bodin, and Folke (2010, p. 265) acknowledged lock-in traps, but then did not recognize that if a system in a rigidity trap loses potential it is then in a lock-in trap. Finally, Schoon et al. (2011) describe a persistent K-phase of the adaptive cycle as a 'lock-in situation,' but don't acknowledge the term 'trap' in their discussion. In this study, I use the definitions for traps provided in the previous section and avoid all of the alternate visions of MS traps presented in this section.

The four types of maladaptive systems have had variable significance to the resilience-thinking literature. Nearly all publications that discuss maladaptive systems acknowledge, define, or describe rigidity traps or poverty traps. However, isolation traps and lock-in traps are often ignored. As stated above, isolation traps are rare and have only been mentioned in two publications (Allison and Hobbs 2004; Gunderson, Holling, and Allen 2010). Lock-in traps have been defined in the literature for nearly a decade, but many authors have resisted acknowledging them in discussions of MS traps. Some of these publications have been widely cited (Folke et al. 2007), appear in the foremost resilience-thinking-oriented journals (Schoon et al. 2011), and are authored by major authors in the field (Folke et al. 2010). Despite this, the concept of lock-in trap is particularly applicable to this study and is explicitly discussed in later chapters.

2.3.2 Issues of Time and Space in Maladaptive System Traps and Transformation

Scales of time and space appear to have a profound effect on the analysis of SES. For example, Allison and Hobbs (2004) describe the western Australia agriculture system as going through

adaptive cycles and as being in a back loop. However, they also show that when viewed in a more holistic context the same system can be seen as being in a lock-in trap. One lesson to be drawn from Robards et al. (2011) is that one person's rigidity trap may be another person's robustness. Michael Schoon et al., writing from the perspectives of archaeology, provide insightful commentary to this point in a special feature section of *Ecology and Society* (Schoon et al. 2011, n.p.). They state:

> What is perceived as a transformative event from a local or short-term perspective may appear as a more gradual adaptation at a larger scale. Conversely, a slowly dwindling population may appear stable to an observer within the population, but may result in a transformative shift at a societal level when viewed on a larger time scale. Likewise, a shift in the geographical scale may change perspectives of what constitutes adaptation or transformation.

This point is further evident when comparing two widely cited interpretations of the same case study. Gunderson et al. (2006) describe management of the Florida Everglades as being in a rigidity trap, while Olsson et al. (2006) describe it as having undergone multiple transformations and as being in a late K phase. This difference in interpretation is especially notable since both publications appeared in the same year (2006) and each lead author co-authored the other publication. Neither publication discussed this apparent contradiction nor has the point been acknowledged elsewhere in the literature. However, one possible explanation is that Gunderson et al. (2006) were referring to a rigidity trap at the larger scale of a 'management by manipulation' paradigm and Olsson et al. (2006) were referring to transformation at the smaller scale of how that management was done.

2.3.3 What Causes Maladaptive System Traps?

There have been relatively few explicit attempts to explain the causes of MS traps. Nevertheless, these few attempts have tapped a broad array of ideas from similar academic fields and applied them to the resilience-thinking context. This approach serves to provide explanations for the existence of MS traps, provide a basis for judging how to avoid or escape MS traps, and to inspire future attempts to glean useful insight from literature in other fields.

Scheffer and Westley (2007) adopt an evolutionary perspective toward MS traps and explore the apparent contradiction between the long-term survival of systems and the nearly ubiquitous tendency of systems to become rigid and vulnerable to collapse when conditions inevitably change. These authors argue that evolutionary pressure favors short- term efficiency over long- term innovation in systems ranging from cells to individuals to groups of people. They note that in controlled experiments, groups tend to eliminate voices of dissention when given the option, even when doing so impairs the effectiveness of the group (Boulding 1964). A widely studied example of this phenomena is 'group think,' first observed by Janis (1972) in the run-up to the Bay of Pigs

invasion. Furthermore, Scheffer and Westley (2007) discuss the tendency of societies to over value material infrastructure, the so-called 'sunk-cost effect' (Janssen, Kohler, and Scheffer 2003), and how this may have led to the collapse of some ancient civilizations (Diamond 2005). The work of Scheffer and Westley (2007) provides a starting point for approaching MS traps as a phenomenon that is evolutionarily hard-wired into systems.

One possible cause of MS traps is related to ongoing discussions in the MS resilience literature on the so-called 'problem of fit,' a mismatch between management institutions and the ecological, economic and socio-cultural aspects of a SES that the institutions are expected to manage.(Folke et al. 1998; Young 2002; Folke et al. 2007; Galaz et al. 2008). Olsson, Bodin, and Folke (2010) describe how this issue impairs feedback loops between social and ecological systems and leads many systems into lock-in traps. One lesson from these publications is that SESs managed in this way do not merely perform poorly, they also tend to fall into lock-in traps.

The issue of path dependence is also described as a mechanism of trap formation (Olsson, Bodin, and Folke 2010). These authors utilize the definition for **path dependence** provided in Kay (2003, p.406), "A system [in which] initial moves in one direction elicit further moves in the same direction; in other words, there are self-reinforcing feedback mechanisms or positive feedbacks." Path dependence was particularly popular in the economics and institutional governance literatures in the 1990s and was linked to 'lock-in' behavior of economies nearly two decades ago (Liebowitz and Margolis 1995). Kay (2003) showed positive feedbacks within the European agricultural system are a result of past policy decisions and serve to reduce the realistic range of options for future policy reforms. The result is very similar to a lock-in trap. Within the resilience-thinking literature, Schlüter and Herrfahrdt-Pähle (2011) show that positive feedback mechanisms related to path dependence are largely responsible for causing a missed window of opportunity to reforming an outdated Soviet-style water management system in the Amudarya River Basin in Uzbekistan.

Olsson, Bodin, and Folke (2010) describe the contribution of the field of historical institutionalism[16] to understanding the feedbacks that lead to path dependence. Within the resilience-thinking literature, Pelling and Manuel-Navarrete (2011) demonstrate how rigidity at high levels of government squashed windows of opportunity for change at lower levels within the system. This squashing occurred largely through manipulating the public discourse on management issues to suppress expression of viewpoints that challenge the current structure of the government, a phenomenon described in other fields as limiting conscientization (Freire 2005).

[16] Historical institutionalism is described in Steinmo (2008) as "an approach to studying politics" distinguished by "its attention to the ways in which institutions structure and shape political behavior and outcomes."

Schoon et al. (2011) evaluated five case studies of SESs conducted from an anthropology perspective and identified four distinct positive feedbacks that led to rigidity or lock-in traps. The first positive feedback is caused by rigidity in infrastructure. Infrastructure tends to be highly effective at fulfilling specific needs but can also become less useful as conditions change. For example, erecting extensive water supply infrastructure may make a particular area hospitable for human settlement. These settlements may come to overestimate the reliability of the infrastructure and resist allocating resources to 'unnecessary' alternatives to the established infrastructure. However, if conditions change sufficiently the usefulness of the infrastructure can suddenly be reduced dramatically, leaving the settlement with few options. This feedback can work synergistically with another positive feedback observed by Schoon et al. (2011), that as investment in infrastructure increases, the willingness of a society to abandon that infrastructure in favor of pursuing other ways to meet societal needs tends to decrease. This view is echoed in earlier works that describe the consequence of the 'sunk cost effect' in SESs (Janssen, Kohler, and Scheffer 2003) and is reminiscent of other works that discuss the role of path dependence in causing MS traps (Olsson, Bodin, and Folke 2010). A case study presented in Nelson et al. (2010) illustrates the synergistic effects of rigid infrastructure and heavy investment in infrastructure. Nelson et al. observed that overextending reliance on obsolete and rigid irrigation infrastructure led the native peoples of the Hohokam culture in the southwest United States to ruin.

Schoon et al. (2011) point to two other sources of feedback that lead to lock-in traps. Large population size tends to drive reliance on heavy infrastructure and increase the perceived costs of resilience-enhancing strategies. In other words, large populations rely on heavy infrastructure for amenities such as water, electricity, and food supply. Once in place, heavy infrastructure can make the population hesitant to adopt resilience-enhancing strategies, such as diversification. For example, large cities generally utilize central water supplies. From a resident perspective, the existence of a safe and reliable central water supply likely diminishes the willingness to diversify water supplies through a strategy such as rainwater harvesting. Finally, Schoon et al. (2011) found that threats to security tend to reduce variability within a society, which leads to lock-in traps. Scheffer and Westley (2007) report similar observations of ancient societies that became increasingly rigid during resource crises, precisely at the time they needed to be diverse and flexible. This same theme is perhaps most famously depicted in the bestselling book *Collapse: How societies choose to fail or succeed* (Diamond 2005).

2.3.4 How Can Maladaptive System Traps be Detected?

The literature offers remarkably little guidance on how to verify the presence of a MS trap. In one sense, identification of traps, defined as a persistent and undesirable state, seems obvious; you will know it when you see it. However, the literature offers no examples of studies that set out explicitly to evaluate MS traps. Instead, observations of MS traps often arise from studies of resilience or transformation of specific systems. The doctoral research done by Helen Allison in the Western Australian agricultural region is illustrative of this approach (Allison 2003; republished as Allison and Hobbs 2006). Allison set out to evaluate the history of natural resource management in Western Australia from 1889 to 2003 with regard to the three key factors in the adaptive cycle framework, resilience, connectivity, and capital. She successfully identified two complete iterations of the adaptive cycle and noted the present system is characterized by high connectedness, high resilience, and low potential. Allison also discussed the maladaptive nature of the arrangement and coined the term 'lock-in trap' to describe it.

Later research done by Bunce et al. (2009) took an approach similar to Allison (2003) and is significant to this study for being the only attempt in the literature of evaluating SES behavior on a small island with regard to the adaptive cycle. These authors evaluated the small semi-autonomous island of Rodrigues in the Indian Ocean for the three variables in the adaptive cycle framework to explain SES behavior over time. Bunce et al. were unable to identify movement of the SES through adaptive cycles, although they did document the conditions characteristic of a poverty trap. They did not identify the MS trap explicitly, although they did state on p. 223, “Overall, we support a notion that social–ecological systems may get stuck in a post-collapse recovery, in which no structure emerges.” In both the Allison and Bunce cases, traps became visible after evaluating a SES for the three variables in the adaptive cycle framework.

Some guidance may be inferred from contributions to the literature that evaluates other aspects of resilience thinking. Biggs et al. (2010) provide seven attributes of systems they deemed to have transformed in the past. In addition, The Resilience Alliance has published two workbooks dedicated to assessing resilience in social-ecological systems (Resilience Alliance 2007, 2010). Section 3.2.1 documents how this study utilizes all of these building blocks to construct a method to evaluate Grenadian water management for the presence of MS traps.

2.3.5 Can Traps be Escaped or Avoided?

The practical goal of studying MS traps is to develop strategies to avoid or escape them. The resilience-thinking literature provides limited advice on specific strategies to pursue these ends.

Gunderson, Holling, and Allen (2010) indicate that there are two fundamental ways for a system to break out of a MS trap. One is through a sufficiently large crisis; the other is a slower erosion of resilience in the trapped system. Sufficiently large crises are often not conveniently available and can be unattractive alternatives altogether. The slower erosion of resilience seems a more attractive option in most cases, and is the approach considered in the large majority of literature on MS traps.

One direct approach to break out of a trap is to identify and remove the fundamental feedbacks that reinforce the trap. For example, Steneck et al. (2011) identified a MS trap in management of the Maine lobster fishery driven by a strong financial incentive to cultivate monocultures of lobsters. These authors contend that removing the financial incentive for the fisheries management agency to resist change is essential before change is possible.

Multi-scalar collaborative networks have also been shown to be useful in overcoming a trapped situation. Butler and Goldstein (2010) showed how the US Fire Learning Network, a multi-scalar collaborative network, was used to overcome a rigidity trap in US wildland fire management. These authors validated the multi-scalar collaborative network approach, but also draw attention to complications that limit the effectiveness of such networks. Nevertheless, in concept, this lesson is applicable to other multi-scalar networks, notably the different forms of integrated resource management that have gained popularity in recent years.

Moore and Westley (2011) argue that networks must possess agency to move effectively beyond MS traps. In this context, Moore and Westley base their view of **agency** on the description provided in Emirbayer and Mische's appropriately titled and widely cited publication, 'What is Agency?' (1998, p. 962):

> (A) temporally embedded process of social engagement, informed by the past (in its habitual aspect), but also oriented toward the future (as a capacity to imagine alternative possibilities) and toward the present (as a capacity to contextualize past habits and future projects within the contingencies of the moment).

Moore and Westley (2011, n.p.) maintain such agency "is needed in order to form a targeted 'pipeline' and so create an interaction that might otherwise not have occurred." They go on to discuss agency in a MS traps context and draw from case studies of institutional entrepreneurship to describe the necessary skills and characteristics of network members to foster the agency needed to move beyond trapped situations.

Some large corporations overcome non-creative, efficiency focused, 'trapped' corporate cultures by isolating research and development and cultivating an innovation-oriented culture. Scheffer and Westley (2007) describe the production-oriented and innovation-oriented cultures as incompatible,

necessitating their separation. This strategy has apparently worked to keep large corporations such as Phillips and IBM competitive for many decades.

Other suggestions in the literature to avoid and break free of MS traps are more general in nature. For example, maintaining flexible and diverse physical and social infrastructure, such as by fostering foreign trade, and managing across diverse scales, such as by allowing flooding to happen on small scales, have been suggested (Schoon et al. 2011).

2.3.6 Lessons Learned and Next Steps

One lesson drawn from the preceding discussions of transformability and MS traps is that they look remarkably like opposite sides of the same coin. One concept (transformability) describes processes of change, the other (trap) describes processes of resistance to change. The same issues cited as the causes of MS traps are also identified in literature that describes obstacles to transformability, particularly with regard to networks. For example, Pelling and Manuel-Navarrete (2011) and Butler and Goldstein (2010) describe multiple-scale aspects of networks and their effect on transformation (Pelling and Manuel-Navarette) and freeing a system from a rigidity trap (Butler and Goldstein). Olsson, Bodin, and Folke (2010, p. 266) go so far as to say that understanding MS traps is a key to fostering transformation of a system. Conversely, the literature on transformation has great, if largely unarticulated, application to understanding MS traps better. In essence, the way to avoid or break out of a MS trap is to foster transformability, and the way to foster transformability is to avoid or break out of a MS trap. Explicitly evaluating the two phenomena in concert appears to be a gap in the literature, but is a fundamental feature of this study.

One important gap in the traps literature is a method for determining and describing the severity of a trap. It is intuitive that some trapped systems are closer to breaking free of the trap than others, yet no method, or even nomenclature, exists to quantify or describe the severity of traps. If we had such a method, it may provide insight to how to free systems from traps. It might also be possible to judge the effectiveness of interventions.

The cutting edge in research on transformability and MS traps is to adapt the lessons from other academic areas. Utilizing relevant concepts from other academic areas is a fundamental strength of using the resilience-thinking framework and the opportunity in this regard is tremendous. Table 2.4 provides two dozen examples of areas in the literature applicable to transformability, MS traps, and this study in particular and is far from exhaustive. Concepts from most of the areas in Table 2.4 have been applied to transformability or MS traps to some degree, but some have not, such as conservation psychology and community-based social marketing. A handful of these topics has been used with

great success to explain certain aspects of transformation and MS traps, especially networks and governance. The analysis technique of explanation building was specifically incorporated into this study to provide an opportunity to explore the usefulness of concepts from other literatures, such as those in Table 2.4.

Table 2.4. Selected literature relevant to the current study.

Name of Literature or Framework	Selected References	Potential Relevance to Study
Planning (Strategic)	Mukhtarov 2007 Mukhtarov 2008, p. 173-4	Directly applicable to IWRM, according to Mukhtarov
Planning (Communicative)	Goldstein 2009	Useful to enhance resilience to surprises and cooperation through innovative approaches to 'collaborative deliberation'
Policy Transfer	Mukhtarov 2007	Directly applicable to operationalizing IWRM, according to Mukhtarov
Psychological Empowerment	Menon 1999 Spreitzer 1995 Ker Rault and Jeffrey 2008	Has potential for explaining an underlying factor affecting participation in water management; Is also measurable and easily integrated into research methods
Governance	Gelcich et al. 2010 Huitema and Meijerink 2009	Provides insight to processes of transformation; Provides insight to assist the transition from normative to operational water management
Ecosystem Stewardship	Chapin et al. 2009	Reframes resource management transitions from a stewardship perspective
Change Management	Medema 2008 Meijerink and Huitema 2010	Provides insight into fundamental processes of change and strategies for overcoming barriers to change
Transition Management	van der Brugge and van Raak 2007	Provides insight into transformations, particularly the role of shadow networks and arenas
Learning via Adaptive Management	Armitage, Marschke, and Plummer 2008 Pahl-Wostl 2009 Olsson, Bodin, and Folke 2010	Provides insight to transformation processes.
Critical Consciousness	Freire 2005 Pelling and Manuel-Navarrete 2011	Provides insight into transformation and SES traps, grounded in Marxist theory
Environmental Futures	Bishop, Hines, and Collins, 2007 Bishop 2011 Strong 2011	Very similar to SES resilience literature, but utilizes a distinct framework with different models and analogies; provides an alternative perspective to SES resilience

Name of Literature or Framework	Selected References	Potential Relevance to Study
Organizational Science	Olsson, Bodin, and Folke 2010 Gladwell 2000 Robards et al. 2011	Provides insight into transformation from corporate settings, particularly with regard to networks, agency, and innovation
Sustainable Development or Sustainability	Brundtland 1987 Redclift 1987 Redclift 2005	Provides a context and political space to apply concepts of transformability, traps, and resource management; limited use to apply to transformability and traps
Conservation Psychology	Saunders 2003	Psychology-based insight into why people hurt or help the environment; particularly applicable to elements of transformation
Community Based Social Marketing	McKenzie-Mohr 2000 Westley, Holmgren, and Scheffer 2010	Psychology-based pragmatic approach to fostering changes in human behavior
Multi-Stakeholder Platforms	Steins and Edwards 1999 Warner 2007	Provides insight into overcoming issues of power and contrasting vision in stakeholder negotiation; particularly applicable to IWRM
Multi-Scalar Collaborative Networks	Butler and Goldstein 2010	Provides insight similar to multi-stakeholder platforms
Social Innovation	Biggs, Westley, and Carpenter 2010 Olsson et al. 2006 Olsson, Folke, and Hahn 2004	Used by some authors to describe the process of transformability within the context of the adaptive cycle and panarchy
Punctuated Equilibrium	Olsson, Bodin, and Folke 2010	Provides insight into transformation by focusing on 'branching points' and critical junctures from which development changes paths
Conflict Resolution	Hipel et al. 2008 Fang, Hipel, and Kilgour 1993	Provides insight into managing stakeholder conflict
Historical Institutionalism	Hall and Taylor 1996 Olsson, Bodin, and Folke 2010	Provides insight into processes of stability and control, particularly applicable to SES traps
Sociotechnical Transitions	Geels 2005 Geels and Schot 2007	Provides insight into transformations, particularly with regard to processes of stability and the nature of transformation
Diffusion of Innovation	Rogers 2003 Atwell, Schulte, and Westphal 2008	Provides insight into the spread of ideas among groups
Political Ecology	Bryant and Bailey 1997 Pelling and Manuel-Navarrete 2011	Provides insight into the power dynamics of social change
Windows of Opportunity	Birkman et al. 2008 Michaels, Goucher, and McCarthy 2006	Provides insight into one critical aspect of transformation

The literature on resilience thinking was a central influence on the design of many parts of the study (Figure 1.2). At the beginning of the study, I pursued a purpose, “to determine what interventions are most likely to stimulate transformation of Grenadian water management” and considered a wide swath of literature, most of which is not captured in this chapter. Resilience thinking resonated as the best way of addressing my purpose in my specific setting and I decided to utilize it as the central concept underpinning the study.

Evaluation of the resilience-thinking literature revealed important gaps in knowledge and research methods, some of which needed to be filled to conduct this study. I made judgments on which gaps were necessary to resolve in order to pursue my purpose in my specific setting, based largely on my experiences living and working in Grenada since 2006. For example, it was necessary for me to define an MS trap and develop a way to identify one before I could assess if one exists in Grenadian water management. The gaps I determined to be crucial to enable pursuit of the study purpose are captured in the 'research gaps' box of Figure 1.2.

I worded my problem statement carefully based on my understanding of the resilience-thinking literature. My criteria were to form a question that was worded as concisely as possible, adequately fills the research gaps identified above, and that, once answered, would allow me to properly address my study purpose. In the literature review, it became apparent that traps and transformations are closely related, described above as 'different sides of the same coin.' Upon further deliberation, I judged that it is fundamentally impossible to evaluate transformation in my setting without also evaluating what prevents transformation, namely traps. Thus, I decided it was not necessary to include the term traps in my problem statement and settled on the wording, “How do traps and transformability affect progress of Grenadian water management?”

The depth of the literature review became particularly relevant in determining the research questions and objectives. It was immediately evident that to address the problem statement it is necessary to evaluate the status of Grenadian water management with regard to both the presence of traps and the degree to which it is transformable. *This became the basis of the first two research questions.* It was also clear that it would be necessary to adapt methods of assessing aspects of resilience, traps, and transformation found in the literature to the Grenadian water management setting, which led to the formation of objectives 1A and 2A.

Finally, *research questions #3 and #4* were created to verify if the academic concepts of traps and transformation have value in an operational water management context. Research question #3 was created to judge recent and current interventions with regard to transformability and determine if they can be made more effective by manipulating the transformability of the system. Research

question #4 seeks to verify if the concepts of transformability and MS traps can be used as a basis to form insightful recommendations to stimulate progress in Grenadian water management.

2.4 Integrated Water Resources Management

Integrated water resources management (IWRM) is one approach to advance water resources management beyond making decisions based solely on the narrow mandates and authority of water management authorities. The IWRM approach establishes a new management style of accommodating diverse water users with potentially conflicting needs (Mitchell 1990). Attempts to implement IWRM have been difficult and have achieved varying levels of success (Rahaman and Varis 2005; Medema, McIntosh, and Jeffrey 2008). Some assessments of the difficulties of implementing IWRM maintain the basic concept of IWRM is valid and cite difficulties in implementation in the local context for inconsistency in IWRM effectiveness (Medema 2008), although other authors challenge the basic value of IWRM (Biswas 2004a; Jeffrey and Gearey 2006). The following discussion evaluates both the basic concept of IWRM and its application in practical settings.

The purpose of this section is to provide a basis for judgments made later in this thesis regarding progress of efforts to implement IWRM in Grenada. To reduce confusion, IWRM, defined as a concept in the normative sense, is termed *normative IWRM* and IWRM, defined as an operational water management approach, is termed *operational IWRM* from this point forward.

2.4.1 Normative IWRM

Normative IWRM is rooted in early efforts to manage water resources to meet diverse needs. Early forms of integrative water management have existed since at least the early 20th century (Table 2.5). However, the current normative framework for IWRM has developed over the last 35 years as a reaction to the widespread existence of non-inclusive water management. The IWRM concept was advanced dramatically at three key conferences: Mar del Plata (1977), Dublin (1992), and Rio (1992; Rahaman and Varis 2005). The core normative IWRM concepts were enshrined at the later two conferences in the Dublin Statement (ICWE 1992) and Chapter 18 of Agenda 21 of the Rio Declaration (United Nations 1993), occasionally referred to as the Dublin Principles (Table 2.6). Other descriptions of IWRM are provided in the academic literature (Walther 1987; Mitchell 1990).

Table 2.5. IWRM timeline.

Year	Events relevant to the development of Integrated Water Resources Management
1900's	Setting the stage: Growing realization that each sector cannot continue to manage water independently of each other and of the environment (Medema, 2008)
1930's	Tennessee Valley Authority first attempts at what would someday be known as IWRM (Jeffrey and Gearey, 2006; Mitchell, 2007)
1960	Catchment-based approach to water management appears in England, Wales, and France (Mitchell, 2007)
1977	First UNESCO conference on water in Plata del Mar, origin of modern form of IWRM (Medema, 2008)
1980's	Water fades from international political agenda, Despite it being the WHO "international decade for water supply & sanitation" (White, 1998) Alberta introduces some form of IRM for public land management (Walther, 1987; Alberta Energy and Natural Resources, 1983)
1992	International Conference on Water and Environment (Dublin) **Key product: the four 'Dublin Principles'** Rio Earth Summit, Rio de Janero, 178 nations essentially ratify the Dublin Principles **Key product: Agenda 21** (United Nations, 1993) Plata del Mar (1977), Dublin (and by inference Rio) were later described as the three 'productive' conferences of modern times (Gleick and Lane, 2005; Gleick, 2006)
1993	World Bank develops a widely cited definition of IWRM
1997	1st World Water Forum - Marrakech, Morocco, in 1997, 500 people in attendance (Gleick and Lane, 2005; Gleick, 2006)
2000	GWP defines IWRM (Global Water Partnership, 2000), which continues to be the most widely accepted definition (Medema, 2008) 2nd World Water Forum & Ministerial Conference - The Hague, 12,000 people in attendance, ushers in era of large water conferences (Gleick and Lane, 2005; Gleick, 2006) UN Millennium Project launched, Millennium Development Goals adopted one year later; Key water goals are to "halve, by 2015, the proportion of people without sustainable access to safe drinking water and basic sanitation"
2002	World Summit on Sustainable Development (WSSD) in Johannesburg - called for countries to develop IWRM and Water Efficiency Plans by 2005
2003	3rd World Water Forum – Kyoto, 24,000 people in attendance (Gleick and Lane, 2005; Gleick, 2006)
2004-06	Biswas (2004) and Jeffrey and Gearey (2006) publish widely cited criticisms of IWRM
2005-15	International Decade for Action - Water for Life (World Health Organization, 2005)
2006	4th World Water Forum – Mexico, nearly 20,000 in attendance (Gleick, 2006)
2009	5th World Water Forum – Istanbul, 33,000 people in attendance (WWF 5 web page)

Table 2.6. The Dublin Principles (ICWE 1992).

Number	Description
1	Fresh water is a finite and vulnerable resource, essential to sustain life, development and the environment.
2	Water development and management should be based on a participatory approach, involving users, planners, and policymakers at all levels.
3	Women play a central part in the provision, management and safeguarding of water.
4	Water has an economic value in all its competing uses and should be recognized as an economic good.

One criticism of normative IWRM is that it lacks a solid, meaningful definition (Biswas 2004a). Critics point to the number and diversity of IWRM definitions. To illustrate this point, I provide a non-exhaustive list of nine definitions for IWRM in Table 2.7. This issue also led Jønch-Clausen and Fugl (2001, p. 502) to state that, "To some extent IWRM has degenerated into one of these buzz-words that everybody uses but that means many different things to different people." Molle (2008, P. 132) describes IWRM as an idealistic 'nirvana concept' that, on its face, is unobjectionable and sounds nice. However, flexibility in its meaning can easily sabotage implementation when each stakeholder decides to promote a distinct interpretation of IWRM to its own benefit. Mole (2008, p. 136) acknowledges that, in concept, the gentle and flexible interpretation of IWRM can serve as a 'boundary object,' or a common platform for stakeholders that are typically antagonistic to one another. To this end, IWRM can provide a valuable common ground for negotiation between stakeholders that are willing to engage others in good faith.

The effect of normative IWRM on modern water management is profound. An early high-profile success was the explicit endorsement of IWRM at the Earth Summit in Rio de Janeiro, including a commitment to develop national IWRM plans as outlined in Agenda 21, Article 18, which was ratified by all 178 nations attending the conference (United Nations 1993). Since this time, IWRM has served as a political rallying point for efforts to transform water resources management around the world. Jeffrey and Gearey (2006, p.2) go so far as to say, "It is difficult to overstate the extent to which IWRM has become the norm or even, one might say, the orthodoxy in water

resources management." Lamoree (2004, p. 400) credits the promotion of IWRM for a “move away from single-sector institution responsibility and decision making,” a “renewed focus on stakeholder participation in water management," and “broadening the water profession to include non-technical disciplines and multi-disciplinary research.” To some degree, the popularity of IWRM can share some of the credit for putting and keeping water issues on the international political agenda.

Table 2.7. Selected definitions of Integrated Water Resources Management.

Selected Definitions of Integrated Water Resources Management	
Global Water Partnership	A process which promotes the coordinated development and management of water, land and related resources, in order to maximize the resultant economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems. (Global Water Partnership 2000)
World Bank	An integrated water resources perspective ensures that social, economic, environmental and technical dimensions are taken into account in the management and development of water resources. (Easter et al. 1993)
USAID	A participatory planning and implementation process, based on sound science, that brings stakeholders together to determine how to meet society's long-term needs for water and coastal resources while maintaining essential ecological services and economic benefits. (USAID 2006)
Cap-Net	A systematic process for the sustainable development, allocation and monitoring of water resource use in the context of social, economic and environmental objectives. (http://www.archive.cap-net.org/iwrm_tutorial/p_2_1.htm)
World Water Forum	An incremental and adaptive policy approach that seeks the coordinated development and management of water, land and related resources. It also seeks to harness water resources to attune to national development goals and challenges, such as poverty alleviation, economic growth, social development and environmental sustainability. (Comisión Nacional de Agua 2006)
Grigg (1999)	A framework for planning, organizing and controlling water systems to balance all relevant views and goals of stakeholders.
Grigg (2008)	A framework for planning, organizing and operating water systems to unify and balance the relevant views and goals of stakeholders.
Medema (2008)	A democratic process for developing and managing water and related resources in a coordinated and sustainable manner.
Jonker (2007)	A framework within which to manage people's activities in such a manner that it improves their livelihoods without disrupting the water cycle.

2.4.2 Operational IWRM

Operational IWRM can be described as a decision-making framework that combines the consideration of diverse management needs alongside the more idealistic concepts of normative IWRM. The form of an operational IWRM framework is entirely flexible and success or failure often depends on adapting an IWRM framework to match specific applications (Walther 1987; Mitchell 1990, 2009). Figure 2.9 provides a generic graphical representation of my conceptualization of operational IWRM. To be consistent with recent literature, this figure is intentionally vague regarding how diverse management concerns are considered, and to what degree the normative aspects of IWRM laid out in Global Water Partnership (2000) and in the Dublin Statement (United Nations 1992) are adhered to. The most critical aspect of Figure 2.9 is that management actions are informed by a holistic consideration of diverse stakeholder concerns and are not fragmented in nature.

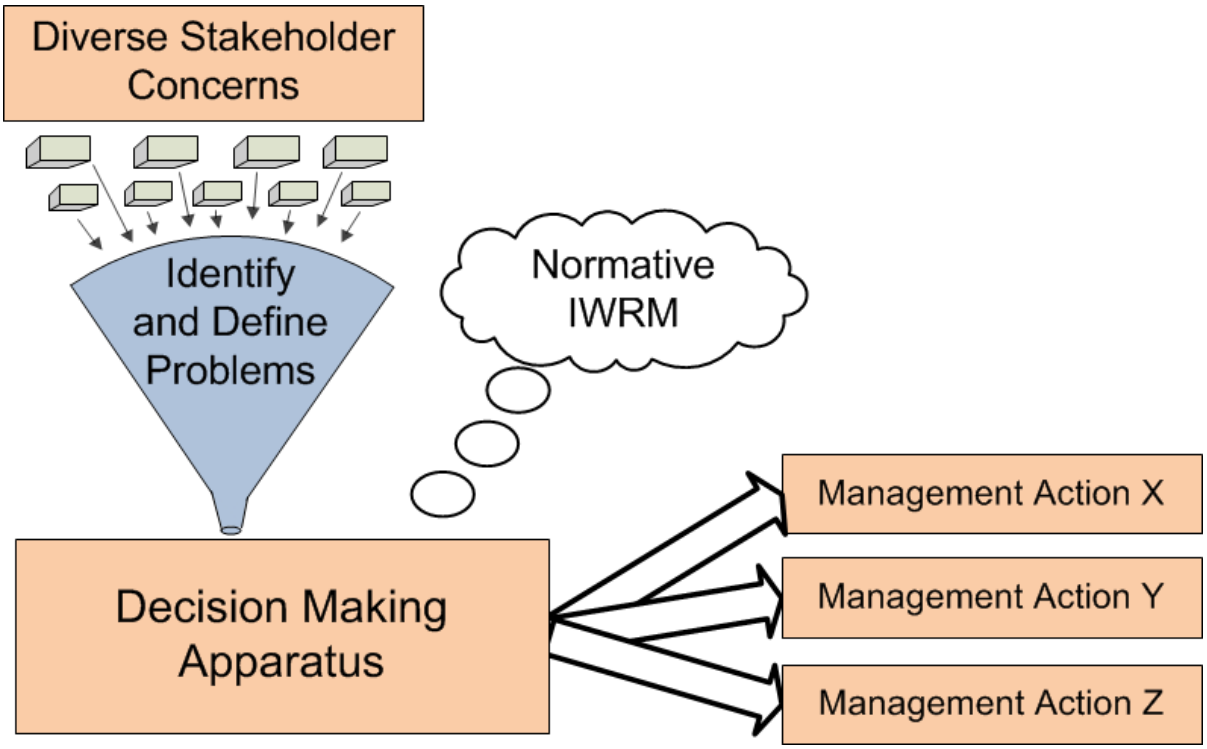


Figure 2.9. Author's representation of linkages between the normative and operational aspects of IWRM within a decision-making framework.

2.4.2.1 Criticism of Operational IWRM

While normative IWRM has widespread support, implementing it in specific settings has had inconsistent results. To a large degree, examples of managing water resources while integrating diverse concerns of management predate the origin of the term IWRM. For example, the origins of

what would eventually become known as IWRM in Canada can be traced to the establishment of the Ontario Conservation Authorities in 1946 and the initiation of 'comprehensive river basin management' in the 1960s (Mitchell 2006). Notable successes under the 'official' IWRM title are not uncommon and include the implementation of integrated catchment management in west Australia (Mitchell and Hollick 1993) and north Australia (Johnson, Shrubsole, and Merrin 1996). A Global Water Partnership Background Paper from 2004 provides a robust inventory of ongoing IWRM efforts from around the world, including in Uganda, Burkina Faso, China, Quebec, Thailand, India, and Brazil (Jønch-Clausen 2004). However, virtually all case studies of IWRM implementation contain some elements of both success and failure. Other works document cases of apparent failure of IWRM. For example, implementing IWRM in southern Africa has largely failed to achieve substantive integration of water management concerns and may even prove impossible at this time (Pollard 2002; Swatuk 2005; Swatuk and Motsholapheko 2008).

A substantial body of literature describes the difficult transition from normative to operational IWRM, sometimes referred to as the 'implementation gap,' and cautions against the idealistic application of normative IWRM (Walther 1987; Mitchell 1990, 2009). Experiences from the field indicate that implementing IWRM should not be approached in terms of following a recipe (Mitchell 1990; Lankford et al. 2007). However, this caution has not deterred some authors from expecting such recipes (Biswas 2004b, 2008). Lankford and Cour (2005) observe that attempting to implement all aspects of normative IWRM in any given setting invites failure. These authors recommend approaching IWRM as a 'toolbox' and to be adaptive about which tools are needed to accomplish a specific management objective in a given setting. Mitchell (1990, p. 4) made this point 15 years prior:

> at the strategic level, a comprehensive approach should be used to ensure that the widest possible perspective is maintained, but in contrast, a more focused approach is needed at the operational level where attention should be directed to a smaller number of issues that account for most of the problems.

Many authors have treated ambiguity in the normative definition of IWRM as desirable flexibility to implement a management framework customized to fit specific management situations. In fact, some authors emphasize that successful implementation of IWRM *depends on* customizing the concept to fit the specific management context and can be vital to overcoming conflict between agencies at the boundaries between their jurisdictions (Mitchell 2004; Lankford and Cour 2005; Lankford et al. 2007; Mitchell 2009).

Despite this literature, some authors have criticized IWRM sharply for failures in traversing the implementation gap (Biswas 2004b; Jeffrey and Gearey 2006; Biswas 2008; Merrey 2008). This

criticism is acknowledged as valid, even among champions of IWRM (Lamoree 2004; Mitchell 2007).

It deserves highlighting that the problem of implementation is not specific to IWRM, or even to water management, and is not insurmountable. Implementation difficulties face all attempts to move water and other types of resource management beyond the fragmented, rigid, and non-inclusive decision-making practices of the past. Change in water management is difficult, regardless of the type of management regime being implemented or the framework utilized. For example, 'adaptive management' is another common water resources management approach that is championed in the literature but widely criticized for similar implementation issues (Table 2.8; McLain and Lee 1996; Walters 1997). Rynes et al. (2001) note that similar criticism over implementation exists in every field that has both academics and practitioners. Despite the difficulties of implementing new approaches to water management, there are success stories. To date (2012), 24 examples of successful implementation of innovative approaches to water resources management have received the annual national (Australia) and international Thiess River*prize* award from the International RiverFoundation[17]. Case studies of past award winners are provided in International RiverFoundation (2007) and Gregory, Brierley, and Le Heron (2011).

Table 2.8. Challenges and criticisms of adaptive management. Similar criticisms are grouped.

Challenge or Criticism	Source
<u>Social Inflexibility</u>	
Fundamental conflicts in ecological values between stakeholders	Walters (1997)
In practice, research and management stakeholders express strong self-interest, seeing AM policy as a threat to themselves, not an opportunity for improvement	Walters (1997)
Experimental policies have been seen as too costly, particularly monitoring costs	Walters (1997)
Poor flexibility in the social system, more so than the ecological system	Gunderson (1999)
Stakeholders may be resistive due to perception that AM is a risk to their interests	Stankey et al. (2005)
Stakeholders may see AM as too costly	Medema (2008)
Stakeholders may see AM as too complex	Medema (2008)
<u>Ecological Risk</u>	
Experimental policies seen as too risky, particularly to endangered species	Walters (1997)
Stressed ecosystems may have little or no resilience, causing a fear of triggering an ecosystem shift to an unwanted stability domain	Gunderson (1999)
Contradictory to the precautionary principle	Nudds (1999)

[17] The River*prize* is an award given annually since 1999 to recognize development and implementation of innovative and sustainable programs in river management. More information is available on the International Riverfoundation website, http://www.riverfoundation.org.au/.

Challenge or Criticism	Source
AM is not appropriate in situations calling for risk-averse approaches or where management decisions are irreversible	Trauger (1999)
Stakeholders may see AM as too ecologically or economically risky	Medema (2008)
Difficulties in Operationalizing	
In practice, relies on linear systems models	McLain and Lee (1996)
Discounts non-scientific forms of knowledge	McLain and Lee (1996)
Doesn't foster shared understandings among diverse stakeholders	McLain and Lee (1996)
Modeling of management scenarios is imperfect	Walters (1997)
Monitoring data is incomplete or imperfect	Walters (1997)
AM requires well thought out and adaptable long-term monitoring	Kernohan and Haufler (1999)
In practice, the best information is not normally used, in favor of 'conventional wisdom' and anecdotal science	Trauger(1999)
Managers aren't truly in control of basic physical, chemical, and ecological processes, let alone the social, economic, and political parameters of the system: it may more complex than we can understand	Trauger (1999)
Conflicting definitions, poor direction for implementation	Failing et al. (2004)
As a process, AM is better suited as one element of a structured decision process, rather than as a decision process itself	Failing et al. (2004)
Requires long-term funding source	Medema (2008)
Is time consuming, stakeholders may lose interest	Medema (2008)

2.4.3 Lessons Learned and Next Steps

IWRM has emerged as a dominant paradigm in water resources management (Jeffrey and Gearey 2006), but faces persistent problems in an operational context (Pollard 2002; Swatuk 2005). Normative IWRM has been embraced by the Global Water Partnership, perennially endorsed at the World Water Forum conferences, enshrined in Agenda 21 of the Rio Declaration, and implemented the world over. However, at an operational level, problems have emerged, resulting in many failures and criticism (Merrey 2008). Some authors have endorsed dropping the IWRM concept altogether (Biswas 2004a, 2008), but have not proposed an alternative, and thus a more prudent path forward is to search for new insight that might help guide current and future attempts to implement IWRM.

At the core of IWRM implementation difficulties lies a fundamental resistance to change. Pollard (2002) makes an important point that integration is about changing behavior, both of

individuals and of organizations. Mitchell and Hollick (1993, p. 742) suggest that for IWRM to succeed "people and agencies [need to] to move out of their present comfort zones. By definition, such a move creates discomfort." Swatuk (2005, p. 878) frames the full meaning of implementing IWRM as "fundamentally [reconstituting] how resource access, allocation and use decisions are made," which he describes as "a profoundly political act which challenges the very bases of power," and advises that "resistance is to be expected." Case studies of attempts to implement IWRM show that this change in behavior is difficult to accomplish and may be perceived as threatening to some (Mitchell and Hollick 1993).

Despite ongoing attempts to develop advice and guidelines for IWRM implementation (Rahaman and Varis 2005; Mitchell 2009), bridging the implementation gap continues to be a research need. This is a daunting challenge that has frustrated academics in other contexts and disciplines. Undoubtedly, insight is readily available in literature on other academic disciplines (Table 2.4). One way forward may be to reframe the fundamental issue from being a problem with IWRM to being an issue of overcoming traps, or possibly an issue of SES transformation, as discussed earlier in this chapter (Gunderson and Holling 2002; Allison and Hobbs 2004). In short, many of the apparent failures of IWRM can be recast as failed attempts to transform systems in a maladaptive trapped state. Certainly, the scope of literature focused on changing entrenched social-ecological systems is vast and deep compared to the IWRM literature focused on overcoming implementation challenges.

To date (2013) there have been no attempts to my knowledge to apply the resilience-thinking concepts of transformability and MS traps explicitly to implementing IWRM. A handful of publications has applied concepts similar to those found in the transformability and MS traps literature to the implementation of IWRM. Examples come from literatures on policy transfer networks (Mukhtarov 2007), governance (Funke et al. 2007; Turton et al. 2007), strategic planning (Mukhtarov 2008), and change management (Medema 2008). Additionally, the role of IWRM in fostering water management for resilience can be inferred from Carpenter et al. (2009). A reasonable next step is to assess attempts to implement IWRM explicitly from the SES perspectives of MS traps and transformation.

The above discussion on IWRM provides am important contextual contribution to the study. In Grenada, progress has been made recently on adopting IWRM as a management approach. Tracing the evolution of IWRM in Grenada provides great insight into both processes of transformability and MS traps. A solid fundamental understanding of IWRM is crucial in this regard. In addition, a solid understanding of IWRM informs the execution of interviews and enriches interpretation of data gathered from all sources.

2.5 Summary and Conclusions

The first section of this chapter establishes the conceptual framework that inspired the study. Specifically, SES resilience is defined and presented as a key goal of resource management. The evolution of SES resilience literature is discussed, including the adaptive cycle and panarchy. Resilience thinking is discussed as a metaconcept that emerged to explain how to foster resilience. Importantly, trapped systems are also discussed. Finally, other approaches to explain resilience were acknowledged and briefly discussed.

The second section builds upon the discussion of resilience thinking and identifies specific research gaps and opportunities for contribution to the literature on transformability. The definition of transformation is discussed and a distinction is made between transformability and adaptability. Literature on the process of transformation is discussed. The first research gap identified is how transformability occurs in developing world and especially SIDS settings. The second research gap identified is to explore farther how ideas and insights from other academic literatures can help explain transformation of SESs. A bias in the transformation literature toward relatively orderly, intentional, and gradual processes over transformations that result from unexpected and abrupt shocks to SESs is also acknowledged. Finally, the ways in which the literature on transformation informed the design of the study are provided.

The third section of this chapter focuses on MS traps, builds upon the discussion of resilience thinking provided in the first chapter, analyzes the literature on the causes of traps, and identifies research gaps and potential for future research. The first research gap identified is to explore the usefulness of considering MS traps and transformation concurrently. The literature on each concept has considerable insight to offer the other. The second research gap identified is to explore the applicability of lessons and concepts from other disciplines for application to the relatively sparse MS trap literature. Applying concepts from other literatures appears to be the current direction of research on traps, which has powered remarkable progress in recent years. However, the potential to continue on this trajectory is vast and future research will validate which concepts from other disciplines are truly useful to improve understanding of MS traps. Finally, the ways in which the literature on MS traps informed the design of the study are provided

The section on IWRM discusses the evolution and criticism of normative and operational IWRM and draws attention to a research need for improved understanding of how to implement IWRM. In general, wide support for the normative concepts of IWRM exists but successful implementation is inconsistent. It is argued that value exists in reframing the implementation

challenges of IWRM from an issue of IWRM to an issue of transformation and the difficulty of transforming water management systems in a maladaptive trapped state.

A ‘low hanging fruit’ approach to advance all three literatures considered in this chapter involves drawing from concepts in other academic areas to guide future research. The opportunity to do this is enormous, perhaps even intimidating. Table 2.4 contains a partial summary of dozens of academic topics with specific potential for application to the literatures reviewed in this chapter. The challenge for researchers is to sift through the literature in a sensible but expedient manner and select which concepts to draw upon. A researcher’s experiences, strengths and limitations, and the research project at hand, may serve as a guide for selecting which concepts to draw upon.

The largest ‘take-home’ point of this literature review is that considerable synergy likely exists in applying the concepts of transformability, MS traps, and operational IWRM to one another. The application of these themes in concert defines the intellectual space in which this study is conducted. Perhaps most importantly, the scholarly understanding of transformability, MS traps, and IWRM dictated to a large degree how the study was designed and conducted.

Chapter 3
Methodology

This study originated from a desire to understand processes of change in Grenadian water management.[18] Following this interest, an extensive literature review was performed (see Chapter 2) to inform the construction of a framework for a study of Grenadian water management, including a problem statement and research questions (see Chapter 1). This chapter documents the design and methodological decisions regarding (1) the use of a single-case study approach, (2) the use of mixed methods, (3) the mix of research methods chosen and how they were executed, and (4) how data were analyzed.

3.1 Research Approach

This section documents the decisions to utilize a single-case study approach and to use mixed methods. Included are discussions on the ontological and epistemological underpinnings of the study and the strengths and weaknesses of the approach. Finally, measures to ensure academic rigor in this study are summarized.

3.1.1 Case Study Approach

A case study design was chosen based on the nature of the research inquiry and considerable reading on case study research design to confirm and define its applicability to the study. Landmark textbooks (Stake 1995; Yin 2009) and reviews of case-study research methodology (Tellis 1997a, 1997b; Baxter and Jack 2008) provided rich guidance for considering the case study approach and defining how it should be used in the study. Notably, the introduction of Yin's textbook is subtitled, *How to Know Whether and When to Use Case Studies as a Research Method* (Yin 2009, p. 3). Yin's discussion provides useful information on research methods in the social sciences and commentary on the appropriateness of each in various situations (2009, p. 5-14).

In describing the applicability of case-study research to specific studies, Yin (2009, p. 4) advises, "The more that your [research] questions seek to explain some present circumstance (e.g., 'how' or 'why' some social phenomenon works), the more that the case study method will be relevant." Yin continues, "The method is also relevant the more that your questions require an extensive and 'in depth' description of some social phenomenon." Baxter and Jack (2008, p. 545) provide more specific advice in their discussion of Yin's position for applying case study design:

[18] The term "water management" refers to a broad management of water resources and extends beyond the operation of the water authority.

> [A] case study design should be considered when: (a) the focus of the study is to answer 'how' and 'why' questions; (b) you cannot manipulate the [behavior] of those involved in the study; (c) you want to cover contextual conditions because you believe they are relevant to the phenomenon under study; or (d) the boundaries are not clear between the phenomenon and context.

The current study was judged by me to fulfill all of these conditions. Specifically, in this study I seek to understand *why* water management in Grenada is slow to progress and *how* transformative change can be brought about. Additionally, it is not possible to manipulate the system and in-depth analysis of the social-ecological context is likely to be important.

Defining case study research is less precise than describing when it is applicable. Yin (2009) defines case study in terms of how and what it studies. First, case study is empirical and considers existing phenomena in their real-life context. Second, case study manages complex situations with many variables by relying on the widely-used method of triangulation of evidence.

Despite the appeal of case-study research, several aspects have been sharply criticized (Tellis 1997a, 1997b; Myers and Newman 2007; Diefenbach 2009). Yin (2009, p. 14-16) describes and refutes the most common perceived drawbacks (Table 3.1). These drawbacks are acknowledged here and considered as avoidable pitfalls. They are further discussed below and later in Chapter 5.

Given the decision to use a case study design, I then decided to pursue a single case study. The choice between studying multiple cases or a single case involves making a tradeoff between the breadth of research and the depth. As a practical matter, I had an opportunity to research the Grenadian case much more deeply and with greater insight than was possible for me to do elsewhere. Also, I had reservations that the value of comparing multiple cases would offset the gains possible from a focused study of the Grenadian case. As a practical matter, living and working in Grenada provided me with insight into the local culture and water resource issues and access to key actors that would be difficult to duplicate in another setting without cutting deeply into my ability to explore the complexities of the *why* and *how* questions that interested me. In my view, the opportunity to dig as deeply as possible into the Grenadian setting was an opportunity too great to pass up. The literature on case-study design supports this reasoning. Specifically, the single-case model is justified because it is a *revelatory* case, in that "the investigator has an opportunity to observe and analyze a phenomenon previously inaccessible to social science inquiry" (Yin 2009, p. 48). This view is consistent with case-study methodology review papers (Tellis 1997a, 1997b; Baxter and Jack 2008).

Given the use of a single-case study design, I further decided to utilize an 'embedded,' rather than a 'holistic,' case study approach. A holistic approach focuses on the global nature of an entity, without regard to the dynamics between individual parts within the entity being studied, while an

embedded approach focuses on the dynamics of subunits within a case (Yin 2009). To a large degree, the point of this study was to examine the dynamics between individual parts of the case, Grenadian water management. Therefore, the study was designed as an *embedded* single-case study. This methodological selection is consistent with published review articles on case study methodology (Tellis 1997a, 1997b; Baxter and Jack 2008). Other authors have used the terms 'nested' or 'layered' to describe the embedded case study (Patton 2002).

Table 3.1. Common criticisms and rebuttals of case-study research (based on information provided in Yin, 2009).

Perceived problem with case-study research	Explanation
It is not rigorous	This perception is an artifact of sloppy research and is not a fair criticism of the methodology
It provides little basis for scientific generalization	Case-study research is generalizable analytically (to theory), but not statistically (to populations)
It takes too long and produces long, unreadable documents	This is true of many case studies, but these problems can be avoided
It does a poor job evaluating cause and effect relationships	This is true to a large extent, but case studies can elaborate why and how a causal relation exists - something other methodologies struggle with

The case in this study is defined as Grenadian water management and multiple embedded units were chosen, or emerged during the study, to capture the relationships between and among key actors in the system. The embedded units of analysis were not mutually exclusive and some units overlapped. For example, embedded units included the water authority, water sector reform[19], and the resident experience with regard to water supply. The single-case, embedded design utilized in this study is depicted in Figure 3.1.

[19] Water sector reform is the term given to a recent attempt to legislate greater integration of water concerns into water resources management.

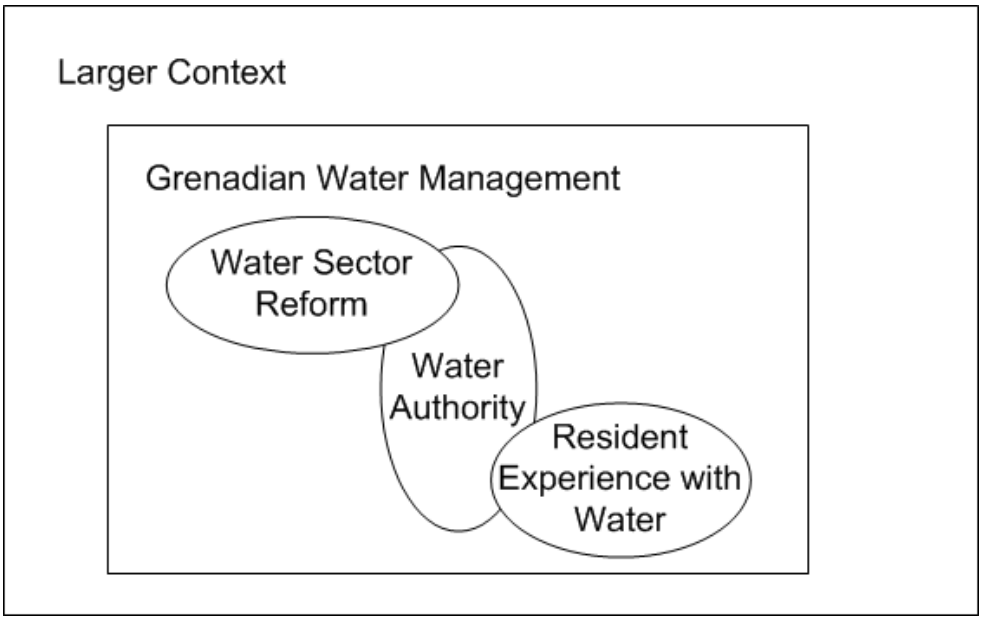


Figure 3.1. Diagram of the embedded single-case study design, recognizing overlap between some embedded units. Image adapted from Yin (2009).

Case-study design can further be described in terms of being exploratory and explanatory. Exploratory case studies are said to pursue 'what' types of questions, while explanatory case studies pursue 'why' and 'how' types of questions (Tellis 1997a, 1997b; Yin 2003; Baxter and Jack 2008). Explanatory case studies are more readily recognized as ‘normal’ case studies, while exploratory case studies may even begin with a study framework, but develop research questions and hypothesis *after* data are collected (Tellis 1997a). Exploratory case studies are particularly useful when used as pilot projects to assess what types of questions to pursue in further study, but are considerably more limited in interpretation of their results. For example, Biggs et al. (2010, n.p.) used an exploratory case study approach based on criteria provided in Stake (1995) as justification to "not predefine potential factors facilitating transformation, but rather allowed them to emerge from the case studies." Consequently, Biggs et al. (2010, n.p.) cautioned their results are inconclusive and that "detailed, rigorous, explanatory case study approaches are needed to firmly establish causal connections between conditions and events." The design of this study has some aspects of exploratory case study models, but is essentially an explanatory case study. The nomenclature *explanatory single case embedded case study* accurately describes the study. However, to prevent wordiness, use of this lengthy term is avoided.

3.1.2 Use of Mixed Methods

Decisions on the use of quantitative and qualitative methods in a study were informed by my basic assumptions regarding the nature of truth (ontology), how knowledge is created (epistemology), and specific, valid ways to gain knowledge (methodology). Guba and Lincoln (1994) describe such basic assumptions as forming a research paradigm. A spectrum of perspectives on the nature of truth exists, with the quantitative research paradigm occupying one end and the qualitative paradigm occupying the other. The quantitative research paradigm is underpinned by the ontological notion that a single, knowable truth exists and epistemologically by the positivist belief that a single reality exists and is waiting to be *discovered* (Hesse-Biber and Leavy 2010). These beliefs lead to the use of specific techniques, including experiments and the scientific method to pursue knowledge. In contrast, the qualitative research paradigm holds the ontological view that reality is situational and socially constructed. Epistemologically, adherents to this perspective can be classified as constructivists and view truth as something that humans construct based on their perceptions and experiences.

Mixed methods research forms a third paradigm and was the one chosen for this study (Johnson, Onwuegbuzie, and Turner 2007). This research paradigm is a synthesis of the quantitative and qualitative approaches and is underpinned epistemologically by pragmatism. This approach embraces the construction of knowledge by focusing on the research question as a starting point, and how to answer it most effectively, rather than focusing on the nature of the methods used (Cherryholmes 1992; Johnson, Onwuegbuzie, and Turner 2007; Creswell 2009; Bullock 2010). Within this research paradigm, researchers select the methods most likely to address their particular research questions.

Adherents of the three research paradigms claim inclusion in a wide variety of 'isms' beyond positivism, constructivism, and pragmatism. Many dozens, perhaps hundreds, of epistemologies and ontologies exist and influence the research paradigm chosen by a given researcher. To complicate matters, much disagreement exists in defining specific 'isms' and how each is distinct. For example, within pragmatism there are camps that self-identify with critical pragmatism, pragmatic pluralism, prophetic pragmatism, and democratic-socialist-feminist pragmatism (Cherryholmes 1992). Johnson, Onwuegbuzie, and Turner (2007) lump these classes together as pragmatism of the left, right, and center. Still others might split the constructivist epistemologies further. However, true to the pragmatist underpinning of this study, I did not dedicate great effort to define a “correct” or even a “best” philosophical approach. Rather, I identified a rationale for the study design, selected individual research methods, and acknowledged the limitations and strengths of these decisions.

3.1.3 Rigor

To ensure rigor in case-study research, Yin (2009, p. 40) advocates the application of four tests to verify the quality of empirical social research. These tests include construct validity, internal validity, external validity, and reliability. Other authors have articulated criteria for rigor differently. I acknowledge these differences and note general similarities among criteria used to judge rigor by well-cited authors in qualitative, quantitative, and mixed methods research (Table 3.2). For example, Yin's tests compare to differently-named criteria provided in Denzin and Lincoln (2008) for judging rigor of qualitative studies. Likewise, Yin (2009) and Dellinger and Leech (2007) share comparable conceptualizations of construct validity in judging rigor.

Yin (2009) also provides robust guidance on how to design, conduct, and interpret case study research with regard to these four tests and to ensure rigor of case study research. These tests, the advice provided in Yin (2009), and specific details about how this study was conducted to accommodate this advice are presented in Table 3.3.

Table 3.2. Comparison of criteria for rigor in quantitative, qualitative, and mixed research studies with tests proposed by Yin (2009) to verify rigor in case studies, regardless of methodology used.

Yin (2009) Tests for Rigor in Case Studies	Criteria for Rigor			
	Qualitative Studies		Mixed Methods Studies	Quantitative Studies
	Denzin and Lincoln (2008) Lincoln and Guba (1985)	Morse et al. (2002)	Dellinger and Leech (2007)	Lincoln and Guba (1981, 1985)
Construct Validity	Credibility	Validity	Construct Validity	Objectivity
Internal Validity	Dependability		Interpretive Rigor	Internal Validity
External Validity	Transferability	Reliability	Legitimization	External Validity
Reliability	Confirmability		Design Quality	Reliability

Table 3.3. Summary of the four tests for judging the quality of research design, advice provided in Yin (2009), and how this study utilizes Yin's advice.

Test	Explanation	Academic Advice (Yin 2009)	Phase of Study	How this Study Utilizes Academic Advice
Construct Validity	The degree to which the study accurately measures what it is trying to measure	Use multiple sources of evidence (triangulation)	Data Collection	The study uses many types of evidence
		Establish chain of evidence	Data Collection	This was developed in conjunction with the case-study protocol and database (see below).
		Have key informants review draft case study report	Composition	This is documented in the results chapter.
Internal Validity	The degree to which the conclusions are logically sound and sufficiently supported with evidence	Use pattern matching	Data Analysis	These are analytic tools for interpreting case studies presented in Yin (2009). The intention is to use one or more, but not necessarily all four, of these tools to analyze a case study to improve internal validity. . The results were analyzed using explanation building, pattern matching, and addressing rival explanations
		Use a logic model	Data Analysis	
		Use explanation building	Data Analysis	
		Address rival explanations	Data Analysis	
External Validity	The degree to which results can be generalized from the unique to the other	Use theory in single-case studies	Research Design	The study is grounded conceptually with regard to design, methods, and interpretation of results
Reliability	The repeatability of the findings and conclusions	Use case study protocol	Data Collection	These tools were used to guide day-to-day operations and were used to document the procedures and results of the study
		Develop case study database	Data Collection	

3.2 Research Methods

Beyond the methodological issues with mixed methods research and the need to perform the methods well, decisions were made regarding what data to collect, from which sources, and how. This section discusses these decisions.

3.2.1 Information Sought in Data Collection

The study focused on evaluating Grenadian water management in order to identify possible maladaptive system traps (MS traps) and evidence of transformability. The literature offers limited insight into what information should be sought when applying these concepts to real-world situations. Two studies, discussed elsewhere in this thesis as effectively applying the resilience thinking concept, did not influence my data collection. Allison (2003) successfully applied resilience thinking concepts to assess a social-ecological system for a maladaptive state and Found and Berbés-Blázquez (2012) effectively assessed the resilience of the sugarcane plantation landscape in the Caribbean. However, neither study provides direction on what methods are effective to assess social-ecological systems or describe data collected.

Other studies did provide some insight and informed aspects of my data collection. Bunce et al. (2009) provided considerable commentary on data collection rationale and methods, which helped inform my approach to data collection. Biggs et al. (2010) provide seven attributes of systems they deemed to have transformed in the past. The Resilience Alliance has published two workbooks dedicated to assessing resilience in social-ecological systems (Resilience Alliance 2007, 2010). One remarkable similarity in all of these publications is that the specific criteria used to assess a given social-ecological system are judged to be situation dependent and largely left to the judgment of individual researchers. While maladaptive system traps have a specific academic definition, assessing real-world systems for such traps is considered to be situation specific.

Based on these studies and my experiences of living in Grenada since 2006, I developed a series of questions to judge MS traps and transformability in Grenadian water management. The first set of questions addressed how MS traps were judged.

- Had the water management system, or individual adaptive cycles within the water management system, remained in one state for a long period, relative to one another?
- Did formal attempts to improve the system, such as implementing IWRM or conducting capacity-building exercises, tend to lose momentum and fail? Why?

- Was ‘progress’ (e.g., positive system change) being stifled via panarchy influences such as political factors, funding shortfalls, or key personnel or organizations?
- Did stakeholders believe change was necessary or possible?
- What ideas did study participants have regarding rigidity of water management?

The second set of questions addressed how transformability was judged.

- Had transformations taken place in the past? Past transformations were judged on five key questions, adapted for the study from similar criteria utilized in Biggs et al. (2010).
    - Have new named and identifiable entities emerged that were intended to facilitate a positive, meaningful change in how water was managed, especially entities that replaced a previous dominant or rigid authority that had a narrow scope?
    - Had attempts at this failed or succeeded?
    - To what degree had this entity displayed flexibility, adaptiveness, and an ability to foster incremental and transformative change in how water is managed?
    - To what degree had this entity improved water supply conditions?
    - Had the entity become a stable part of water management in Grenada?
- Did fresh ideas and perspectives exist within the system? Where? And did these ideas and perspectives flow from stakeholders with little power to those with the most power? Or vertically within the water authority?
- What planning of the Grenadian water system was being done and has it been effective?
- Did stakeholders identify a need to change the system?
- Had there been a reduction, or increase, in the number of intermediate-scale adaptive cycles? Explanation: Corporations are noted for fostering internal adaptive cycles to retain some adaptability and transformability (Gunderson and Holling 2002). Examples of this would be maintaining a research and development division within a corporation or conducting periodic internal reviews of mission statements. Did intermediate adaptive cycles in the Grenadian water management system play a role in adaptability and transformability?
- What ideas did study participants have regarding transformability?

With regard to from whom data were collected, I drew upon the resilience-thinking framework that underpins the study, particularly on the concept of panarchy. In the panarchy context, all actors who potentially influence Grenadian water management are important. This includes a wide range of participants, including:

- residents
- academics
- consultants, both foreign and Caribbean
- water managers
- funding agencies
- other relevant perspectives discovered during the study

Once the relevant perspectives were identified, decisions were made regarding who the key actors were within each perspective to target for data collection. For example, within the water manager perspective, key actors included persons working at multiple levels within the water authority, as well as in the Ministry of Agriculture. As described below, the snowball sampling technique was used with interviewees to capture a wider range of key actors within each perspective.

With regard to *how* data were collected, four methods were chosen. These included observation, questionnaires, secondary document review, and semi-structured interviews. Each of the four methods informed the use of the others and is described below.

3.2.2 Observation

Observation is a useful and established qualitative research method which involves observing and recording phenomena at a research site as they occur (Yin 2009; Creswell 2013). Yin (2009) notes the opportunity to collect data through observation is inherent to most case studies. Since the data are unique, useful, and available for observation, they may as well be collected. However, qualitative research texts warn that observation is not without peril and should be approached thoughtfully (Patton 2002; Yin 2009; Creswell 2013).

Nuances exist within the observation method of data collection. In particular, researchers should consider and define their role relative to the case. Patton (2002) describes a continuum of participation from complete immersion, or “going native” (p. 267), on one end to complete removal and observation as a spectator on the other, reminiscent of what Yin terms participant observation and direct observation, respectively. Similarly, John Creswell (2013, p. 166) describes one end of the continuum as "participant as observer" where, "the researcher is participating in the activity at the site. The participant role is more salient than the researcher role." On the other end of the continuum, Creswell (p. 167) defines a "complete observer" as "the researcher is neither seen nor noticed by the people under study."

Yin (2009) describes advantages and drawbacks to participant and nonparticipant observation in case study research. The advantages to both include adding contextual detail to a case study and the ability to cover events in real time. However, recording and keeping records of observations requires

discipline and can be time consuming. Also, observation data can be *selective*, in that it is difficult or impossible to illuminate *all* perspectives within a case fairly, possibly distorting the dataset. Another danger is that the participation of the researcher may alter the events being studied.

The participant end of the observation continuum comes with additional benefits and perils relative to nonparticipant observation. Yin (2009) acknowledges being a participant can help researchers gain access to events and persons otherwise inaccessible to a study. Another advantage is that participant observation can be used to gain rich understanding of the context of a case, including in-depth insight into the motives and actions of study subjects. Yin (2009) described this as providing the opportunity to perceive reality from the viewpoint of someone 'inside' the case study rather than someone on the 'outside.' Patton (2002, p. 268) described this benefit as, “the participant observer not only sees what is happening but feels what it is like to be part of the setting.” Finally, Yin (2009) strongly advises researchers who participate in the case being studied not to become a supporter of the group or organization being studied, or in other words, to be ‘captured.’

The level of my participation in this case was in the middle ground between the 'participant' and 'non-participant' extremes, and closer to the non-participant end. First, some aspects of my experience with the case tend toward 'participant.' I have lived in Grenada since 2006 and held a faculty position at a local university most of that time, teaching courses in environmental health. Living in the case setting familiarized me with water supply problems and cultural aspects of the setting. Additional aspects of my experience in Grenada tended toward 'participant' in the case. For example, I had substantial exchanges with key actors in the case both before and during the study, including residents throughout the country (many of whom I had surveyed for other projects), elected officials, persons in the water authority and in the Ministry of Agriculture, the primary regional funding agency for environmental health projects, and academics and consultants in the water sector. I also reviewed draft reports regarding the implementation of IWRM in Grenada and had attended and presented research relevant to water management in Grenada at regional conferences. Perhaps most notably, at separate times I lived next door to, and became friends with, two foreign consultants tasked with reviewing the operations of the water authority.

Although aspects of my experience with the case tend toward 'participant,' other aspects suggest my involvement was 'nonparticipant' in nature. First, I believe I have never had any influence over the case and therefore doubt that my participation has affected or could affect the events studied. This point is a source of personal frustration and in fact inspired my decision to pursue a project evaluating mechanisms preventing change in Grenadian water management and how they might be overcome. Second, I maintained constant attention to how subjects perceived me and how that might bias their

responses to my questions. I made a conscious effort to be perceived by participants as 'intelligent, invested, but not dangerous or influential.' My goal was to improve my access to key elements of the case only accessible to 'insiders,' without altering the events I was studying.

My familiarity with the case enabled unique insight into the perspectives and motivations of key actors. Simply stated, I better understood the perspective of residents because I was one. I better understood the perspective of outside consultants because I was friends with two of them and I reviewed draft reports for others. I better understood the perspectives of people working in the water authority because I personally knew several of them and had discussed aspects of their work with them.

My familiarity with the case also enriched other methods of data collection. First, my status as a long-time resident often proved useful when conducting other methods. For example, when giving questionnaires to local residents, conveying that I had lived and worked here since 2006 and was not a 'here today, gone tomorrow foreigner' noticeably increased the enthusiasm of respondents. My familiarity with the case also informed how I approached other methods and interpreted data. For example, when conducting and supervising questionnaires for a related past study on rainwater harvesting (Neff, Rodrigo, and Akpinar-Elci 2012), I noticed that the respondents were very sensitive to what they believed the researcher wanted to hear or were possibly eager to frame their responses to solicit some form of assistance. It was observed in this past study that simply mentioning the words “rainwater harvesting” biased responses to advocate for use of the technique and at times for assistance in doing so (Neff, Rodrigo, and Akpinar-Elci 2012). In the present study, care was taken to focus the questionnaire on the resident experience with regard to water supply and solicit views in indirect ways including use of several open-ended questions to avoid biasing the data.

In addition to the considering and defining the level of participation in the case, qualitative research literature recommends researchers consider and define procedures for recording and interpreting observations. Creswell (2013) provides detailed procedures for observation, in contrast to Yin (2009), who recognizes a range of formality is possible within observation. For this study, I kept a notebook of my observations and an MS Word document on the project laptop titled,' who is who and how they relate.' I updated the notebook the same day that new observations were made. Consistent with advice provided by Maykut, Morehouse, and Morehouse (1994), I reviewed the notebook document periodically and considered alternate ways of interpreting the observations. As necessary, updates were made to the 'who is who and how they relate' document.

3.2.3 Questionnaires

A questionnaire is one form of a survey that contains "questions and other types of items designed to solicit information appropriate to analysis" (Babbie 2008, p. 272). In some disciplines, questionnaires administered by an interviewer are termed structured interviews and the term questionnaire is reserved for self-completed survey instruments that do not involve an interviewer. Some go so far as to describe face-to-face questionnaires consisting of open-ended questions to be semi-structured interviews (Brace 2008). Yin's widely cited book entitled, *Case Study Research: Design and Methods*, is notable for treating surveys as a type of interview (2009, p.108). In this study, the term 'interview' is intended to denote a "guided conversation," to borrow Yin's term. The term 'questionnaire' is intended to denote a more highly structured query using both close- and open-ended questions, but with follow-up questions limited to clarifying participant responses rather than to probe for more information. Interviews are discussed below in a separate section.

The questionnaire method has some notable advantages and drawbacks. It provides an efficient and effective way to capture the views of a large number of people (Milne 1999). In addition, questions used in questionnaires may be either closed-ended or open-ended, to generate quantitative and qualitative data. This provides for triangulation in the analysis of questionnaire data, which supports strong internal validity. However, questionnaires are notoriously sensitive to the wording, order, and other details of the questions posed (Babbie 2008; Brace 2008). Conducting face-to-face questionnaires can be time consuming and use of open-ended questions can produce large and difficult to interpret datasets. Additionally, it can be difficult to judge how much thought respondents give to questions, how truthful they are, or if they are interpreting the questions correctly (Milne 1999).

Questionnaires were used to capture the views of residents. Questionnaires were administered face-to-face because it was the most practical way to capture the views of residents as accurately as possible. I rejected conducting questionnaires by mail-in forms or telephone interviews based on practical considerations and to avoid difficulties in written or verbal communication. Questionnaires were also targeted at communities based on specified criteria, as described below, and conducting the questionnaires face-to-face by myself enabled me to verify in real time that recruitment was directed at communities with the desired characteristics. Finally, I felt that a face-to-face interaction with respondents would better enable me to leverage my residence in Grenada since 2006 to gain credibility with respondents, create an opportunity to make first-hand observations, and better sensitize myself to the resident perspective.

Questions used in the questionnaire were developed to help define the water management system and were both open- and close-ended (see Appendix B). Questions were designed to identify key variables, thresholds, drivers, power relations among actors, and panarchy within the system. Most questions were close-ended, with the advantage of generating data that were relatively quick and easy to administer and analyze, but were prone to bias, a problem observed in previous questionnaires used in Grenada (Neff, Rodrigo, and Akpinar-Elci 2012). Open-ended questions had the advantage of being less likely to bias participant responses, but were time consuming to analyze. All questions were piloted, modified, and compiled into a final questionnaire.

One crucial aspect of the questionnaire is that it was administered to evaluate the range of resident opinion about Grenadian water management, not necessarily to capture the views of a ‘typical' Grenadian. First, as a practical matter, recruiting randomly among all residents in Grenada is difficult. Second, I judged that targeting diverse factions of residents could effectively capture the range of resident views and answer my questions regarding key variables, thresholds, drivers, power relations among actors, and panarchy within the system, as described in the preceding paragraph. Third, targeting specific groups of residents in extreme circumstances defined the range of resident experience and attitude most efficiently.

Recruitment targeted communities of contrasting experiences regarding their potable water supply. In addition, based on personal experience I judged that the attitudes, empowerment, and behavior of residents vary between rural and urban settings and further recruited to capture communities with contrasting degrees of urbanization. Combining the factors of contrasting water supply and contrasting urbanization yielded four classifications of communities from which to recruit.

- Urban communities with a stable, high quality water supply
- Rural communities with a stable, high quality water supply
- Urban communities with water rationing and/or frequent water quality problems
- Rural communities with water rationing and/or frequent water quality problems

Two aspects of the study population complicated the selection of sampling methods for the questionnaire. First, the quality of water supply and the degree of urbanization in a given community tend to occur as a gradient, not in an 'either/or' arrangement (Figure 3.2). However, ideal examples of communities in each classification were known to me or were tentatively identified by screening communities for geographic characteristics typical of each classification. Proximity of communities to water infrastructure was determined using the Grenada Water Information System (http://www.cariwin.gd). Communities lying in topographically difficult to service areas such as on

ridgelines and at high elevation were determined using Google Earth. Communities relying on water treatment plants drawing from catchments with a dry season precipitation to evapotranspiration deficit were identified in CEHI (2006). Based on this information, I then conducted reconnaissance field trips to over 40 communities to discuss the water supply situation with residents and observe the urban/rural character of each community. Field reconnaissance allowed me to identify communities with the 'best' and 'worst' water service, and with ideally 'urban' and 'rural' character.

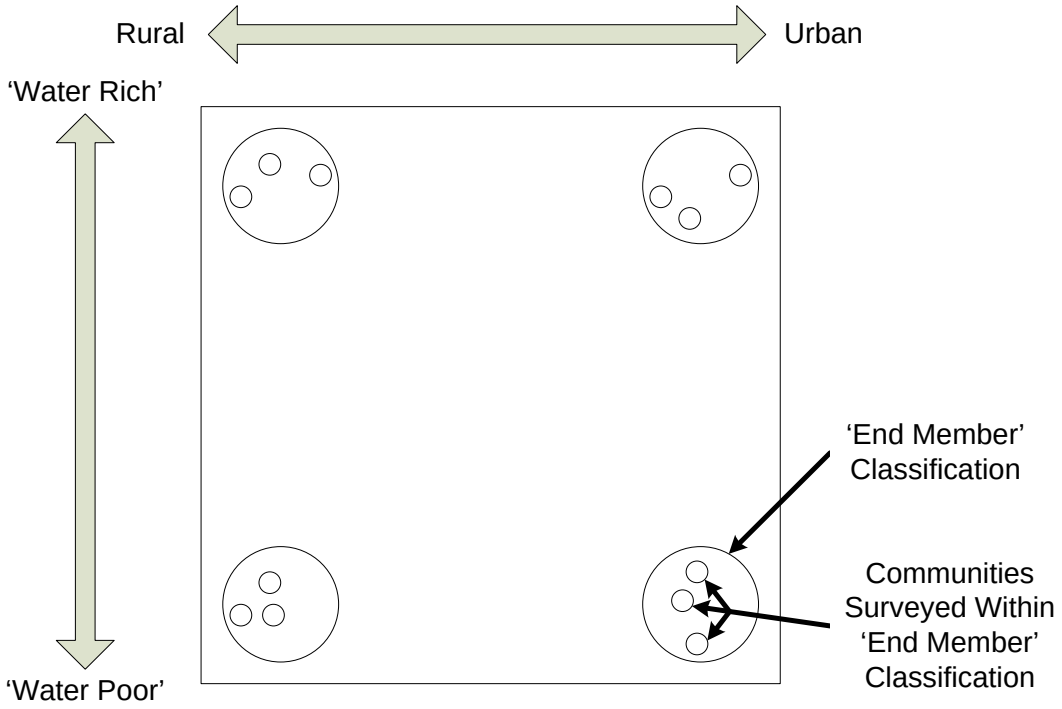


Figure 3.2. Diagram depicting the population of the study area existing along gradients of the degree of urbanization and the quality of water supply. The majority of residents likely live somewhere between extremes. However, communities existing at the extremes are considered 'end members' and define the four community classifications surveyed in this study. Within each classification, three communities were selected for recruitment.

The second aspect of the study population that complicated the selection of sampling methods was variability of the attitudes and behaviors of communities within each classification. To capture this variability within individual classifications, I sampled three communities from each classification. Thus, three communities were sampled for each of the four classifications for a total of 12 communities sampled (4x3). Figure 3.3 describes the geographical distribution of the communities surveyed.

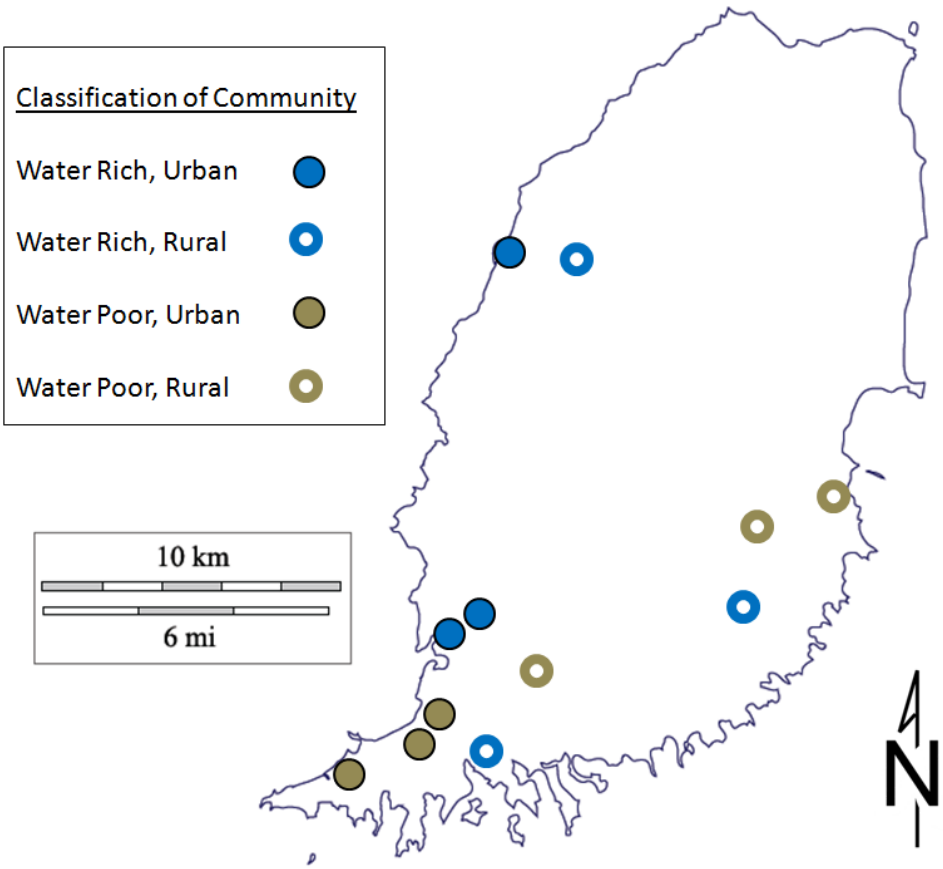


Figure 3.3. Approximate locations of the 12 communities surveyed. Base map of Grenada provided by d-maps.com, http://d-maps.com/carte.php?num_car=1707&lang=en.

Key considerations for recruitment were to ensure representativeness of the sample. Houses within communities that were sampled were selected randomly by beginning the survey in a random location within the community and soliciting a head of household, male or female, at every third house encountered. I returned up to two additional days to solicit homes that were not recruited on the first attempt. A summary of communities visited in each classification and the total number of homes recruited and surveyed is provided in Table 3.4. To ensure representativeness of the sample, the size of population sampled from each community was homogenized. First, the size of a typical rural 'town' community in Grenada was estimated to be approximately 80-120 homes and then urban 'city' communities were divided into smaller ‘neighborhood’ units of 80-120 homes for sampling. This ensured that every third home was recruited throughout all communities sampled.[20]

[20] Statistically, sampling 100 individuals in a population of 1,000 is different from sampling 100 individuals in a population of 100,000. In the first case, 1 in 10 individuals is sampled, in the later case 1 in 1,000 individuals is sampled. These two samples are not as comparable as samples taken from similar-sized populations.

Table 3.4. Summary of communities taking part in the questionnaire and recruitment rates.

Classification	Community Surveyed	Homes Recruited	Questionnaires Completed	Recruitment Rate
Urban communities with a stable, high quality water supply	St. George's (Carenage area)	41	15	37%
	Tempe (lower portions)	37	15	41%
	Gouyave (North-Central)	26	15	58%
Rural communities with a stable, high quality water supply	Felix Park	25	15	60%
	Florida	27	15	56%
	Lower Woburn	34	15	44%
Urban communities with water rationing and/or frequent water quality problems	Calliste	33	15	45%
	Kafé Beau Hill	30	15	50%
	Mont Tout	32	15	47%
Rural communities with water rationing and/or frequent water quality problems	Munich	40	15	38%
	La Potre / Mt. Fann	25	15	60%
	Mt. Airy / Bay Gardens	31	15	48%

Questionnaires were administered in November 2011 and May 2012 and all questionnaire interviews were conducted by myself to preserve consistency. It is possible that splitting surveying between a wet season month (November) and a dry season month (May) could affect resident perceptions and therefore responses to some questions. However, I believe the effect of splitting the time of year of administering the questionnaires is mitigated because I similarly divided sampling within each category between November 2011 and in May 2012. Moreover, splitting surveying between wet and dry season may have enhanced data collection with regard to capturing a more broad range of resident concerns than would have been possible sampling only at one time of year.

Formal procedures were followed with regard to record keeping and data processing. The area of each community surveyed was delineated using Google Earth and saved as .KML files (Figure 3.3). I took notes in the field, then summarized them electronically and attached them to the .KML files. Finally, I coded questionnaire data and transferred them to a Microsoft Excel spreadsheet for analysis. I recorded details of quality assurance procedures and data processing in an MS Word file

for future reference and to facilitate writing this thesis. Details of data analysis are captured in comments embedded in MS Excel files kept securely on the project laptop.

Challenges were encountered while conducting the questionnaire survey. Many homes had guard dogs and fences that prevented me from approaching; this was particularly true of wealthier residences (Figure 3.4). Wealthier residents were also observed to be less likely to be home, especially during weekdays. The effect on sampling was to capture a disproportionate number of women, unemployed, and elderly residents, while missing a disproportionate number of men, wealthy, and dog owners. Finally, response rates to some questions were low. I attribute this to: residents declining to answer some questions; my forgetting to ask a question or record the response; and my failure to decipher the shorthand notations recorded for a given response and then not counting the response.

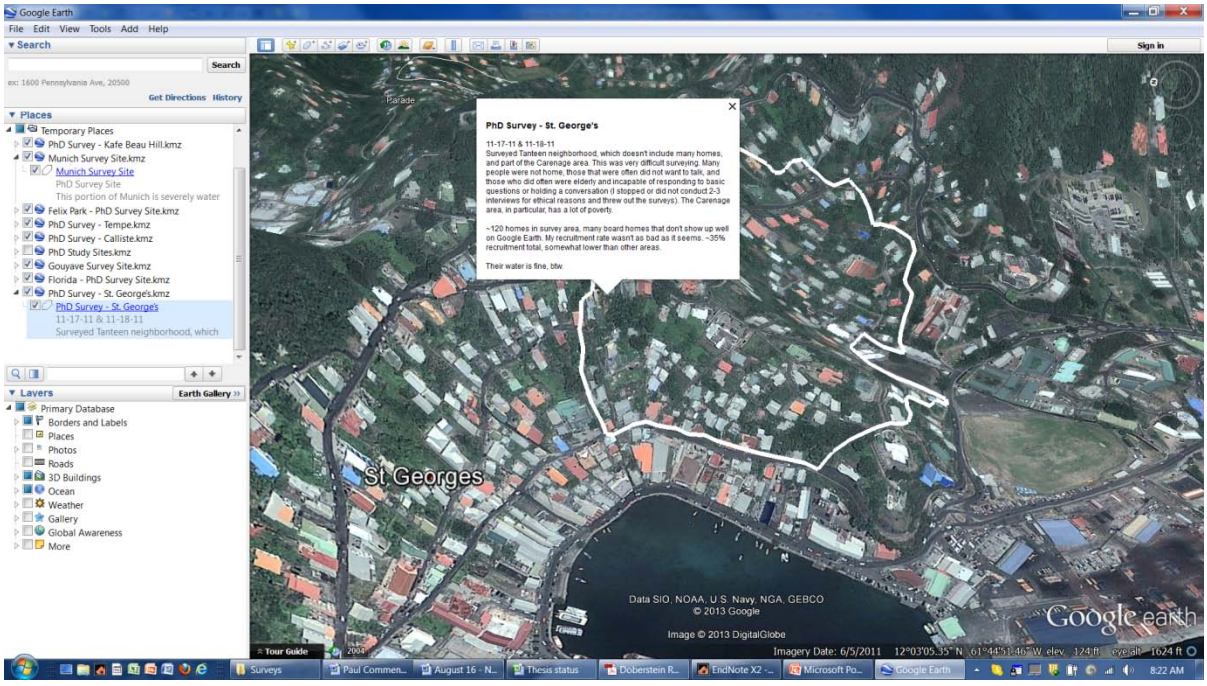


Figure 3.4. A screen capture showing a .KML file in Google Earth displaying the delineation of the St. George's survey area and field notes summary.

I administered questionnaires at the beginning of the data collection phase of the research to have them enrich the use and interpretation of other methods. For example, having a solid understanding for how residents experience and feel about water supply improved my confidence and especially my credibility when conducting interviews.

Figure 3.5. Grenadian residence with gate and guard dog. This arrangement was common among wealthier homes in the study area.

For the most part, descriptive statistics were utilized to describe respondent survey results. To test associations between some of the questionnaire variables, Spearman rank correlation coefficients were calculated. Spearman correlations were used because questionnaire data were categorical, yielding rank ordered data for many questions. A sample size of 180 respondents (45 per community classification) was considered more than sufficient to maintain adequate statistical power (0.8) for correlation analysis. A very widely cited publication by Cohen (1992) presents the sample sizes required to test the significance of correlation coefficients at a range of scenarios relating to population effect size, statistical power, and alpha levels. For a medium population effect size (r=0.3) and an alpha value of p=0.05, a sample size of 85 is needed to ensure adequate power. When the alpha value decreases to p=0.01, a sample size of 125 is sufficient. Because some of the associations analyzed involved only a subset of the entire sample (e.g., tank owners), a much larger total sample size than necessitated by Cohen was targeted.

3.2.4 Document Analysis

Document analysis facilitates evaluating written records and extracting information to develop empirical knowledge (Bowen 2009). The method may be approached with varying levels of formality. Peräkylä (2005) describes an 'informal approach' to document analysis as not having a

predefined protocol and involves researchers reading and rereading materials until they are able to identify key themes and gain insight to the world the document originates from. In sharp contrast to the informal approach, other authors describe document analysis as a process of skim reading and interpreting material that “combines elements of content analysis and thematic analysis” (Bowen 2009, p. 32) and utilizes coding and category construction, often with elaborate protocols (Basit 2003; Peräkylä 2005; Fereday and Muir-Cochrane 2008; Bowen 2009).

Peräkylä (2005) acknowledges the validity of approaches with contrasting levels of formality and describes the appropriate use of these approaches to document analysis as provided in the widely cited *Sage Handbook of Qualitative Research:*

> An informal approach may, in many cases, be the best choice as a method in research focusing on written texts. Especially in research designs where the qualitative text analysis is not at the core of the research but instead is in a subsidiary or complementary role, no more sophisticated text analytical methods may be needed. (p. 870)

The author continues, “In projects that use solely texts as empirical materials, however, the use of different kinds of analytical procedures may be considered.”

The literature reflects a wide range of views on the level of formality in document analysis. Some authors embrace the more formal forms of the method, often firmly rooted in grounded theory (Basit 2003; Fereday and Muir-Cochrane 2008; Bowen 2009), while others such as Yin view the use of documentation in case-study research largely as a tool to support inquiry using other methods. Yin (2009, p. 102) states: "For case studies, the most important use of documents is to corroborate and augment evidence from other sources" and although a section of text is dedicated to "documentation" (p. 101-106), the words “document analysis” occur only once in the book.

Bowen (2009) and Yin (2009) discuss distinct advantages and disadvantages of document analysis and the use of documentation. Bowen (2009) states that document analysis is often the most effective technique for gathering information on past events. Thanks to increasing use of the Internet, vast amounts of documentation are normally readily available and conveniently attained. Use of documentation can be done without directly interacting with the case being studied. In addition, both authors tout the stability of documentation, in that documentation is not altered by the presence of the investigator, and exactness, particularly in documenting names and events, as advantages of documentation. Yin (2009) and Bowen (2009) also discuss the drawbacks of documentation, including bias in the documentation itself or in the availability or selection of it. However, assessing the bias in documentation can itself be a useful output of documentation research (e.g., if documents consistently fail to indicate long-term planning or vision). Finally, a drawback to use of

documentation is the time and energy required to sort and review the vast documentation usually available through web searches.

The rationale for utilizing document analysis was to tap a large and readily available source of information to complement other methods used. Documents informed the use of other methods and provided a critical source of triangulation in the study. Documentation was also readily available. Electronic documents were available either online or by request from organizations such as NAWASA or CEHI. Paper documentation was also available through newspapers and an archives room maintained by NAWASA.

The use of document analysis was guided by the pragmatist epistemological underpinning of the study, which directly conflicts with the epistemological basis of more elaborate approaches based on grounded theory approaches that claim to 'let the data speak for itself.' Document analysis involves distinct costs in terms of resources that are directly proportional to the level of formality involved in the analysis. Grounded theory approaches tend to dedicate vast resources to elaborate methods to inform a researcher and often provide rich, unique insight to a study (Basit 2003; Bowen 2009). In contrast, the pragmatist perspective dictates that methods be selected based on their value to resolving the research questions (Peräkylä 2005).

Unfortunately, some of the up-side potential of the more aggressive approaches to document analysis is mitigated by selection bias in the documentation available as well as from bias within the documentation itself. The large majority of documents available for the case in this study are produced by NAWASA or by consultants working with the water authority. Even newspaper articles on water management issues are often reprints of water authority press releases. This reality creates a bias toward the water authority viewpoint of the case, while often marginalizing other perspectives not documented as thoroughly. Beyond selection bias, the outward image projected by the water authority and consultants was also biased, as discussed in a later chapter. Simply stated, I did not want to read too much into the rhetoric of the water authority and associated consultants. A sensible alternative was to focus more on the existence of the bias in documentation rather than to dissect the rhetoric in it. In fact, evaluating what was *not discussed* in documents (e.g., multi-decade planning) provided great insight to the case. An elaborate approach to document analysis was ruled out because the 'value added' over a more basic approach was not likely to offset the costs.

A more practical approach to the aggressive, formal document analysis technique was successfully used in the study. Electronic documents were gathered via the internet or through requests to key actors in the case. Paper documents were gathered by browsing the water authority

records room and keeping a scrapbook of newspaper articles from the five Grenada-specific newspapers widely available on the island. Finally, relevant videos were identified and reviewed.

I pursued coding of documents at progressively greater levels of detail until I perceived the value of doing so diminish. The first cut of coding was to read each document and judge if it was relevant to the study. As per the informal approach to the document review described above, I approached the initial reading of documents with a liberal and flexible sense of what was important for inclusion. Simply stated, I scanned each document searching for any reason to include it in the document review. For example, documents that discussed any aspect of water management or sustainability in Grenada were retained. Electronic documents deemed relevant were read, then saved in PDF form when practical and attached to an EndNote file. Keywords were assigned to the document in EndNote based on the topical content of the document or aspects of the document of particular relevance to this study. Text within the document was highlighted as relevant, and written and verbal annotations were embedded on the PDF document. I took notes on websites and organized them topically as they related to specific research questions. Paper documents deemed relevant were saved and organized either in a scrapbook, as with newspapers, or topically as they related to research questions. Many paper records, such as those in the water authority records room, were available only for a brief viewing. In these cases, I took notes regarding the document and later organized them topically alongside other paper documents. In most cases, the first cut of document categorization and note taking was sufficient to answer individual research questions.

Knowledge gained from document analysis was used to develop a basic sense of the case, identify the potential existence of deeper issues, and to enrich the insights from other data collection methods. Various documents contained much information on the fundamental issues regarding water supply in Grenada. However, many documents were noteworthy for the information they *did not* contain, pointing to deeper issues. For example, the "National Rainwater Harvesting Programme for Grenada" was authored by a regional UNEP body and barely mentioned the local water authority (CEHI 2006a). At the same time, the 5-year strategic plan of the water authority contains brief and vague mention of rainwater harvesting and no mention of CEHI. Additionally, none of the documentation evaluated for the study revealed direct criticism between these two organizations. This apparent lack of coordination, or perhaps non-antagonistic territorialism, provided initial evidence for how these two actors view one another and influenced how I approached interviews with both.

It is impractical to estimate the total number of documents reviewed. Over 200 documents survived the first cut of document selection and were potentially relevant to the study. Finally, 42 Grenada- or Caribbean-specific documents were particularly relevant to specific points made in this

thesis and cited. In addition, I collected and used 27 newspaper articles to describe the resident experience with regard to water.

3.2.5 Semi-Structured Interviews

The semi-structured interview is characterized by the use of relatively few primary questions, but with additional follow-up questions to probe for further information (Gillham 2005). Semi-structured interviews have characteristics consistent with what Yin (2009) terms 'in-depth interviews' and 'focused interviews,' both of which Yin indicates can be used to ask the interviewees to articulate their own thoughts and insight into research matters.

Some controversy surrounds interviews, including semi-structured interviews in qualitative and case study research. Nevertheless, semi-structured interviews offer the opportunity to gain unique insight not matched by other methods and has led some authors to tout semi-structured interviews as vital to qualitative and case study research (Opdenakker 2006; Yin 2009; Turner 2010). However, others have expressed deep concern about a lack of respect for some serious drawbacks and limitations of the method in case study research, in particular, that data collected with semi-structured interviews are prone to inaccuracy, bias, and reflexivity (Diefenbach 2009).

Interview data are prone to inaccuracy because individual interview subjects are thought to have a limited ability to respond to questions accurately. Interview subjects, as all of us, can have honest difficulties remembering past events accurately (Yin 2009). It can also be difficult for subjects to articulate responses in a way that will be correctly interpreted by the interviewer.

Bias in semi-structured interviews can result from multiple sources, many of which are similar to the problems noted above for other methods. First, the data provided by interviews are subject to the selection and availability of interviewees (Diefenbach 2009). This limitation is essentially the same as was noted above with the selection and availability of documentation and can have similar consequences. Creswell (2007) advises that researchers select interview subjects deliberately, using one or more defined sampling procedures such as criteria and snowball techniques (p. 127). Second, as with questionnaire data, bias may result from poorly articulated interview questions (Yin 2009; Turner 2010). Third, the interview setting can alter how interviewees respond to questions (Diefenbach 2009). For example, in this study I observed that the attitude of some prospective interviewees changed from enthusiastic to uninterested when I suggested introducing an audio recorder to the interview setting.

The issue of reflexivity in interviews refers to a respondent who intentionally provides misleading information. Yin (2009, p. 102) describes this phenomenon as the “interviewee gives what

interviewer wants to hear." Diefenbach (2009, p. 881) provides considerably more detail and coins the term "socially accepted answering attitude" to describe a situation in which:

> an interviewee mainly provides such answers he or she assumes they are expected from him or her, the interviewer wants to hear, and which are socially accepted. The interviewee tries to provide the interviewer with 'information' that do [sic] not reveal what he or she really thinks but what appears to be plausible, appropriate and sufficient.

This dilemma is similar to bias in 'official' documents in which an organization or agency wishes to portray a certain image or conformity to certain policies, but is perhaps more difficult to navigate in a dynamic and short-lived interview setting.

The rationale for utilizing semi-structured interviews was to gain insight into how the actors within the case viewed the world around them. Semi-structured interview data were anticipated to be the most direct way to capture the various insights related to the case. This method was also selected as an important component of data triangulation. In particular, it was hoped that interview data would be helpful in identifying the bias of organizations and agencies left unstated in their documents.

A second rationale for using semi-structured interviews is to take advantage of my position as being viewed as familiar and genuine, but not threatening, to many of the actors in the case. Since moving to Grenada in 2006, I have become familiar with many of the actors in the case, from the perspective of being interested in what they do and from a position without authority or even funding. Furthermore, I have consciously fostered a 'curious,' 'non-judgmental,' and 'non-threatening' image since my arrival in 2006. Not necessarily by intention, but of equal value to this study, I have also come to be viewed as 'not a source of funding.' Notable actors I have had repeated interactions with include personnel in the water authority, the Ministry of Agriculture, and five foreign consultants working on two projects. One of these consultant projects was tasked with capacity building to support IWRM and the other with leading an EU-funded project to audit the water authority for operational effectiveness.

Interviews were conducted face-to-face (n=13) to keep the interview conversation spontaneous, minimize the subject's opportunity to craft 'socially desirable' responses, and maximize my ability to observe nonverbal cues. Other interview types are easier, faster, and cheaper, but do not offer the same upside potential (Opdenakker 2006). When necessary, interviews were conducted by Skype or telephone (n=6).

The issue of recording interviews was approached carefully. Recording was desirable as a means to maximize the accuracy of the interview record. However, Yin (2009) reports that recording can alter subject responses. This point is consistent with my own observations during the study, and

makes sense given Diefenbach's discussion of the presence in many cultures of a "socially accepted answering attitude" (Diefenbach 2009, p. 881). For these reasons, an attempt was made to emphasize the confidential nature of the recording and the potential benefit of avoiding the need for me to take notes while respondents spoke, with the default being to not record the interview unless the subject indicated a willingness to allow it. One other drawback to audio recording is the massive amount of resources needed to transcribe interview recordings (Opdenakker 2006). In this study, I did not attempt to transcribe entire recordings. Instead, I listened to interview recordings and took notes based on the recordings. I also transcribed limited passages that I felt were particularly relevant to research questions. For data analysis purposes, notes made from audio recordings were then treated the same as notes taken during interviews that were not audio recorded. All interview notes were recorded digitally and coded to aid analysis. During analysis, interview notes for each code were queried from all interviews and evaluated side-by-side to aid answering research questions.

Interviewees were selected in a multi-tier process. First, a list of perspectives was identified as being particularly important to the case. Examples include the water authority, resident, foreign funding agency, and domestic and foreign consultant perspectives (Table 3.5). Second, individuals were identified who had insight to each perspective. Third, individuals were selected to capture the diversity of opinions within the perspective. Fourth, the snowball interview technique was used to identify and pursue further interview leads until no new information was generated for a given perspective. In total, nine perspectives were identified, 28 individuals were contacted to participate in the study, and interviews were conducted with 19 of these individuals; 17 were interviewed in June – September 2012; two additional participants were interviewed and one second interview was conducted in April 2013. Many of the interviewees possessed insight to more than one perspective.

Table 3.5. Summary of the perspectives sought and captured in interviews. 28 individuals were contacted to participate in interviews and 19 were interviewed. Some interviewees had insight to multiple perspectives, accounting for the inflated number of interviewed persons in the second column.

Perspective	Number of persons identified, number interviewed	Description
Academic or Scientist	3 identified 2 interviewed	Researchers in the region who publish findings on water management issues
Consultant - Foreign	4 identified 2 interviewed	Persons based outside the Caribbean who are paid to provide assistance to some aspect of water management in Grenada
Consultants - Grenada	2 identified 2 interviewed	Persons based in Grenada who are paid to provide assistance to some aspect of water management in Grenada
Government (non-NAWASA)	4 identified 2 interviewed	Government personnel, outside of the water authority, who are involved in some aspect of water management
Political	4 identified 1 interviewed	Persons who have served as elected representatives in Grenada, Ministers fall into this category
Regional Funding	1 identified 1 interviewed	Organizations based in the Caribbean that fund research into some aspects of water management
Regional NGO	5 identified 4 interviewed	Non-government organizations engaged in some aspect of Grenadian water management
Resident-focused NGO	4 identified 4 interviewed	Grass roots' non-government organizations focused on improving the lives of Grenadian residents
NAWASA	8 identified 8 interviewed	Persons who do work, or have worked, for the National Water and Sewerage Authority

3.2.6 Analysis Framework

This study utilized two data analysis strategies described in Yin (2009, p. 130-136). The first strategy was to rely on the conceptual[21] propositions to guide data analysis, SES resilience in this case. The second strategy involves examining rival hypotheses to explain the case study. In essence, the two-

[21] Many of the sources cited in this section refer to 'theories' rather than 'concepts' in their discussions. However, the term concept, defined in Section 2.1, also applies in this context.

prong strategy for data analysis was designed to enrich internal validity and place the utility of resilience thinking into context with other approaches to answer the research questions.

Other approaches to data analysis were considered but not selected. These include time-series analysis (Yin 2009), thick description and thick analysis (Patton 2002; Ponterotto 2006), the grounded approach (Corbin and Strauss 2008), and the constant comparative and theoretical sampling techniques within the grounded approach (Boeije 2002).

3.3 Summary

In this chapter, I describe the single-case study approach of this research, as well as the use of mixed methods and multiple analysis strategies to ensure triangulation on the research questions. The case study design was utilized largely for its ability to answer 'how' and 'why' water management in Grenada has been and is slow to progress. Mixed methods were used as a pragmatic way to answer the research questions efficiently and to provide diverse sources of evidence to allow triangulation on each research question. The four specific methods used were observation, questionnaires, document analysis, and semi-structured interviews. Finally, data analysis was designed to triangulate on the research questions while developing new conceptual insights into SES resilience.

Prior to data collection, the Office of Research Ethics at the University of Waterloo in Waterloo, Ontario and the Institutional Review Board at St. George's University in Grenada reviewed details of the proposed study to protect human participants. Both bodies approved this research: University of Waterloo Ethics Clearance ORE File #17549, St. George's University Ethics Clearance IRB Application #11039.

Chapter 4
The Grenadian Water Management System

This chapter opens the second half of this dissertation, both in terms of length and in content. The first half, Chapters 1 to 3, introduced the research problem and questions as well as the case study, provided context for the study within the academic literature, and described the methods used. Chapters 4 to 6 document and discuss the results of the study, answer the four research questions, and underpin the conclusions presented in Chapter 7.

In this chapter, I define ‘improvement’ in water management, evaluate data collected, and define what the Grenadian water management system is based on a detailed description of the three embedded units in the case study (Figure 3.1). More simply stated, this chapter defines 'what' Grenadian water management is, to provide a basis for discussing traps and transformations in later chapters. In Chapter 5 and 6, I will build upon the discussion presented here to address all four research questions. The three main sections of this chapter provide insight regarding:

- the resident experience with regard to water (in 2012),
- the water management system in Grenada, and
- recent efforts to reform the water sector in Grenada.

4.1 The Resident Experience: A Baseline for Judging ‘Improvement’

Defining the resident experience with regard to water provides a baseline to determine if various proposals to change the water management system are 'good' for residents or are likely to be perceived by residents as 'good'. The full value of these judgments will become more clear in later chapters when discussing factors that affect the prospects for transformation. For now, consider that a system is more likely to transform if members in the system perceive transformation is strongly in their best interest. Conversely, a system is less likely to transform if members in the system perceive transformation will not affect them significantly or be detrimental.

Progress in water management is a deceptively complex term and commonly contains two key elements: (1) what to judge it relative to, and (2) how to judge it. In water management, progress is commonly considered relative to the wellbeing of people in some way. However, considerable variability exists in defining which people are of interest and how to define and gauge their wellbeing. Commonly, authors define progress relative to specific water-related development goals, such as the proportion of people with access to improved sources of water and sanitation (World Health Organization and UNICEF 2010). Other works place emphasis on values such as environmental

sustainability. One of UN-Water's stated purposes (UN-Water 2010, p. 10) is to "monitor the water sector performance, from the point of view of a sustainable development objective." The Organisation for Economic Co-operation and Development (2005) provides a book entitled *Statistics, Knowledge and Policy: Key Indicators to Inform Decision Making*, which contains many discussions and examples of how progress can be judged in a variety of settings in water management and beyond.

I chose to define *progress* in Grenadian water management as relative to resident wellbeing and measure it relative to the aspects of water service which residents expressed as most important in questionnaires (e.g., service interruptions, dirty water). Residents consume 70% or more of the potable water on the island and form a basic component of the Grenadian water system[22]. Supplying residents with reliable and potable water is the primary function of the National Water and Sewerage Authority (NAWASA), the target of considerable foreign aid, and a key source of motivation for this study. For all of these reasons, I devoted considerable resources to understanding the resident perspective with regard to water and chose it as the first of three embedded units of study in this case study.

One nuance in defining progress relative to resident wellbeing is the implicit role of ecosystem health. Simply stated, depleting the ecosystem may affect resident well being negatively. One of many possible examples is clearing forests to farm steep hillsides. This action may directly impact the timing, quality, and quantity of water received at water treatment plant intakes, which may also impact water supply and resident wellbeing. Effects of water resources management extend in the downstream direction as well. Actions such as land-use changes, dewatering streams, or polluting streams may impact activities such as irrigation, bathing, washing clothes, fishing, and use of coral reefs. Therefore, ecosystem health is an underlying consideration in my definition of progress in Grenadian water management.

Much of the following discussion on the resident experience is influenced by my decision to use questionnaires to evaluate the *range of resident opinion* about Grenadian water management, not necessarily to capture the views of an ‘average’ Grenadian. As discussed in detail in Section 3.2.3 and depicted in Figure 3.2, I administered questionnaires to residents judged as living in 'end member' communities relative to quality of piped water supply and urban and rural community character. I

[22] NAWASA projections of water use by sector for 2010 are reported in the Grenada Water Sector Review (Government of Grenada 2007b). Residential use was projected to account for 67% of water use, with “government use” accounting for an additional 14%, including an unspecified amount of water flowing to public standpipes. If standpipe use is considered as residential use, the proportion of water used by residents is likely at least 70% and may be closer to 80%. To my knowledge, no follow-up data regarding water use have been published to confirm the projections.

based the following description of the resident experience with regard to water on data collected from:

- questionnaires given to residents (n=180, 45 per each of the 4 classifications),[23]
- semi-structured interviews with system actors (n=19),
- written documents, particularly newspaper stories collected during the study (n=27), basic demographics of Grenada, and
- observations of resident attitudes and actions, as a resident of Grenada since 2006.

Finally, I wish to clarify my use of the terms stakeholder and actor. Stakeholders are all entities with an interest in Grenadian water management, which extends well beyond water supply. Actors are stakeholders who affect Grenadian water management. Essentially, all 'stakeholders' in this study were also 'actors' with the exception of residents, as described below.

4.1.1 Description of Resident Sample

The majority of respondents was female (61%) and fell between the ages of 25 and 34 (34%). The fewest number of participants were between 18 and 25 (8%). The relative degree of impoverishment of residents was determined using three observable indicators suggestive of poverty in Grenada:[24] (1) main water source not piped into the home, (2) lack of an indoor toilet (e.g., outdoor latrine), and (3) less desirable house construction type (e.g., board or makeshift construction). Fifty-five percent of residents fell in the most affluent category, which had zero poverty indicators. Twenty-two percent of participants listed one poverty indicator; 14% had two. Only 8% of respondents had three poverty indicators, placing them in the poorest category.

Comparing demographic data collected for this study with census data is complicated by the dated (2000) census data and the intention to describe the views of residents experiencing extremes in water service rather than capturing an 'average' Grenadian. In addition, census data consider residential water source, bathroom facilities, and house construction type, but do not consider these data as indicators of poverty and calculate the proportion of residents with multiple indicators as I have done in this study. Nevertheless, data for demographics and for individual poverty indicators compare well with 2000 census data (Government of Grenada 2009).

[23] Section 3.2.3 explains details regarding the sampling rationale and strategy, including response rates (Table 3.4) and the geographic distribution of sampling locations (Figure 3.3).

[24] Based on past personal experience conducting surveys in Grenada (Neff, Rodrigo, and Akpinar-Elci 2012), I deemed this observational method more sensitive to respondents than directly questioning their income. In my experience, residents often view direct questions regarding income poorly and many will not answer them. Furthermore, many residents do not have stable income, so cannot accurately cite their annual or monthly income. Many residents also receive remittances, which may disconnect income from living standard.

Table 4.1 presents a comparison of demographic and poverty-related data collected for this study with data reported for the year 2000 Grenada census (Government of Grenada 2009).[25] Relative to census data, respondents were more likely to be female, older, and more likely to have water piped into their home, an indoor toilet, and live in a home with desirable construction type (e.g. concrete block construction). These discrepancies are plausible, considering (a) questionnaires were administered mainly during the daytime, when a disproportionate number of younger adults and men are likely to be out of the home, (b) only heads of households, who are older than randomly selected persons, were recruited for the questionnaire, and (c) questionnaire respondents, interview respondents, and my observations indicate water supply in Grenada improved and the economy has expanded considerably in the 12 years between the data collection for the census and for this study.

Table 4.1. Comparison of demographic data collected with those reported for the 2000 Grenada census (Government of Grenada 2009).

Category	All Questionnaire Responses	2000 Census
Gender - Male	38.9%	49.8%
Gender - Female	61.1%	50.2%
Age 25-34	33.5%	12.9%
Age 35-44	17.6%	13.3%
Age 45-54	15.3%	8.4%
Age 55-64	11.4%	5.8%
Age 65 and Over	14.2%	9.0%
Water Not Piped Into Home	11.7%	37.7%
Lack of an Indoor Toilet	21.8%	47.1%
Less Desirable House Construction Type	45.9%	59.0%

[25] These are the most recent and reliable demographic data available, particularly relating to the poverty indicators. A census was conducted by the Government of Grenada during the study, but results have not been published (2013).

4.1.2 Supply Disruption

Disruption of residential water supply ranged from occasional to chronic (Figure 4.1). Statistical measures of association for nominal variables indicated a strong relationship between categorization and days of service interruption (Cramer's V=0.471, p=0.00, n=174). This indicates the categorization of 'water rich' and 'water poor' communities was accurate.

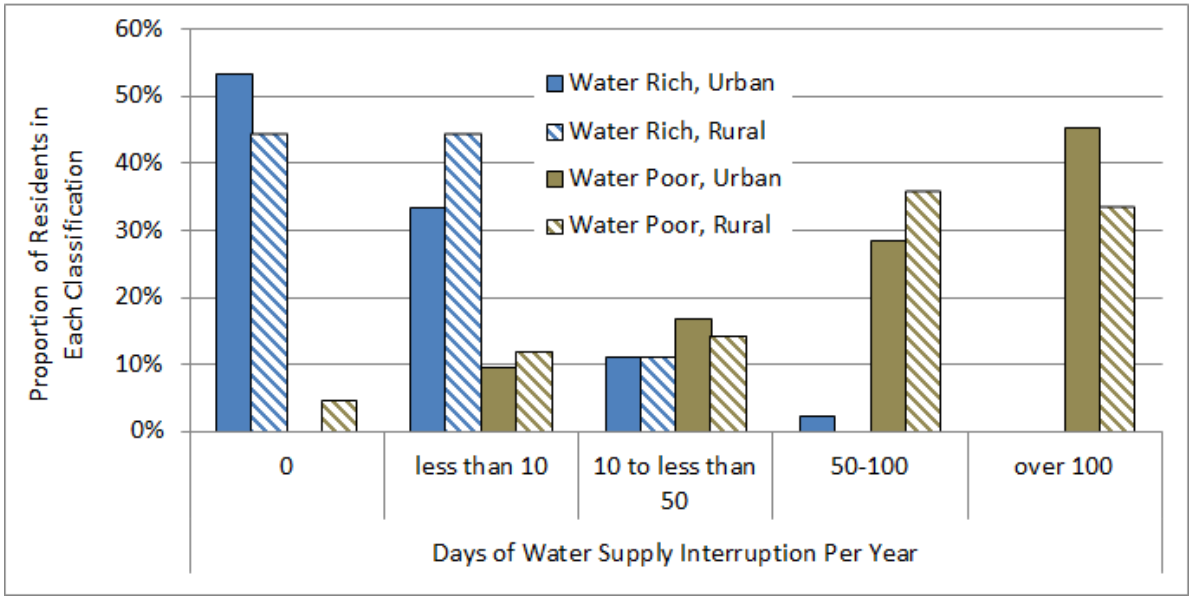


Figure 4.1. Relation between classification of residents surveyed and frequency of water supply interruption reported per year.

Regarding the relation between poverty and supply interruptions, 36% of the most impoverished residents, with three poverty indicators, reported water supply interruptions at least 100 days per year (Figure 4.2). In contrast, only 16% of residents with zero poverty indicators reported over 100 days per year of water supply interruptions. However, poverty indicators are relatively unrelated to supply disruptions for residents experiencing a moderate frequency of supply disruptions ($\chi^2 = 9.798$, df=12, p=0.634, n=174).

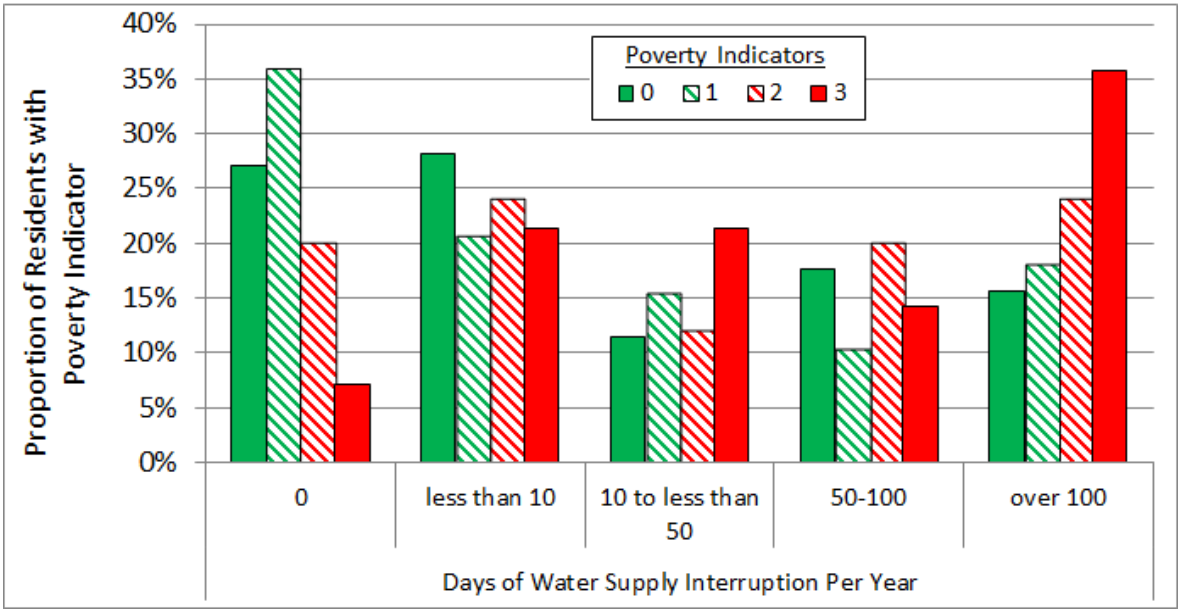


Figure 4.2. Relation between relative wealth of residents (zero poverty indicators = greater wealth, three poverty indicators = less wealth) and frequency of water supply interruption.

A majority of residents reported the water supply situation is either stable or improving over time (Figure 4.3). One notable result was 63% of residents in water poor, urban communities reported water supply interruptions are decreasing over time. Also, relatively few residents reported water supply interruptions were getting worse. When asked why they felt water supply interruptions were (or were not) changing, most residents did not know why (66%) or stated NAWASA was doing a good job (25%; Figure 4.4). Only 2.6% of all residents surveyed felt water supply interruptions were consistently bad or worsening because NAWASA was doing a poor job or infrastructure was in decay.

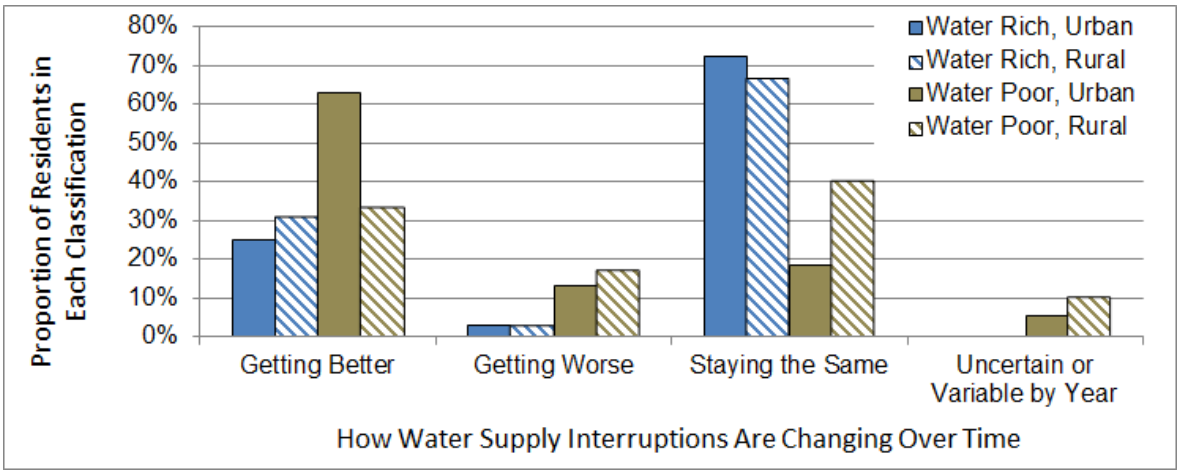


Figure 4.3. Relation between classification of residents surveyed and resident views on how the situation is changing over time

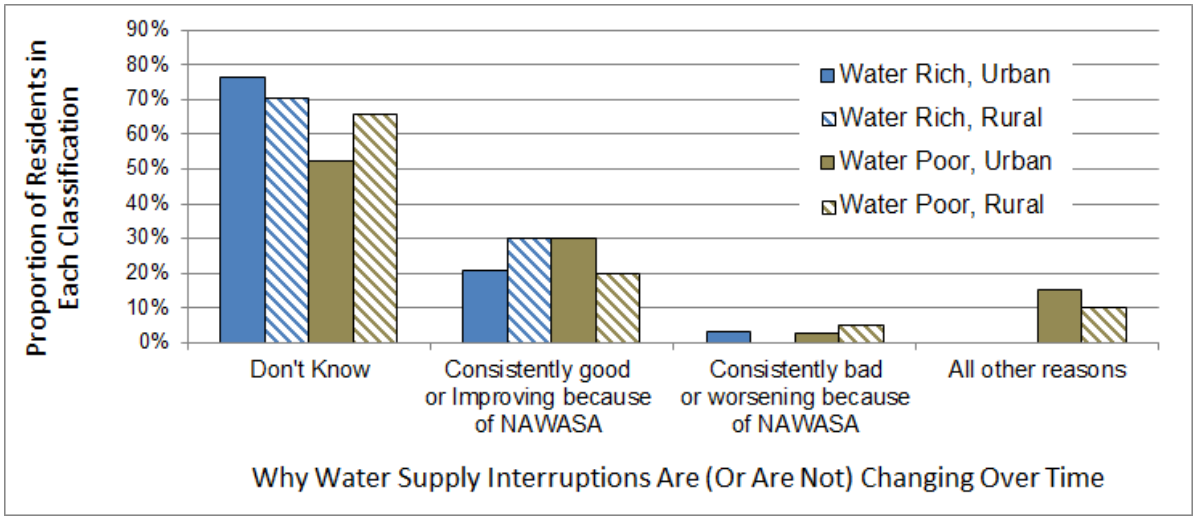


Figure 4.4. Relation between classification of residents surveyed and resident views on why the frequency of water supply interruptions is (or is not) changing.

4.1.3 Dirty Water

According to survey data, residents in both 'water rich' and 'water poor' communities reported receiving sediment–laden water, which they referred to as *dirty water*, at least some of the time (Figure 4.5). However, there was a statistically significant moderate relationship between community classification and days of receiving dirty water (Cramer's V=0.281, p=0.00, n=154). Dirty water was reported as more prevalent in the water poor communities, especially the rural, water poor communities. In addition, there was a small, but statistically significant, relation between poverty and the incidence of dirty water (r_s=0.208, p=.010, n=154; Figure 4.6).

Dirty water is likely to be more frequent in rural, water poor areas due to a combination of episodes of turbid streamflow and insufficient water treatment. Runoff from intense precipitation events erodes the typically steep river valleys in Grenada and flushes sediment into source-water streams. A review of early (pre1990) studies conducted by the Caribbean Conservation Association (CCA; 1991, p. 86) states "various sources are in apparent conflict about the extent of soil erosion" in Grenada. This same review documents reports of sediment loads during flood events up to 1,000 mg/L in the Beausejour River, which supplies source water for a large area that includes five communities surveyed in the present study. CCA (1991, p. 87) further states, "Persons interviewed... in the National Parks, Land Use, and Forestry units of Government, with the National Science and Technology Council, and individuals in the water sports industry (e.g., divers) -- tended to view soil erosion as a serious issue in areas outside of the forest reserves." In addition to the CCAIR review, observations and resident comments received during questionnaires suggest streams can become turbid during large rainfalls.

Compounding matters, water treatment plants in Grenada typically utilize small streams for source water and some NAWASA personnel (# 8 and 12) told me in interviews that many treatment plants in rural areas are antiquated and operate beyond capacity. In addition, rural water treatment plants are sometimes located in remote areas, often without electricity or road access, and are unmanned and not automated, making it impossible to take the plants offline to prevent passing sediment-rich water into the distribution system. Fortunately, residents reported episodes of dirty water were usually limited to a few hours in duration and typical only following rainstorms or repairs to distribution infrastructure.

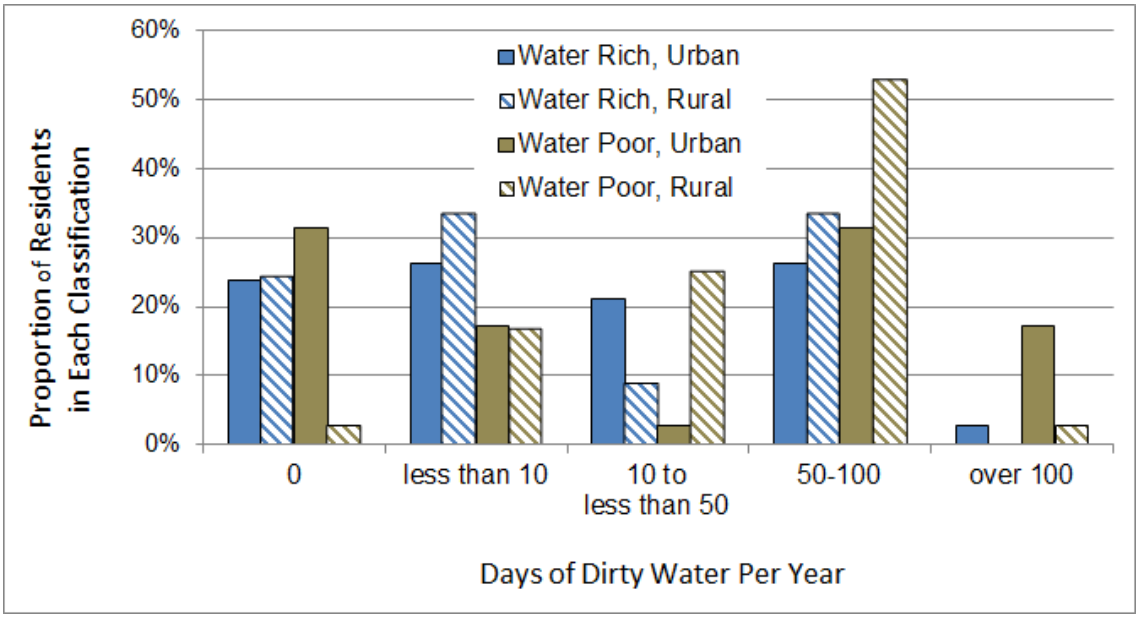


Figure 4.5. Days per year of dirty water reported by questionnaire respondents.

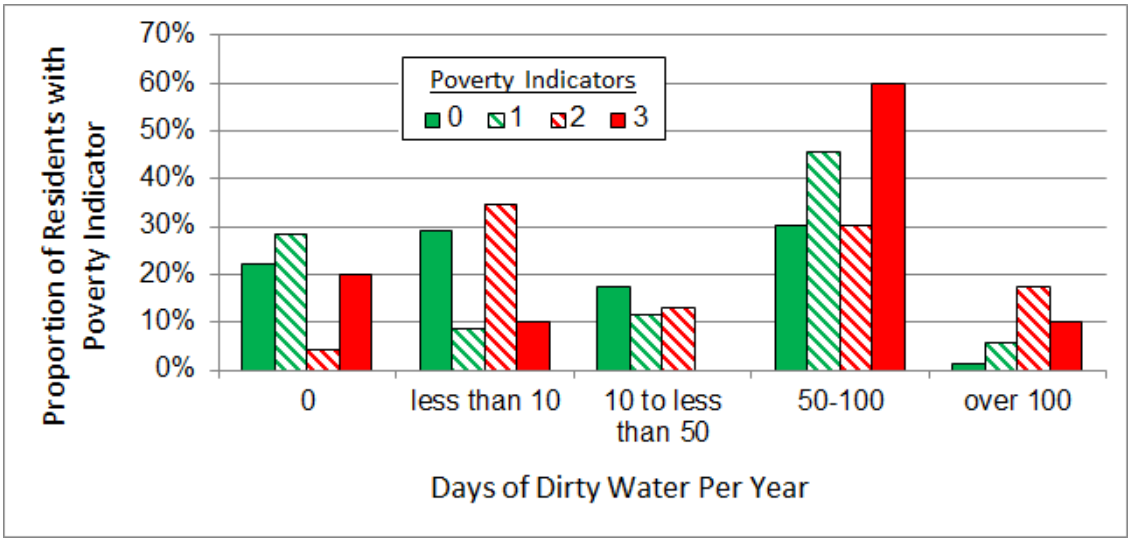


Figure 4.6. Relation between poverty and the incidence of dirty water.

Episodes of dirty water were variable in severity, ranging from some residents who reported never seeing any dirty water and other residents who reported receiving water which was “like mud” (Figure 4.7). In answering this question, I classified the severity with brief follow-up questions or discussion. A participant response of not seeing dirty water was classified 'not dirty.' A response describing an 'off color' or 'some dirt,' but not a major inconvenience, was classified as 'slightly, not bad.' A report of the muddy water being unusable for consumption or cooking was classified as 'brown/very dirty,' or 'severe/mud' if the participant described particularly severe muddiness; "like coffee" was a descriptor used by multiple respondents. In effect, episodes of 'brown/very dirty' water and 'like mud' water represent a water supply interruption. Residents in rural, water poor areas were far more likely to receive water “like mud,” possibly because of the same combination of factors described in the preceding paragraph.

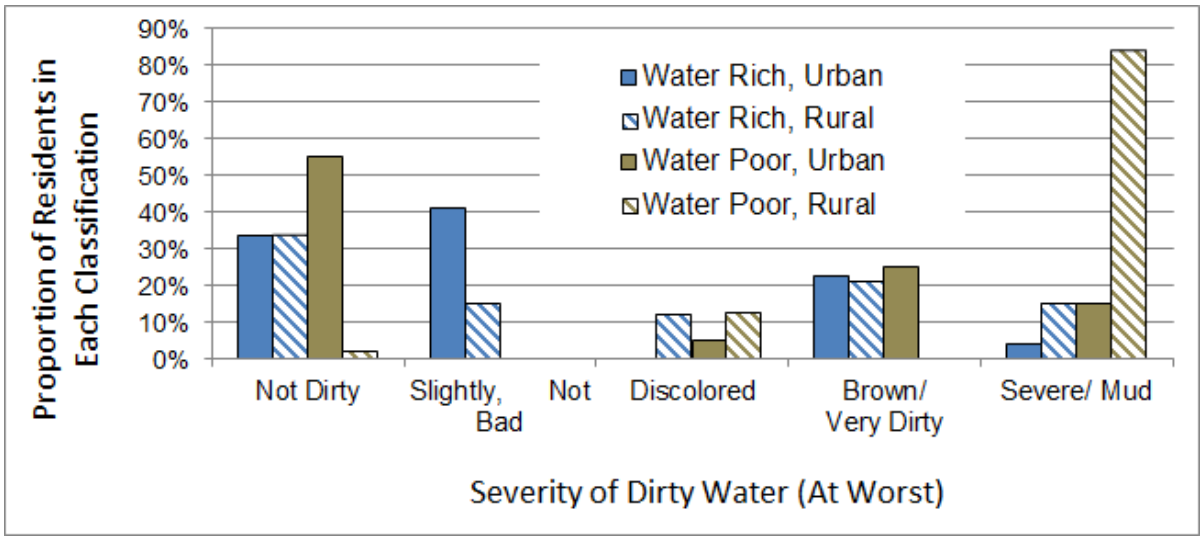


Figure 4.7. Severity of dirty water reported by questionnaire respondents.

Similar to the issue of water supply interruptions, most residents felt the incidence of dirty water is stable or decreasing over time (Figure 4.8). Likewise, residents reported they either did not know the reason for recent changes (or the lack of recent changes) in dirty water or they credited NAWASA for doing a good job on the issue (Figure 4.9).

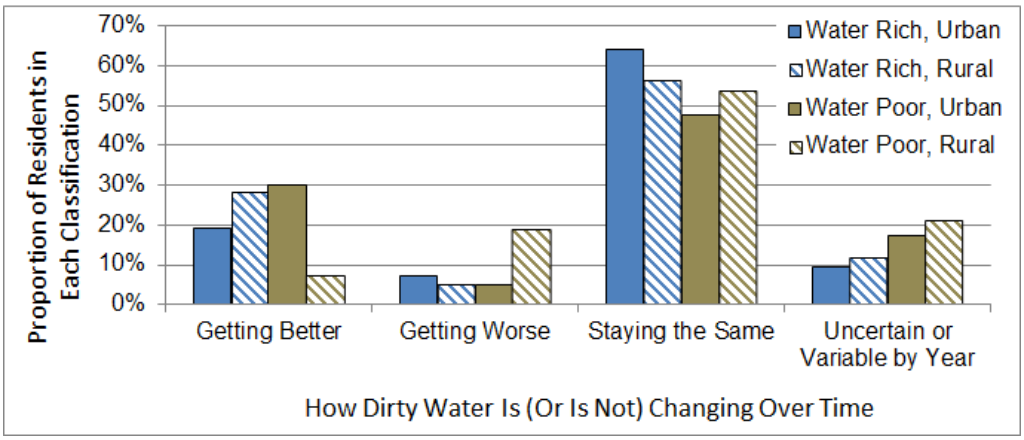


Figure 4.8. Relation between classification of residents surveyed and resident views on how the situation is changing over time.

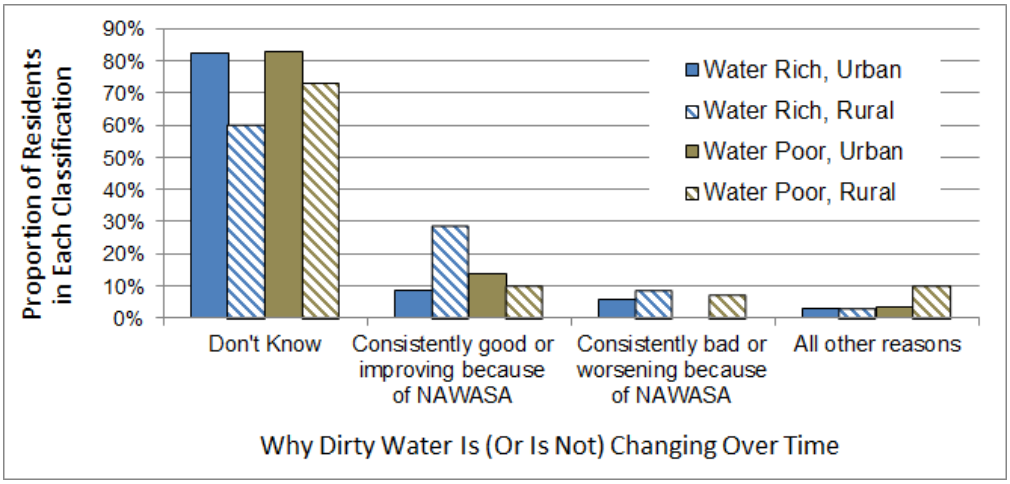


Figure 4.9. Relation between classification of residents surveyed and resident views on why the frequency of dirty water is (or is not) changing.

4.1.4 Other Issues with Water Supply

One-third (33%) of survey respondents identified one or more additional issues with their water supply. The proportion of residents in each classification who reported each additional issue is presented in Figure 4.10. Figure 4.10 and the following discussion reflect only the issues identified by more than one resident.

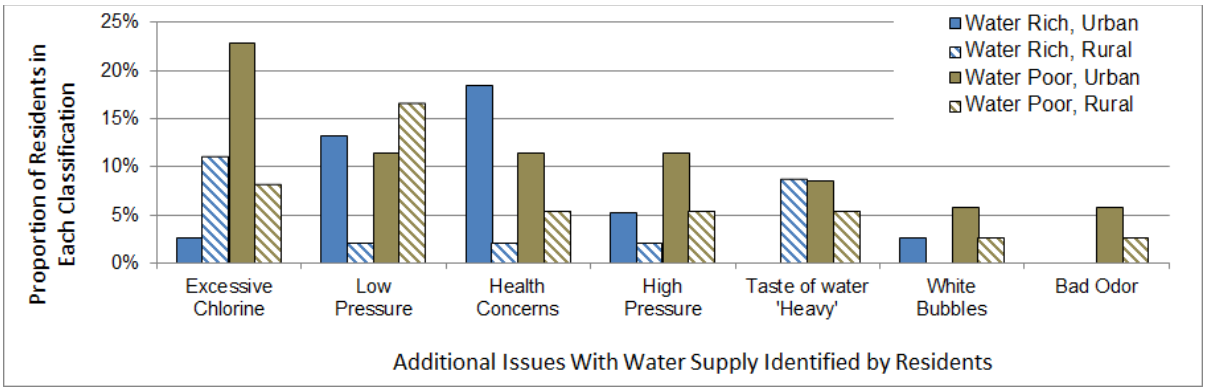


Figure 4.10. Additional issues with the water supply identified by residents.

The most common problems reported by residents, other than water service disruption and dirty water, were excessive chlorine smell and/or taste, low and high pressure at the tap, and health concerns. Questionnaire participants who elaborated on their concerns over water pressure described diurnal fluctuations between low pressure during daytime which interfered with water usage and high pressure at nighttime which commonly broke water fixtures. I have personally observed pressure-related fixture breakage at my home in Grand Anse, which confirms this aspect of questionnaire data, albeit outside the surveyed communities. Due to high nighttime water pressure, I have experienced, on separate occasions, chronic malfunctioning of a hot water tank, a burst under-sink sediment filter, and a broken toilet supply hose.[26] In developed world settings, water pressure in municipal systems is typically delivered to residents at a minimum of 35 PSI, which is considered sufficient for firefighting operations, and at a maximum of 80 PSI, to reduce leaks and prevent breaking water fixtures in the home. One resident whom I surveyed in the Mt. Airy/Bay Gardens community had installed a pressure gauge on his incoming water line and reported diurnal daytime pressure dropped to zero but nighttime pressure sometimes exceeded 100 PSI (Figure 4.11).

Health concerns related to potable water were expressed by 14 of the 180 (7.7%) residents surveyed. However, these residents were concentrated in urban areas for reasons that are unclear (urban water rich, n=7/45, 18%; urban water poor, n=4/45, 11%; rural water rich, n=1/45, 2%; rural water poor, n=2/45, 6%; Figure 4.10).

Questionnaire respondents also commented on abnormalities affecting the aesthetic quality of potable water. During the dry season, NAWASA augments the normal surface water supply with groundwater from boreholes and distributes it in some areas. Potable water with a high proportion of groundwater had a reputation among some questionnaire participants for being undesirable and hard

[26] I also experienced failure of two pressure-reducing valves at my home due to clogging with sediment, which contributed to the malfunctions listed.

with regard to dissolved minerals[27]. Nine participants (6%) complained of its taste and described it as "heavy." Three residents (2%) expressed concern over a "bad odor" of their tap water. Follow up questions indicated the odor was not chemical in nature, but resembled dirt or mud, properties I associate with mold. I discussed this matter with the Production and Quality Manager at NAWASA, who was unfamiliar with complaints of mud-like odor coming from otherwise clean water. The manager said he could not give a definitive answer without seeing the problem first hand, but suspected the odor could result from sediment in the lines, or possibly from a poorly maintained water storage tank or as a result of backsiphonage from a nearby poorly maintained and improperly equipped water storage tank. Finally, four residents (3%) complained of white bubbles in their tap water which disappear after a couple minutes. Three of the four residents believed air bubbles were excessive chlorine, although the phenomenon results from air dissolving into water in the distribution lines under pressure and then releasing when the pressure is relieved as water exits the tap (US Geological Survey 2013).

Figure 4.11. Pressure meter installed on incoming water line by a resident. This person reported diurnal pressure fluctuations between 0 psi (atmospheric pressure) and over 100 psi.

[27] Data describing potable water quality in Grenada are difficult to attain and data describing groundwater quality in Grenada were not available for this study. However, I have observed pipe-borne water in areas supplied with groundwater that had a distinct flavor and mouth feel I associate with hard, mineralized water.

4.1.5 Adaptation to Water Supply Interruptions

The ability to cope with water supply interruptions was influenced by the household storage of water. Storage can take several forms. Crude storage systems captured and stored rainwater using buckets and rain barrels which were not plumbed into the home (Figure 4.12). More elaborate systems stored piped water using elevated black polyethylene storage tanks of 500 gallons (1,890 L) or more and were plumbed to supply the home with water by gravity when water supply was interrupted (Figure 4.12). The tanks are filled when piped water is supplied to the house under pressure and held for use during water supply interruptions. In some cases, large cisterns, typically holding over 10,000 gallons (37,850 L), are located under the home and may hold either rain water or piped water and are plumbed to supply the home with pressurized water automatically during water supply interruptions. With a sufficiently large tank and pressurization, residents may be unaware of water supply interruptions.

Figure 4.12. Left: Example of an elevated 500 gallon (1,890 L) black polyethylene storage tank plumbed into the home. Right: Example of a rain barrel not plumbed into the home.

Questionnaire data showed both the frequency of water supply interruption and wealth of residents are key factors in determining which, if any, of these systems are used. The more frequently residents experienced supply interruption, the more likely they were to have a water storage tank of some kind (Cramer's V=0.298, p=0.004, n=172). Approximately half of survey respondents (n=95)

reported having a tank of some type. However, there is no statistically significant association between poverty index and tank ownership (χ^2=5,253, df=3, p=0.154, n=177). Nevertheless, for those respondents without tanks, most (74%) cited cost as a reason for not owning a tank. Additionally, the *type of tank/system* (e.g., plumbed/not plumbed) was moderately associated with poverty index (Cramer's V=0.374, p=0.004, n=95; Figure 4.13). This finding suggests residents who need to store water for use during water supply interruptions do so, but relatively wealthy residents own large tanks plumbed into the home, while relatively poor residents rely on simple rain barrels which must be accessed from outside the home.

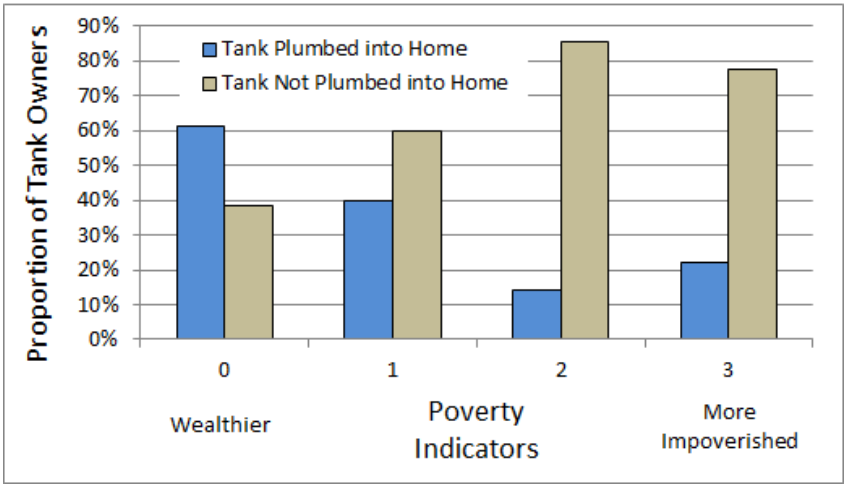


Figure 4.13. Relation between poverty and the type of water tank used.

4.1.6 Cost of Water Service and Resident Satisfaction with NAWASA

The financial cost of water supply in Grenada increased sharply from 2009-2012 in multiple ways. The legislature raised water rates in May 2010 for the first time in 18 years, which caused an approximately one-third increase in residential water bills.[28] At the same time, NAWASA has dramatically increased efforts to collect outstanding bills by disconnecting water service to delinquent residents. Interview participant #19 informed me many residents have access to piped water in a physical sense, but cannot afford their bills, are disconnected, and therefore do not have access to piped water in an economic sense. Additionally, seven questionnaire participants in Kafé Beau Hill, Gouyave, and Woodlands informed me NAWASA removed at least some of the public standpipes in

[28] Interviewee #7 provided information on monthly residential water bills (2012) as follows: the average residential water bill in Grenada is $44 EC ($16.56 CAD), while middle Income and upper-middle income residential bills average approximately $60-70 EC ($22.58-$26.35 CAD). This is in contrast to monthly electricity charges which interviewee #7 stated averages $300-400 EC ($112.91-$150.55 CAD) per household. The electrical utility was unavailable to confirm this estimate, but I believe it to be reasonable based on my direct observations as a Grenada resident since 2006.

their community within the past three years. One resident in Kafé Beau Hill showed me a standpipe he claimed had been retrofitted with a valve to reduce pressure and flow dramatically. I estimated the flow to be approximately 1 L/min.

Residents expressed mixed feelings regarding recent changes in their water bills. When asked if the recent changes in water bills had caused any problems, approximately one-half of residents in each of the four groups described at least some problem (Figure 4.14). Problems experienced by residents included a perception of the water rate being too expensive, financial strain due to paying the water bill, and anxiety over the inability to pay the bill, leading in some instances to a supply disconnection. Residents expressed mixed opinions when asked if they felt the increase was a good deal if NAWASA improved the water supply with the increased revenue (Figure 4.15). While resident opinion was split with regard to water bills, a clear majority of residents in all classifications was satisfied with NAWASA overall (Figure 4.16).

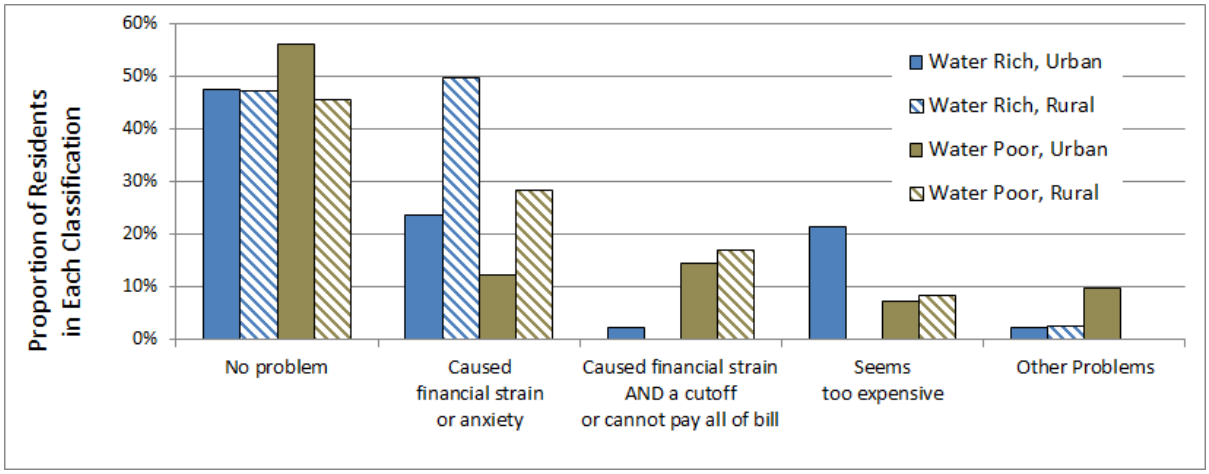


Figure 4.14. Problems residents reported having due to the recent increase in water bills.

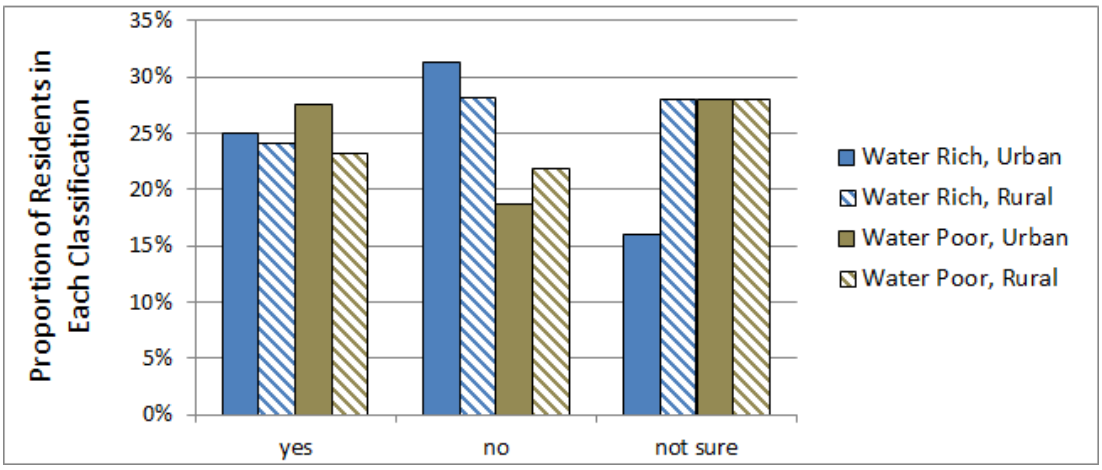


Figure 4.15. Resident responses to the question, "If NAWASA improves the water, do you think the rate increase is a good deal?"

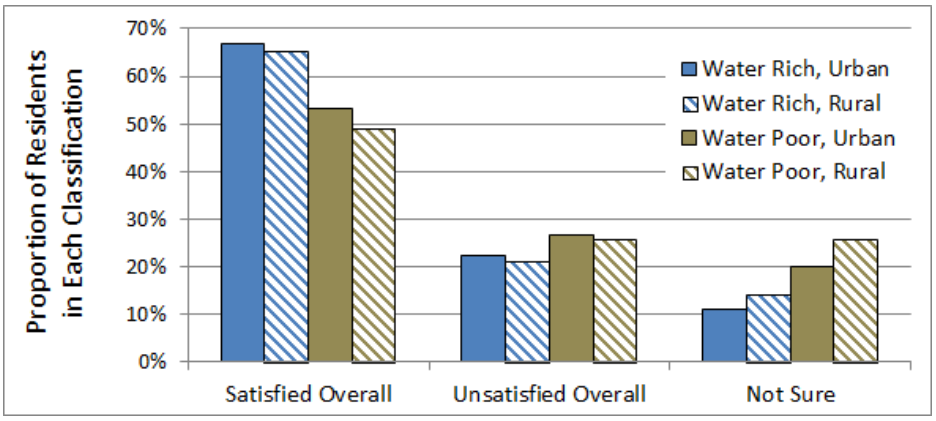


Figure 4.16. Resident overall satisfaction with NAWASA.

4.1.7 Issues of Empowerment

Data from resident questionnaires, document review, interviews, and observations indicated a large proportion of residents felt empowered to address water-related concerns with NAWASA and to a lesser degree with their elected political representatives; however, empowerment was very low with regard to other parts of the water management system. Within the four classifications of residents, between 34% and 48% felt NAWASA would not only listen to their concerns or suggestions regarding the water supply, but also act on them (Figure 4.17). Additionally, interview data indicated a high degree of engagement between NAWASA and residents. Resident needs were a central topic in all seven of my interviews with NAWASA personnel.

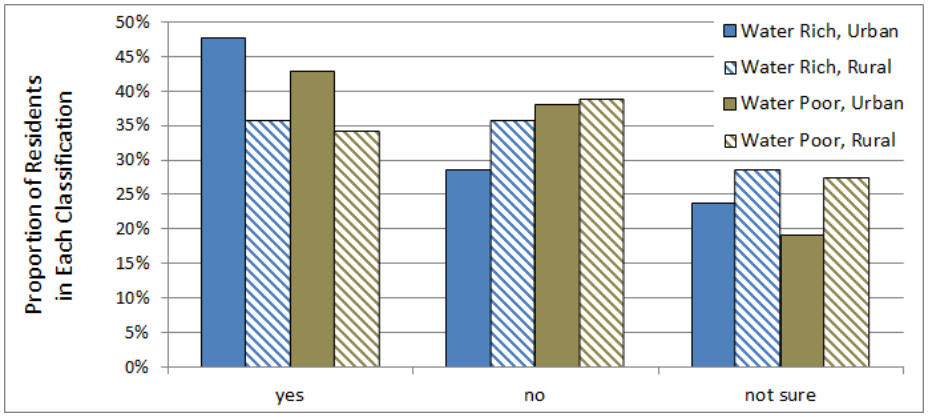


Figure 4.17. Proportion of residents who feel NAWASA would listen and respond if they had a suggestion or complaint about their water supply.

Not only do residents feel empowered with respect to NAWASA, evidence collected also indicates customer service is a key part of NAWASA's identity. The vision, mission, and core values statements of NAWASA focus on residents, who are considered as customers (Table 4.2). I noticed the mission and vision statements prominently displayed in multiple locations at NAWASA offices and page one of the current NAWASA annual report (2012) is dedicated solely to display of these statements. NAWASA personnel referred to the mission and vision statements repeatedly during the interviews done for this study.

Table 4.2. Vision and mission statements of NAWASA.

Vision Statement	A premier water utility, providing excellent service to all customers, fostering a healthy and productive nation.
Mission Statement	To provide customers with a safe, adequate, and reliable water supply and safe disposal of waste-water, in a viable and efficient manner, that meets and exceeds customer expectations, and ensures the development of our organization, communities and our nation.
Core Values	• Excellence in daily operations, with superior customer service; • Social responsibility at the community, parish, and national levels; • Accountability at all levels, to all stakeholders; • Innovation in operations and service provision; • Honest interactions with stakeholders; • A culture of continuous improvement.

During the study, NAWASA made substantive moves to enhance its relationship with residents. First, NAWASA created the Communications Unit[29] in August 2010, which answers directly to the General Manager and is dedicated specifically to resident engagement. Since creating the Communications Unit, NAWASA began communicating with customers using Facebook, Twitter, a blog, and a YouTube channel.[30, 31] Notably, two videos on the NAWASA YouTube channel (NAWASA 2012b, 2012c) feature a local sports club and a church group working side by side in a 'fireman's brigade' to remove rocks and debris by hand from a water supply dam which was completely filled during a land slide. The volunteers excavated the dam and NAWASA soon restored the water supply. Finally, NAWASA published the Customer Service Charter in 2012 (Table 4.3), further strengthening NAWASA's orientation to residents (NAWASA 2012a).

[29] Administratively, a "unit" is similar to a department, but has fewer than three full time employees.
[30] Most Grenadians have access to one or more of these media. 44% of questionnaire participants reported having access to the Internet and cell phones, which can access Twitter, are very widely used in Grenada.
[31] Facebook URL: https://www.facebook.com/nawasa.grenada
Twitter user name: @NAWASAGrenada; URL: https://twitter.com/NAWASAGrenada
Blog URL: http://nawasagrenadablog.wordpress.com/
YouTube Channel URL: http://www.youtube.com/user/NAWASA1Grenada

Table 4.3. NAWASA Customer Service Charter. Reproduced from NAWASA (2012a).

Our Promise	• Respect and courtesy; • Fair treatment; • We will always listen; • We will provide regular updates to customers affected by disruption of service; • We will honour promises; • We will always inform customers in advance of the need to carry out maintenance or investigation on their service; • We will maintain all service connections; • We will keep all information given to us confidential; • Notify customers through the public media of any programme of disconnection for non-payment of bills; • Maintain the sewer systems; • Provide bills on a monthly basis to customers.
Complaint Handling	We will respond to your complaint in an efficient and effective manner to ensure that your concern is addressed openly and fairly. • We will investigate and resolve, as soon as possible, all complaints concerning our services after you contact us. • If a customer feels that he/she has not received fair treatment according to the terms of this Customer Service Charter, then he/she should in the first instance seek a meeting with the immediate supervisor of the member of staff who handled the original problem. • If a resolution of the problem is not possible by the immediate supervisor, then the matter should be referred to the Manager of the Department, or if necessary the General Manager, for his/her consideration.
Customer Responsibilities	• Allow access to your private property; • Notify us promptly of any damage to the meter or supply pipe; • Notify us of your need to relocate the water meter if and when necessary; • Notify us of change of ownership; • Adhere to water conservation practices; • Pay bills on time; • Treat our staff with respect and courtesy; • Provide accurate and reliable information; • Inform us of any interruption in our service.
Service Standards	The Customer Service Charter has too many standards to list all of them in this table. Notable standards include: • Waiting time at the Cashier (3 minutes); • Waiting time for NAWASA personnel to arrive for a site visit at an agreed time (within 30 minutes); • Response time for repairs of burst water mains and sewer lines (ranges from 1 to 5 working days depending on size of line); • Notice times for disconnection (5 working days); • Notice times for scheduled water interruption (2 working days); • Delivery of water truck services requested by customer (2 calendar days).

Feelings of empowerment to address water-related concerns with NAWASA were not shared among all residents and many felt NAWASA would not listen or act if they had a complaint or suggestion (Figure 4.17). Within the four classifications of residents, between 29% and 39% felt NAWASA would not act on their concerns or suggestions regarding the water supply (Figure 4.17). Some of these residents felt NAWASA would listen to their complaints or suggestions, but not act. Comments commonly received from residents included: “NAWASA will respond but not right away,” and "NAWASA will listen, but not act.” Other residents held no hope of having their complaints heard. This was usually a general complaint rather than a NAWASA-specific complaint. Comments received included: "In Grenada here they don't take advice from small people" and “the local man don't have no pass.” I observed a handful of residents (<10) who were clearly disenfranchised and did not know or seem to care if NAWASA would listen or respond to a complaint or suggestion.

Aside from NAWASA, relatively few residents knew of anyone to contact regarding water supply issues. Some residents also felt comfortable contacting their elected officials if they were having water supply issues or had a suggestion. Between 7% and 29% of residents, depending on resident classification, felt they could contact their elected representative to help them with a water supply problem (Figure 4.18).

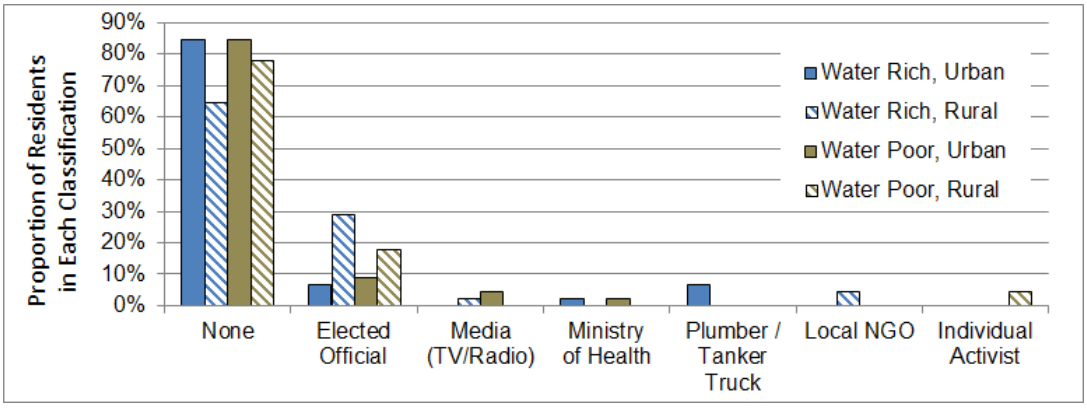


Figure 4.18. Proportion of residents who knew of anyone other than NAWASA to contact regarding water supply issues.

While residents enjoyed some degree of empowerment with NAWASA and local political representatives, empowerment was largely limited to water *supply* issues. Some residents showed frustration with water *management* issues which affect them. For example, one insightful resident asked:

> Why are we letting [the private company] Glenelg bottle water and make money when NAWASA could bottle it and make that money? [And use the money to fund system improvements.] These are the kinds of ideas I expect to come out of board meetings.

Other residents were willing to believe NAWASA was doing the best it can, but at the same time felt frustrated at not understanding the 'big picture' of water supply challenges faced by NAWASA. One resident stated:

> I think the biggest problem here in Grenada, be in NAWASA, the government, the electricity utility, they don't educate the public about why things are the way they are.

I repeatedly observed poor resident awareness or inaccurate perceptions of many aspects of water management and water supply. For example, many residents (>20) spoke of a monthly 'meter fee' on their water bills and 14 residents cited the fee as something they would abolish. I asked interview participant #12 about the meter fee and received almost 5 minutes of explanation on how the meter fee is a 'connection fee,' is consistent with how most utilities structure their fees, and educating the public on this point was an ongoing source of frustration within NAWASA.

Problems with resident awareness were particularly acute in regard to water sector reform, and not a single resident to whom I spoke or surveyed indicated any awareness of water sector reform or of the issue of fragmentation in the water sector. Media coverage of water sector reform was nonexistent during the study. Among four local newspapers published weekly or monthly, I found 27 articles on water issues published between January 2011 and May 2012. Among these articles, none mentioned any aspect of water sector reform or fragmentation of water sector responsibilities. One article, published in February 2007 and collected for an unrelated project, described plans for the formation of an Environmental Management Authority and did discuss fragmentation in environmental management as a problem, but without specific reference to water (Ellard-Deveney 2007). Also of relevance to the present discussion, this same article discussed the need for public education regarding environmental issues and empowering individuals to take action in their communities.

The NGO community[32] provides a weak voice for residents in water issues and residents are almost entirely unaware of water-related NGO activities. Water sector reform reports listed three Grenada-based NGOs as stakeholders and one is a partner of GWP-Caribbean. However, interview

[32] My research revealed at least 10 and possibly as many as 20 active grass-roots NGOs in Grenada, although I do not consider this estimate conclusive. In addition, churches and schools conduct ad hoc projects to improve community well being and poverty reduction. Of these groups, I was unable to identify any that focused explicitly on water issues. Nevertheless, some NGOs and groups conduct water-related projects. Peters and McDonald (2011) provides a review of Grenadian NGO activities following hurricane Ivan and discussion of the factors limiting the Grenadian NGO community.

and document review data indicate water-related advocacy among NGOs was relatively narrow in scope. Whatever the level of engagement of the NGO community in representing resident concerns over water supply, residents surveyed did not view NGOs as an effective ally in addressing water problems. Only one respondent felt a specific NGO was effectively promoting resident concerns with regard to water issues. Only 2% of all residents surveyed could name any NGO or formal community group working on water issues. An additional 3% of residents surveyed had a vague awareness of an NGO or community group they thought might exist. Two NGO leaders (interview participants #17 and 18) stated in interviews that residents have little power in Grenada, especially with regard to water issues, and educating the public on water issues is an area of need.

4.2 The Grenadian Water Management System

NAWASA is the dominant actor in Grenadian water management and was therefore pursued as the second embedded unit of study in this case study. However, there is a growing consensus among actors in the water management system about the statutory limitations of NAWASA and the need for more holistic management of water resources. In this section, I first describe the position of NAWASA within the existing water governance structure. Next, I examine NAWASA in detail: its strengths, weaknesses, internal workings, and relationship to other components of the water management system. Finally, I provide commentary on potential for renewal within the water management system.

4.2.1 Governance

Grenada has no over-arching, coordinating legislation to govern water management. Instead, 14 statutes, enacted or revised over at least three decades, govern various parts of the water sector. This arrangement has led to a piecemeal approach to water management and generally to a top-down bureaucratic structure which provides separate agencies with relatively narrow mandates. Furthermore, the patchwork of water legislation is poorly integrated and partial, lacking any over-arching strategic vision for the long-term (multi-decade) water future of Grenada. One other shortcoming of legislation is the lack of oversight for NAWASA in key aspects, such as setting policies which affect customers and standards of service. The lack of oversight of NAWASA is a structural issue in the water governance structure which has drawn the ire of a 2010 review of Grenada's water sector (Government of Grenada 2007b) and is a key feature of a new (2007), but unimplemented, water policy for Grenada (Government of Grenada 2007c). The following sections describe the 2007 water policy in detail.

To emphasize the limitations inherent in the present fragmented system of water management, many interview participants used the term ‘water *resources* management’ (emphasis added) to denote a holistic and ‘proper’ way to manage water resources and used the term 'water management' to describe what NAWASA does. Interview participant #14 stated, “Presently, because of the number of departments and divisions that have some responsibility for water resources management, very little coordinated work is done with regard to water resource management.” Eight interview participants considered fragmentation in water resources management and lack of overarching management as a reality, a known problem which needs to be resolved. Two additional participants, within NAWASA, discussed administrative fragmentation of the water sector as a problem, but expressed caution with regard to the need to address administrative fragmentation of the water sector.

Long-range planning, defined here to mean multi-decade planning, is not required under Grenadian water management laws and as a practical matter does not occur anywhere in the water governance structure. This situation is true even within the individual ‘silos’ of water management I evaluated and was verified with the document review, interview data, and observation. The document review revealed no multi-decade planning and only weak evidence that multi-decade planning was being thought about. I explicitly discussed long-range planning with 12 of the 18 interview participants, including people in NAWASA, two other Ministries, academics, consultants, and NGOs. None could confirm the existence of any long-range planning with regard to water. Interview participant #2 had excellent insight into the water sector and was blunt when asked if there was any evidence of long-range, multi-decade, planning in the water sector. He said, “No. It's a short answer.” This participant continued to say a lack of planning is not unique to water resources, and that it is the same for social and institutional planning in Grenada and most of the Caribbean. Seven additional interview participants pointed specifically to a 5-year plan developed by NAWASA (discussed further in the next section) as the *only* water-related planning document and four of those seven stated even if planning is occurring, it is not holistic in nature.

Despite the lack of long-range planning, interview participants in positions of authority kept at least a mental list of what needed to be done to improve the current system and prioritized needs well. This finding was true of persons in the political field, NAWASA personnel, consultants, and academics. I observed the ‘list of what needs done’ either consciously or subconsciously as substitutes for a ‘where we want to go’ approach in most interview participants' minds. This finding is, perhaps, understandable given the lack of integration in Grenadian water governance, a 5 years or less time horizon for political elections, the financial ability of NAWASA (discussed further in the next section), and multi-decade planning being a rare occurrence *anywhere* in Grenada.

As discussed in Section 4.1.6, *Resident Empowerment*, resident input in water management exists with NAWASA, and is stipulated in the unimplemented 2007 water policy (Government of Grenada 2007c). Two local NGOs, the Agency for Rural Transformation (ART) and Grenada Community Development Agency (GRENCODA), are frequently identified explicitly as stakeholders in water sector documents (CEHI 2007; UN-ECLAC 2007; CARIWIN 2009a). However, as discussed above, questionnaire data suggest NGOs working on water issues are almost unknown among residents. Nevertheless, the balance of the evidence suggests a basic willingness exists in the water management community to consider resident concerns in water management and, should the 2007 water policy be enacted, a structure will be provided to feed resident concerns into water management decision making.

Despite the actions of individual segments of water management to engage and respond to resident concerns, decision making was still top-down. One interview participant in the NGO community, #18, was particularly critical of the existing top-down approach to water management (and in Grenadian society in general). This participant was enthusiastic about bottom-up approaches to watershed management used by the Division of Forestry in the Ministry of Agriculture, but felt the Forestry Division played only a the slight role in water management and was frustrated at the apparent novelty of the bottom-up approach. These views are consistent with evidence collected in the document review, which showed relatively weak resident representation in stakeholder groups considering residents consume over 70% of the potable water on the island, a point considered further in Section 6.1.1.

4.2.2 National Water and Sewerage Authority (NAWASA)

The dominant actor in water management, by a wide margin, is the National Water and Sewerage Authority (NAWASA), which is solely responsible for supplying potable water throughout the country. NAWASA is administratively located within the Ministry of Works, which also oversees infrastructure such as roads. In addition to being the potable water provider, NAWASA has a legal responsibility to manage water resources under the National Water and Sewerage Act of 1990. In practice, however, several interview participants told me this responsibility means little. In the words of participant #7, "the power that NAWASA has [to manage water resources] is in name only. It is on paper only. NAWASA doesn't have the resources, they have a Water Resources Unit, but it is basically a shell."

The Ministry of Agriculture has some overlapping role with regard to water resources, in that it is responsible for managing land use and agricultural activities, which often occur on lands affecting source water. Within the Ministry of Agriculture, responsibilities are further split between the Land

Use Division and the Forestry Division. Finally, the Ministry of Health works alongside NAWASA to ensure water supplied to customers meets basic health standards. Nevertheless, observations, resident surveys, interview data, and the document review indicate NAWASA is the main actor in the water sector in Grenada. For example, a 2007 review of the water sector in Grenada (Government of Grenada 2007b) contains a chapter devoted to governance. Within the governance chapter, NAWASA is named 12 times and no other agency is named more than three times.

NAWASA recently produced a 5-year strategic plan (NAWASA 2009), the first planning document produced by the agency. This document describes the agency's mission and goals, the challenges it faces, and outlines a plan of action for the years 2009-2014. The plan falls short of providing a long-range (multi-decade) strategic vision for water management, but acknowledges developing such a vision is desirable and the 5-year plan defines the first steps of moving toward such a vision. I asked a high-ranking NAWASA official why planning is limited to a 5-year time horizon and was told:

> The 5-year strategic plan, 2009-2013, was a watershed event for the authority. Because prior to that there had been no serious effort at planning even 5 years ahead. I believe you need to crawl before you can walk, and that [a multi-decade plan] is 'pie in the sky' right now.

The creation of *any* planning document is significant in that it indicates a potential change in the time perspective within NAWASA.

The internal structure of NAWASA consists of a Board of Directors at the top of the organization, which directs the General Manager, who in turn manages the activities of the Chief Engineer and the operations of five departments (Figure 4.19). The Chair of the Board of Directors is appointed by the Prime Minister. The rest of the Board is nominated by government Ministers and approved by the Minister of Agriculture.

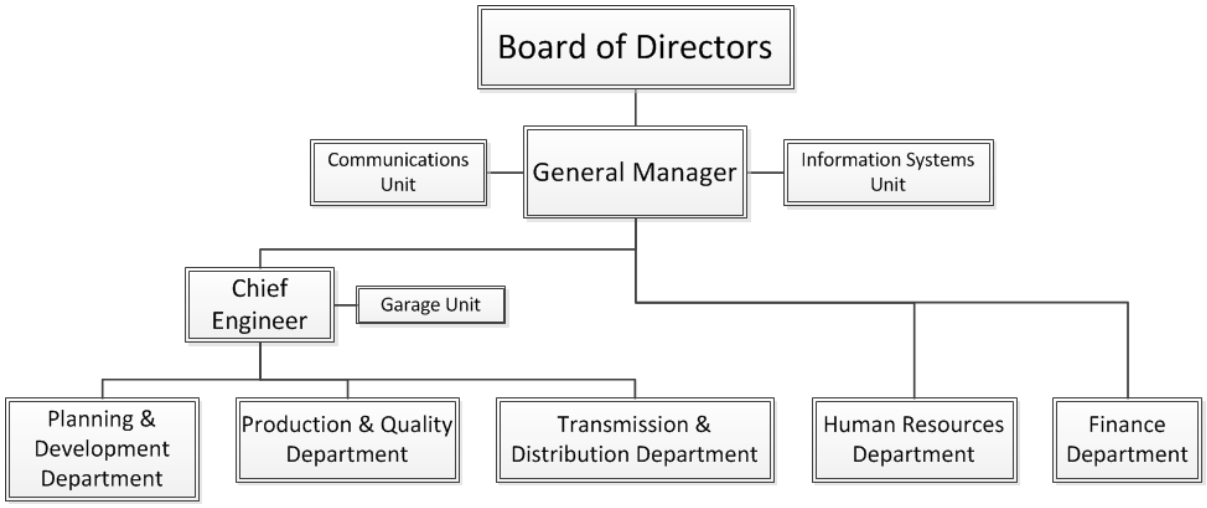


Figure 4.19. NAWASA organizational chart.

NAWASA operates as a business and does not receive funding from the Grenadian Government. Operationally, NAWASA's annual budget is nearly EC$30 million (slightly over $10 million CAD). This sum covers NAWASA's operation and maintenance costs and is collected from charges to water users. However, revenue from user charges is insufficient to fund capital improvements. To fund capital improvements, NAWASA depends on foreign assistance. This arrangement leaves NAWASA in the uncomfortable position of accepting whichever capital improvements foreign assistance grants will fund, whenever they will fund them. One interviewee summarized the situation:

> Right now we are making money to recover our costs. But we are not spending money on capital improvements. We're not making enough money to pay for those capital improvements. Then we have to wait for grants [to pay for the capital improvements] and sometimes they insist on spending the money differently than we would spend it.

Synthesis of document review and interview data led me to identify a common model of foreign technical assistance for funding basic studies to identify projects to improve water services, but leaving the identified projects unfunded. Unfunded projects are shelved until additional foreign assistance becomes available. For example, two important consultant reports referred to by interview participants were the *Northern Grenada Water Supply Study* (Stantec 2001) and the *Southern Grenada Water Supply Study* (OTH International 1995), also referred to as the 'French Report' because it was written by French consultants. These reports describe infrastructure improvements necessary to improve water supply in Grenada. The Northern Grenada project remains unfunded, while the Southern Grenada Water Supply Project was funded in 2009 by a European Union grant for EC$20 million ($7.4 million CAD).

The Southern Grenada Water Supply Project illustrates the frustration of relying on foreign assistance for capital improvements, particularly when based on dated consultant reports. Interview participant #8, who had intimate knowledge of engineering and water supply issues in Grenada, told me the chronic dry-season water supply problems in the southwest part of the island can easily be corrected by building a new and large treatment plant on the Concord River. This river is north of the city of St. George's in the Black Bay watershed and has a relatively large excess of water which, if treated, NAWASA could distribute to communities in the southwest part of the island through existing infrastructure. However, this project was not considered in 'the French report' on which the Southern Grenada Water Supply Project was based. Consequently, a golden opportunity was lost to resolve the water supply issues in the southwest part of the island.

NAWASA operates with limitations on its revenue which private sector businesses generally do not have. Interviewees #9 and 10 cited a 'social responsibility' to keep water rates low enough for impoverished persons to afford, which restricts revenue. Participant #9 explained the situation:

> There is a social aspect to what we do. We cannot set our rates freely to ensure we recover our costs because of our social responsibility. Normally [when running a business] we would look at the cost of providing the service and set the cost to recover our expenses. But we cannot do that because of the social responsibility. That is another serious limitation we have.

Interview participant #5 described the situation as:

> There is a social view that people almost have a right to water, not everybody was convinced that they should have to pay an amount sufficient to make the water supply company a viable business.

In addition, the legislature approves all water rate changes, which is politically contentious. The water rates were raised during the study, in 2010, for the first time in 18 years (since 1992). Also, the Grenadian government must guarantee any loan which NAWASA receives, adding a bureaucratic barrier to gaining loans and working around an inability to raise water rates. Therefore, NAWASA is effectively a 'corporation-like' entity with artificially low revenue, poor control over increasing revenue, and few other options for generating revenue such as taking loans.

I did not find any hint of corruption within NAWASA. Only one resident I spoke to or surveyed indicated corruption was a problem in NAWASA. Another resident told me he had *unsuccessfully tried to bribe* his way to the top of the water truck delivery route during the drought of 2009/2010. This resident told me he eventually tried calling NAWASA and repeatedly told the customer service agent he wanted to talk to "whoever signs your paychecks." The resident claimed his call was routed to "some guy named Christopher Husbands," (the resident apparently did not realize Christopher Husbands was the General Manager of NAWASA). The resident complained the water truck was

consistently supplying his neighbors and running out of water before reaching his home. The resident then politely asked whom he had to pay off and how much it would cost to have the water truck start at his house. The resident then described vividly the reply from Husbands explaining how bribery had been a problem with the water trucks but it was no longer tolerated. A water truck supplied this resident with water within a few days without requesting a bribe.

Although corruption within NAWASA did not appear significant, multiple sources indicated NAWASA is vulnerable to a lack of political transparency and manipulation *from above.* For example, NAWASA owns three desalination plants it apparently did not request, was not consulted on, and are now inoperable and unwanted. In an open letter to the former Minister of Works of the now-opposition party, dated 4/22/2010 and published on the Grenadian Connection web site (Ferguson 2010), a prominent political activist named Sandra Ferguson wrote:

> The Ministry of Public Utilities bought and installed three desalination plants without any input from NAWASA, without the benefit of any feasibility study. When the plants were installed in Petite Martinique and in Carriacou, they could not be hooked up to any distribution system since a distribution system did not exist. In Woburn, AFTER the plant had been installed, drilling for water took place and it was found that the brackish (ground)water (needed for desalination) did not exist in the location where the plant was installed.

I verified basic details of this account with three interviewees, who emphasized NAWASA was never consulted regarding the plants and due to the technical and practical implausibility the plants would never be useful. Two of the three plants are out of operation (2012) and the third is run minimally to keep it operational in the event it may become useful someday. I asked interviewee (#10) about the source of the funding for the project and received this response:

> I don't know. Like I said, we didn't know anything about it and then it was built. They were going to build it on Grand Anse Beach, but there were objections from the hotels that were close to it, and they moved it to Woburn. It cost around seven million dollars [EC] and was never finished. We were never consulted on where it should be. The Minister of Works bought the plant. They gave a private contractor the job to install it. When the contractor ran into problems then they said, NAWASA you take it now, you fix it. So we tried to get a copy of the contract to see what is the responsibility of the contractor and what is the responsibility of the government. We never got this contract. We were trying to work with our chairman back then, who was the permanent secretary in Works. We said, you are the guy in Works, you are second in command, just get a copy (of the contract). Not even he could get a copy of the contract. So that's the justice of political interventions and how they can cost a company like NAWASA.

I asked interviewee #9 how this sort of thing could happen. The interviewee responded, almost exasperated, "Ah, the Ministries do these things."

A similar story, dating to the 1970s, was told to me separately by four interviewees regarding the siting of the water treatment plant at Mardi Gras. Water managers had originally planned to locate the treatment plant conveniently downhill from the source water intake, near a valley bottom. However, the Prime Minister at the time, Sir Eric Gairy, demanded NAWASA build the plant on a nearby hilltop so "everyone can see what we have built." Interview participant #10 recalled:

> Mr. Noel was the manager or chief engineer at the time [Mr. Noel later came back as the General Manager]. He left over this project… Mr. Noel protested (locating the plant at the top of a hill). And the PM told him, 'look, if you want your job you will do as I tell you.' So Mr. Noel left to go work with CARICOM over that project. And our hope when the Americans came [in the 1981 intervention] is that they would 'accidentally' bomb the plant (so it could be relocated to a suitable location). Gairy insisted it go there. So Noel left.

From these data, I conclude that while corruption is apparently not an issue within NAWASA, it is vulnerable to manipulation from above in questionable and non-transparent ways. This conclusion is consistent with global rankings of governance indicators ranking Grenada moderately high globally, although the 2002-2011 trend indicates a modest decline in this regard (Figure 4.20). In 2011, Grenada ranked in the 69th percentile globally in control of corruption, approximately the same as nations such as Czech Republic, Hungary, Cuba, and Korea.

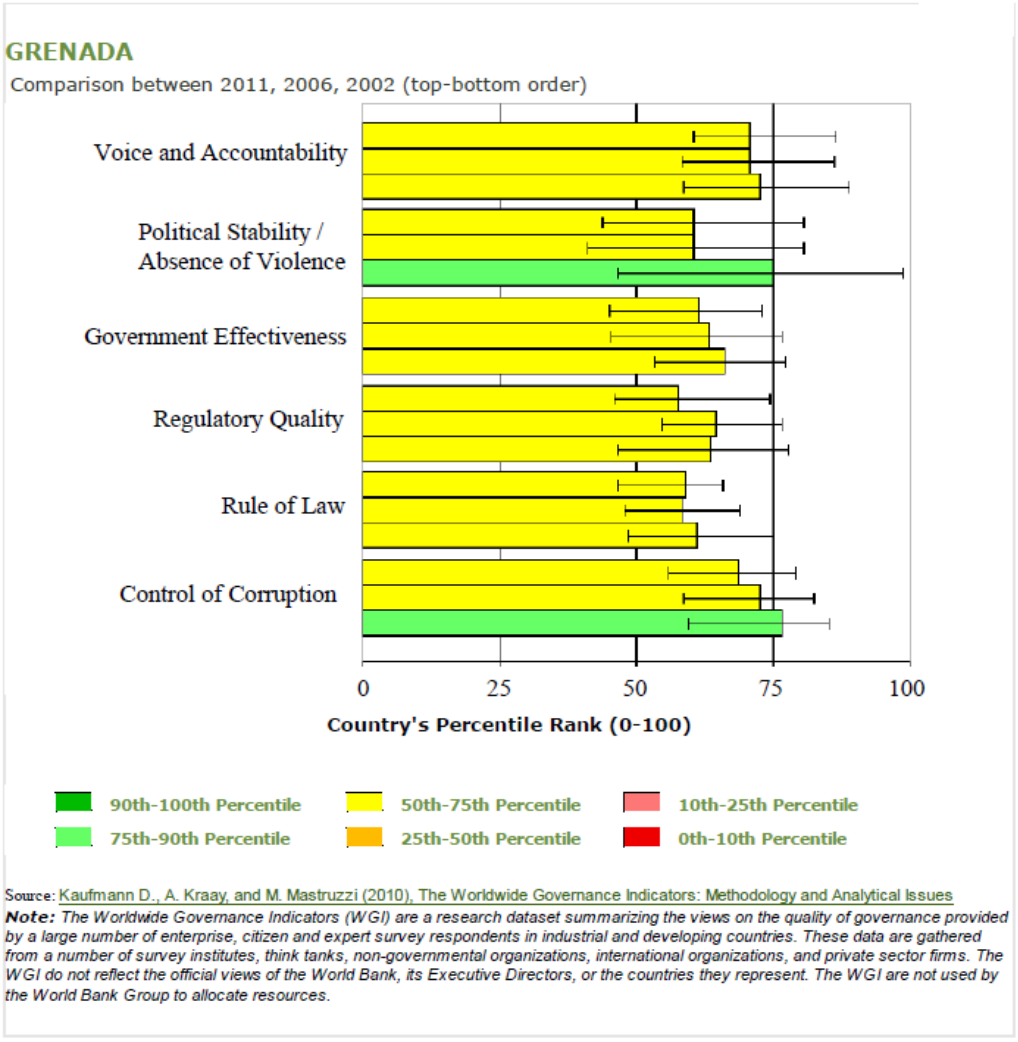


Figure 4.20. Governance indicators for Grenada. Higher percentile values indicate better governance. Chart created at the World Bank Worldwide Governance Indicators web page, http://info.worldbank.org/governance/wgi/sc_country.asp, and was modified to enhance clarity.

4.2.3 Potential for Renewal of the Water Management System

Capacity exists to mitigate the structural deficiencies in Grenadian water resources management. First, individual components within the water management system function well *within their individual mandates*. This is particularly true of NAWASA. On an individual basis, personnel in the Grenadian water management system revealed remarkable insight and enthusiasm for what they were doing. Second, Global Water Partnership-Caribbean (GWP-C) has especially strong ties to Grenada. Former Grenada Prime Minister Keith Mitchell was the keynote speaker at the GWP-C inauguration ceremony in 2004 and seven GWP-C partner organizations are Grenadian; including one local NGO;

two consulting firms; and four Government agencies. Two of the nine Caribbean-based members of the GWP-C Steering Committee are from Grenada; including the Committee Chair, Trevor Thompson, Land Use Officer for the Ministry of Agriculture; and Terrence Smith, owner of an engineering consulting firm in Grenada and Chair of the NAWASA Board of Directors. Both GWP-C and a foreign-based capacity-building project (the Caribbean Water Initiative, CARIWIN) have devoted considerable resources to promote sustainable water management in Grenada,[33] especially IWRM. Third, Grenada is sufficiently small for all of the key water sector actors to know one another, communicate regarding water issues, and share datasets. Interview data did not reveal any antagonism within the water sector and interviewee #10 explicitly stated, "There is no antagonism between [NAWASA and the Ministry of Agriculture]. We collaborate where we need to." Finally, the wheels of change may already be moving. A new water management policy for Grenada was drafted and adopted in 2007 (Government of Grenada 2007c), and is described in the following section. The 2007 policy mandates a more holistic approach to water management, including the eventual implementation of IWRM. However, the new policy remains unlegislated, unimplemented, and, in the words of interviewee #10, "an academic exercise, just a piece of paper."

4.3 Water Sector Reform

In 2007, the Government of Grenada initiated a process to create a national water policy as a condition to receive EC$20 million from the European Union for the Southern Grenada Water Supply Project. The Government of Grenada contracted with consultants to produce three key documents: the Grenada Water Sector Review, a Draft National Water Policy, and a Framework for Water Policy Implementation. These documents sought to identify the deficiencies in water resources management, define a water policy for future integrated water resources management, and chart a path to implementing the new policy. Later in 2007, the Grenada Legislature formally adopted the newly drafted water policy and the EU released funds for the Southern Grenada Water Supply Project.

However, a crucial distinction exists between adopting the 2007 water management policy and water sector reform. Legally, a policy serves to inform the actions of the government, but does not automatically dictate how the government operates. To change how the government operates, the legislature must take additional action and establish one or more new statutes which mandate and direct change. In the case of Grenadian water management, the current system (2013) is a patchwork of 14 statutes, which govern specific aspects of water management. None of these statutes has

[33] It is difficult to quantify the magnitude of funding spent to improve water governance in Grenada. However, conversations with interview participants #2 and 3 and significant internet-based research suggest funding in excess of $10 million (CAD) flowed annually since at least 2008, and possibly much earlier, into 15 English-speaking Caribbean nations explicitly for the purpose of improving water governance.

overarching authority, or is holistically oriented. To implement the provisions of the 2007 water policy, the legislature must establish a new, overarching statute to supersede the existing legislative arrangement and redefine how the water sector operates. The EU required the Grenadian government to create and adopt a 'sensible' water policy[34] but did not require the government to pass supporting legislation.[35] In effect, the EU allowed the Grenadian government to give lip service to changing the structure of water management, without actually doing so. Although Grenada has not passed legislation to implement key aspects of the 2007 water policy, efforts are ongoing to facilitate passage of such legislation. The effort to create a new, holistic system of water resources management in Grenada by passing legislation to implement key aspects of the 2007 water policy has come to be known as **water sector reform** and forms the third and final embedded unit of this case study.

4.3.1 Key Provisions

The water sector review (Government of Grenada 2007b) provides a detailed analysis of Grenadian water governance. A central issue raised in the review is that the current water governance structure puts NAWASA in the position of being all of water provider, manager, and regulator. With little oversight, NAWASA sold water, but was also in charge of setting standards of service, creating policies, and making strategic decisions which affect revenue from water sales. NAWASA also fields complaints about water service. Resident survey data show residents had few options if they had a problem with NAWASA. Correcting these conflicts of interest is a primary feature of water sector reform. Another point made in the water sector review and confirmed in interviews conducted for this study is the NAWASA Board of Directors consists of political appointments from the ruling party, not an ideal arrangement.

The water sector review (Government of Grenada 2007b) articulates the many challenges to providing water services throughout Grenada, highlighting the need for a more holistic management of water resources. Based on the water sector review, a new water policy was drafted in 2007 which calls for the restructuring of the water sector to (a) separate water service provision and regulation and (b) create an overarching water resources management entity (Figure 4.21).

[34] The EU required Grenada to adopt a new water policy. However, the precise language used by the EU to describe the requirements for a new water policy was unknown to any interview participant and was not described in any document reviewed. The term 'sensible' emerged in interviews to describe what system actors set out to develop in a new policy.

[35] It is also unclear if the EU intended to allow Grenada to adopt a new water policy but not implement it.

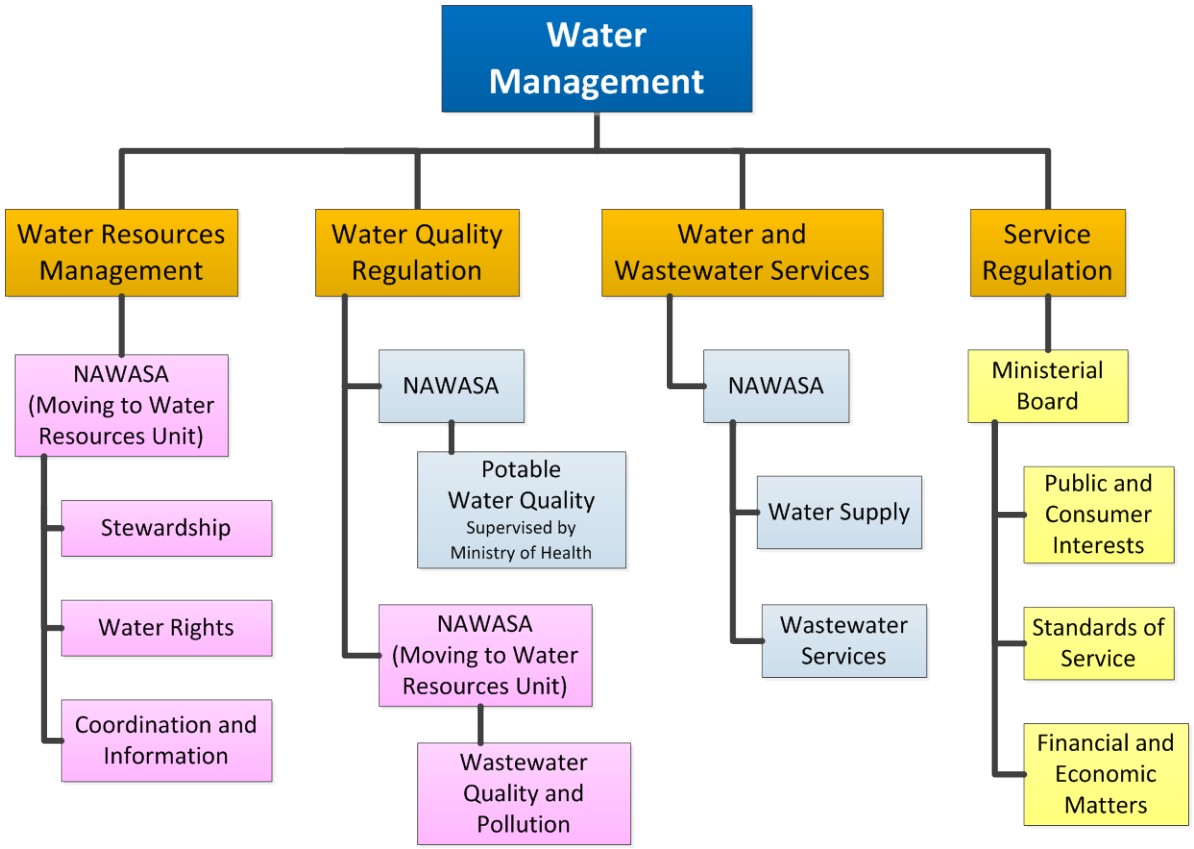


Figure 4.21. Chart of water resource management responsibilities in the new (2007), but yet unimplemented, water policy. Modified from Government of Grenada (2007b).

The function of water sector reform to create an overarching water resources management entity appeared to strip authority from NAWASA. Legally, NAWASA has had a mandate to manage water resources and has had an administrative unit, named the Water Resources Unit, to manage water holistically. However, this unit was perceived as ineffective due to a lack of resources as explained by interviewee #7:

> the power that NAWASA has [to manage water resources] is in name only. It is on paper only. NAWASA doesn't have the resources, they have a Water Resources Unit, but it is basically a shell. NAWASA isn't doing 5% of what it should be doing in the area of water resources management. It doesn't have the financial and other resources to do it. So [the statutory authority for NAWASA to manage water resources] is on paper only.

Interviewees #5 and #8 described NAWASA's financial condition as having revenue from user charges sufficient to survive operationally and relying on foreign funds to address other priorities such as capital improvements. Simply stated, foreign entities funded at least some capital

improvements, for example the Southern Grenada Water Supply Project, but no foreign funding existed for tasks such as holistic water resources planning.

Despite the relocating of authority for water resources management from NAWASA to a new entity, persons within NAWASA did not feel water sector reform would affect their day-to-day operations. In the words of interviewee #12:

> The water sector reform structure does not change anything we do, it provides for something that is not being done by anyone.
>
> It is going to provide an entity that is going to take a forward looking and a management approach to the entire nation's water resources. We [NAWASA] only provide very limited information on water resources that we use or have intentions of using. Things that are downstream from us, we don't play a part in that. So no one is really doing organized catchment protection or anything like that. [Water sector reform] provides an opportunity for that to take place.

One key feature of the 2007 water policy (Government of Grenada 2007c) is a provision for IWRM to be carried out within the Water Resources Unit. However, the 2007 water policy provides little direction for the form of IWRM, providing vague language for "the coordination with and inclusion of national and community-based agencies and (water) stakeholders" (p. 7). One vision for how IWRM could be implemented is presented in the *Road Map Toward Integrated Water Resources Management Planning for Grenada* (CEHI 2007). This document presents a relatively elaborate vision for implementing IWRM, featuring a 20-page description (p. 48-67) of 100 distinct activities presented as "necessary for attaining IWRM at the national level" (p. 46). Notably, the *Road map* document (CEHI 2007) did not discuss or acknowledge alternative management approaches or ways of interpreting IWRM, a point I return to in Chapter 6. In summary, much remains to be resolved in regard to implementing IWRM in Grenada.

4.3.2 Legislation as the Key Barrier to Implementation

Interviewees #2, 6, 7, 12, and 14, who were all in excellent positions to judge water sector reform, felt passing legislation to support the 2007 water policy was the critical threshold to transform water management in Grenada. To paraphrase these interview participants, once the government passes legislation to support the 2007 water policy, a tipping point is reached and the system moves to something different. Interestingly, none of the interviewees considered non-legislative means of transforming water management. Nevertheless, at the middle of 2013, the 2007 water policy remained unsupported by new legislation for reasons explored in Chapters 5, 6, and 7.

4.4 Summary

In this chapter, I define 'improvement' in the water sector as improving the resident experience with water. I established a baseline description of the range of residents' views on their water service and water management, identified trends, and assessed resident empowerment in water management. The resident experience with regard to water was variable, with substantial water shortages in some communities[36] and problems with episodic poor water quality nearly everywhere. In addition, NAWASA is overwhelmingly the single most significant system actor, in the view of residents. Residents were nearly completely unaware of NGO engagement in water supply issues and NGO's typically did not engage or educate residents directly on water issues except as part of specific projects. Resident empowerment in the Grenadian water system is mixed; residents felt some empowerment on water issues with NAWASA and to a lesser extent with their elected representatives, but not with any other component of the water management system. Finally, the level of resident knowledge of water issues was largely limited to water supply and matters typically handled by NAWASA. Residents were unaware of issues such as fragmentation of water management and water sector reform.

The water management system in Grenada is fragmented and lacking a coherent, overarching approach. Fragmentation results mainly because 14 statutes control specific aspects of water management. Additionally, long-range (meaning multi-decade) planning was not present in any part of the system, although actors tended to keep at least a mental list of 'what needs done' to prioritize actions. NAWASA has the legal task of supplying water throughout the island and was generally viewed as the overwhelmingly dominant actor in the water sector. NAWASA is administratively within of the Ministry of Works, but operates similarly to a business, in that it recovers 100% of its operating costs from water tariffs. Revenue is sufficient to cover its operating expenses, but NAWASA depends on foreign assistance to fund capital improvements. Unlike a typical business, NAWASA must contend with political resistance to raising water tariffs and is vulnerable to political manipulation from above. NAWASA also operates as a monopoly. The identity of NAWASA is remarkably customer-oriented and management of the company is relatively healthy and adaptable. However, NAWASA is limited in its relatively narrow legal mandate as a water service provider.

Water sector reform is the term given to an ongoing effort to transform the water management system from a fragmented system into a holistic, integrated, and transparent system. As a first step, a

[36] In this study, I surveyed six communities that experience substantial water shortages: Calliste, Kafé Beau Hill, Mont Tout, Munich, La Potre, and Mt Airy. However, while exploring the island searching for survey communities, I encountered other communities experiencing water shortages. In general, the proportion of communities experiencing water shortage is small and in decline.

new water policy was adopted by the Grenadian government in 2007, which retains NAWASA as a water provider, but adds independent oversight of NAWASA and consolidates and strengthens water resources management in a new administrative body. However, Grenada has yet to adopt legislation to supersede the existing patchwork of legislation, leaving the 2007 water policy an essentially academic document without legal power.

In terms of the ball in cup analogy, Grenadian water supply and Grenadian water management are depicted in Figure 4.22. Grenadian water supply exhibits low resilience, in that it is vulnerable to shortages in times of low precipitation and episodes of dirty water during times of high precipitation and after maintenance operations. In other words, it takes only a slight disturbance to move the system between stability domains. In contrast, Grenadian water management exhibits high resilience, in that it persists under the existing 14-statute legal framework and is unable to transform to the arrangement called for under the 2007 water policy. The persistence of the low resilience character of the water supply level is linked to the persistence of the current, fragmented water management regime; if water management operated in an integrated, holistic fashion, the water supply would likely be more resilient, in a positive way, than it is today.

Traditional water management and interventions typically focus directly on raising the sides of the 'normal water supply' cup at the water supply level, often by improving infrastructure. While sometimes effective, this approach fails to recognize or address underlying issues. The focus of this study is to explain why the water management system has been reluctant to transform and how to coax it into doing so. In particular, moving the system away from the existing arrangement and to the 2007 water policy domain involves passage of legislation to supersede the existing patchwork of legislation and is a primary topic of discussion in the next chapter, Traps and Transformations.

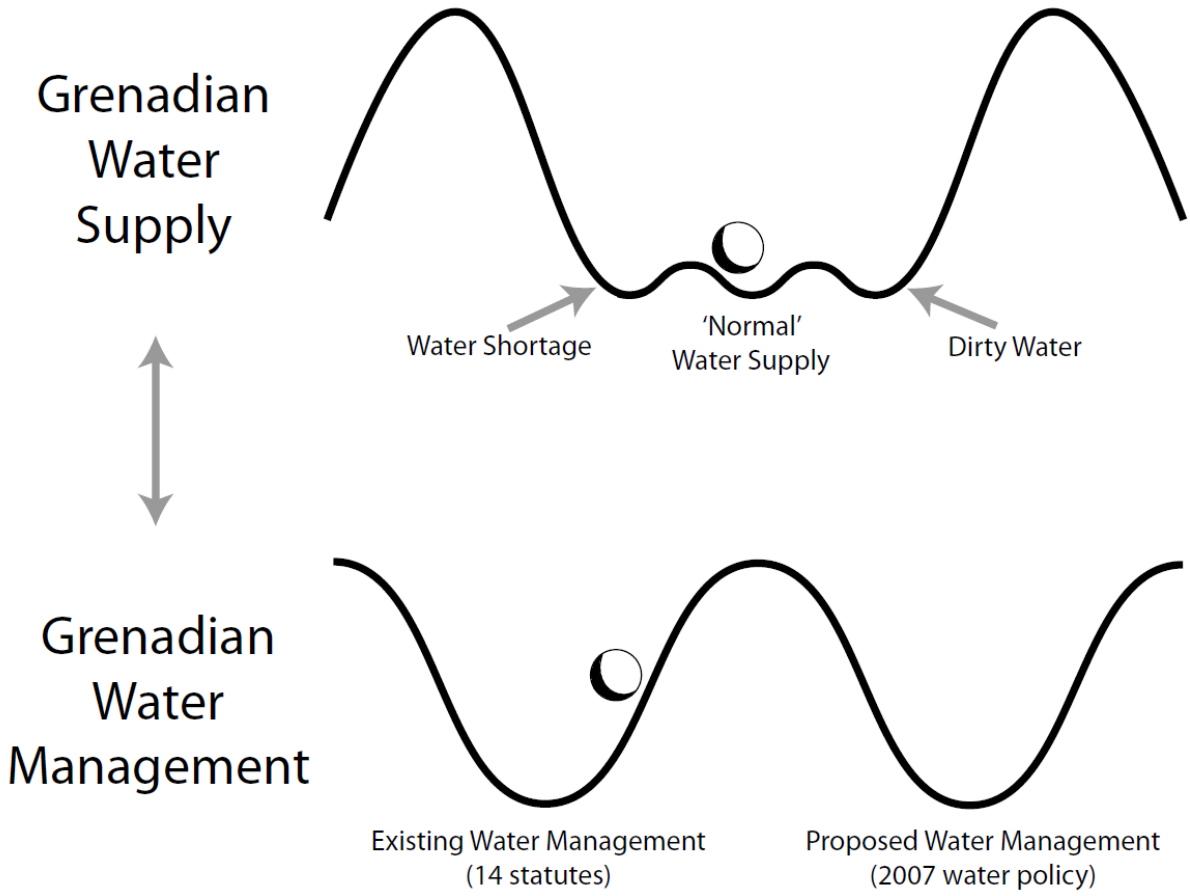


Figure 4.22. Grenadian water supply and Grenadian water management depicted in a ball in cup heuristic.

Chapter 5
Traps and Transformations

This is the second of three chapters which present and discuss study results. Chapter 4 developed a foundational understanding of the case study as it existed in 2012. This chapter explains what is going right with transformation of water management. Chapter 6 will explain what is going wrong with this transformation and suggest what should be done about it. The following three sections answer the first three research questions by developing and applying frameworks to determine (a) the existence and extent of maladaptive system traps, (b) transformations in Grenadian water management, and (c) the effectiveness of intervention efforts in fostering transformability.

A key point of the next three chapters is my use of the Kingdon (1995 [2003]) three-streams framework to judge important aspects of my results. My rationale for choosing the three-streams framework, rather than the many potential alternatives in the academic literature, was threefold. First, key transformation literature has already used and endorsed the three-streams to help explain transformation (see Table 2.2). Second, the three-streams model was developed to explain legislative action and agendas (Kingdon 1995 [2003]), which was particularly applicable to my case study. Third, I spent two months trying, unsuccessfully, to explain my dataset relative to various 'networks and bridging organizations' concepts. The 'a-ha moment' of my analysis came when I applied the three-streams framework, which explained my data well. To be clear, I do not claim the three-streams framework is the only valid approach to explain transformation of social-ecological systems. Alternative approaches may also be effective and might include the advocacy coalition framework (Sabatier 1987) and punctuated equilibrium theory (Baumgartner and Jones 1991). However, I do claim the three-streams framework is valid, reputable, and the approach that provided the best explanation of my data among those with which I am familiar.

5.1 Maladaptive System Traps

This section evaluates Grenadian water management with regard to the presence of SES traps, develops an evaluation framework to assess rigidity traps, and applies the framework to answer the first research question:

1. To what extent is Grenadian water management in a trap?

Maladaptive system traps were defined in Section 2.2.1 as being “a persistent and undesirable state,” while acknowledging both *persistent* and *undesirable* are relative terms. Undesirability of the

current system, described throughout this chapter,[37] was evident from widespread discontent among water professionals over fragmentation of water management responsibilities and poor transparency. 'Persistence' of Grenadian water management was judged using five questions developed in Section 3.2.1, answered in the next five subsections. Section 5.1.6 proposes and applies a method for describing the extent of a given trap and answers the first research question.

Table 5.1 provides a summary of the answers to the five questions regarding persistence. I include this table at the outset to allow readers the option to gain an overview of the bulk of the chapter.

Table 5.1. Summary of answers to five key questions regarding Research Question #1.

Key questions regarding Research Question #1		Summaries of answers to key questions	See Section
1	Had the system, or individual adaptive cycles within the system, remained in one state for a long period, relative to other system components?	Yes. The fundamental structure of the system was persistent.	5.1.1
2	Did formal attempts to improve the system, such as implementing IWRM or conducting capacity-building exercises, tend to lose momentum and fail? Why?	Yes. They failed due to an inability to seize windows of opportunity.	5.1.2
3	Was 'progress' (e.g., positive system change) being stifled via panarchy influences such as political factors, funding shortfalls, or key personnel or organizations?	Yes. Funding shortfalls and political factors were blamed for blocking system change.	5.1.3
4	Did stakeholders believe change was necessary or possible?	Most, but not all, stakeholders felt change was necessary. Stakeholders had varying views on the potential to accomplish change, although most were optimistic.	5.1.4
5	What ideas did study participants have regarding rigidity of water management?	Some interviewees felt change was easily impeded by government leaders.	5.1.5

[37] The resident experience with regard to water can also be considered an undesirable aspect of current water management. However, interview and document review data focused on fragmentation of water management responsibilities as 'the problem.' The impact of water management on residents was largely implied rather than stated and tangential to the first three research questions. I return to the issue of resident experience in Chapter 6.

5.1.1 System Persistence

Interview and document review data indicate the Grenadian water management system was persistent with regard to its structure. In Chapter 4, I discussed interview and document review data, which described Grenadian water management as a patchwork of fragmented and overlapping statutory responsibilities and lacking any overarching, coordinating management. I found consistent evidence, particularly in interviews, that this characterization had not changed since at least 1990.[38]

Interview participant #16 provided a contrasting view on system persistence that was unique among views expressed by other participants and in documents reviewed. Interviewee #16 explained the ruling political party was free to arrange Ministries in creative ways to provide some measure of integration. For example, the former ruling New National Party (NNP) government (1995-2008) administratively arranged for most of the ministries with water management responsibilities to be under the direction of one Minister, Gregory Bowen. Bowen directed the Ministries of Agriculture (which includes the Divisions of Forestry and Land Use); Public Utilities (which contained NAWASA); Fisheries, Lands, and Energy; and Marketing. Although the statutory fragmentation of water management responsibilities was persistent, consolidating many Ministries under one Minister provided some degree of integration of management of the water sector.

While the views of interviewee #16 seem plausible, they were not shared by other interviewees, supported by document review data, or any academic literature to the best of my knowledge. Ten interviewees from diverse perspectives acknowledged fragmentation of the water sector as a problem and none, other than interviewee #16, expressed a view that ministerial arrangements affected fragmentation of Grenadian water management. The effect of arranging Ministries to deal with fragmentation of water management was not considered in any document reviewed for this study, and to my knowledge has not been proposed in the academic literature as a strategy to attain integration of water resources management. Furthermore, an assessment report of IWRM capacity in Grenada, published toward the end of the 1995-2008 NNP reign, viewed Grenadian water management disapprovingly (UN-ECLAC 2007).

Regardless of the potential for ministerial arrangement to overcome fragmentation of water management, ministry arrangements were not stable. Structural arrangements for government Ministries were not legislated; they were simply left to the discretion of the ruling party. Following the 2008 elections, a new government took power and immediately rearranged the Ministries (Grenada Today 2008). In spite of the occasional rearrangement of government Ministries, the statutory fragmentation of Grenadian water management has changed little since at least 1990 and

[38] See Section 5.2.1, Historical Transformations.

was the object of water sector reform efforts. Section 5.2.1 provides additional discussion of the historical stability of Grenadian water management.

5.1.2 Failure of Interventions to Precipitate Change

Interview and document review data indicated sustained and well organized attempts to improve the Grenadian water management system.[39] Seven interviewees cited specific capacity-building efforts as especially influential on the thinking among water professionals in Grenada (Section 5.1.5). Nevertheless, capacity-building efforts failed to precipitate structural change in the system.

In the eyes of many interview participants, particularly #2, 5, 6, 12, and 14, achieving water sector reform presented a clear path to transform Grenadian water management. Water sector reform began in 2007 as a response to an EU requirement for Grenada to create and adopt a new water policy to receive $20 million EC ($7.4 million CAN) to fund the Southern Grenada Water Supply Project (Section 4.3). A new water policy was developed and formally adopted by the Grenada Legislature in 2007 to satisfy the EU requirement (Government of Grenada 2007c). However, implementation of provisions in the new policy depended on passage of legislation to supersede the existing patchwork of statutes and redefine how the water sector functions, which did not occur.

Regional capacity-building efforts focused much of their effort in Grenada to sensitize the water sector to the merit of aspects of the 2007 water policy and build capacity to implement it. Seven interview participants claimed these efforts raised awareness among water professionals of benefits to reforming the water sector and stimulated enthusiasm for change among many system actors.[40] Interviewee #1 discussed development of the Grenada Water Information System online resource (CARIWIN 2008)[41] as a significant contribution to the capacity of Grenada to implement IWRM.

Support for water sector reform was unanimous among stakeholders I interviewed, except for residents, who were unaware of it, and politicians. Notably, all seven of the persons I interviewed in NAWASA were supportive of water sector reform, to varying degrees. This is despite aspects of the 2007 water policy that call for new oversight of NAWASA and the creation of a water resources management entity which, at least on paper, would remove NAWASA's authority for water resources management. Interviewees within NAWASA, #9 and #10, provided effective insight to their

[39] Discussion throughout Chapters 4-7, especially in Section 4.3, provides details of attempts to improve Grenadian water management, most of which promoted water sector reform directly or indirectly.
[40] As stated in Chapter 4, I use the term 'stakeholder' to denote all entities with an interest in Grenadian water management. I use the term 'actor' to denote stakeholders who may affect Grenadian water management.
[41] The Grenada Water Information System webpage only supports the Internet Explorer web browser.

perspective and rationale for supporting water sector reform. During a discussion of the pros and cons of the policy, these interviewees stated:

> Interviewee #10: Generally, I think NAWASA stands to benefit from [water sector reform]. It takes a lot of baggage off from us. Baggage that we do not necessarily need to perform.
>
> Interviewee #9: We collect water, we treat it, we distribute it. That is what we do.
>
> Interviewee #10: That is what we are concentrating on.

In the same discussion:

> Interviewee #10: NAWASA does not have the manpower and finances or the mandate to manage water resources.

Interviewee #15, who was in the Grenadian government but not within NAWASA, was especially articulate with regard to the NAWASA rationale for supporting water sector reform. This interviewee provided a succinct explanation for support within NAWASA that was consistent with views expressed by other interviewees within NAWASA (#7, 9, 10, and 12). Interviewee #15 stated:

> Because they want it. They very much want it. I spoke to Chris Husbands (General Manager of NAWASA) and Terrance Smith (Chairman of NAWASA's Board of Directors). Both of them recognized very much the need for an independent regulatory body with respect to water management that is separate and apart from the current role NAWASA plays. And I think that from NAWASA's perspective allocating the resources towards both providing households with water and self regulating how much water is taken, from where etc. has been a burden to them. They would rather pump their funds into addressing demands and the needs for potable water and not worrying about... how much is being produced by watersheds, how is that being used, how many streams are being tapped, are streams below a certain level being tapped or not, how much water can we anticipate is going to be used in the near future, how can we predict and manage that better, et cetera, et cetera. Setting those kinds of numbers and priorities is a real strain for them. So they are very positive and supportive of (the water policy).

Additional interviews with NAWASA personnel led me to summarize the NAWASA view, in my own words, as:

> We are a water company, that is our identity. We are good at drawing water from the environment, cleaning it, and delivering it to customers for a reasonable fee. That is what we do. We have nothing to hide. We are not in the business of water resources management. If water sector reform lets us focus on what we do, while managing the water resource better, then we are all for it. We will be rid of the on-paper responsibility for resource management and we could even stand to benefit from good water resource management. Just so long as we do not have to fund it and it is not too bureaucratically heavy.

Despite the adoption of the 2007 water policy and widespread support for reforms among water professionals, interviewees noted that no legislation had been passed to support the new policy and maintained the fundamental, fragmented structure of Grenadian water management did not change. In discussing this point, interviewee #8 stated:

> There are a lot of documents going around, some I am not even aware of. These documents, when not backed up with legislation, might as well not exist. You have to have the legislation.

Interviewee #2 felt encouraged that a discussion about IWRM exists, but did not see any impact on management, adding "Concrete things aren't there. No stakeholder group, nothing formal beyond a plan. There are lots of tools, but not much construction."

Failure to pass water sector reform legislation was not for lack of opportunity. Two brief opportunities occurred, termed 'windows of opportunity' in the transformation literature (Section 2.2.2.3; Kingdon 1995 [2003]; Olsson, Folke, and Hahn 2004), but were not seized by reform proponents. First, interviewees #2, 7, and 14 described the circumstances that appeared to come together in 2008. Interviewee #14 summarized the situation, which I paraphrase here as:[42]

> We were very close to passing water sector reform in 2007-2008. There was money for it, a plan for it based on the (2007) water policy, draft legislation, and a detailed structure authored by Chandra Madramootoo. All that was needed was senior management to set it up. Then the election came (in 2008) and with it a change of government. This was followed by the global financial crisis (of 2008).

Interviewee #2 explained the political change from the New National Party (NNP) to the New Democratic Congress (NDC) following the July 2008 elections could have easily derailed changes in water management, but it did not. Notably, the new NDC government appointed Terrence Smith as Chair to NAWASA's Board of Directors, who was a member of the GWP-C steering committee and regarded by seven interviewees as being in favor of water sector reform. However, interviewee #2 explained that changing leadership resets the process of educating key persons in leadership to the need for change, which delayed political action. Interviewee #14 noted the delay came at an unfortunate time, as funding within the government became more restricted following the outset of a global economic recession in September 2008.

The second missed window of opportunity to pass water sector reform legislation occurred in the wake of a severe drought in 2009-2010. According to Farrell, Trotman, and Cox (2010),

[42] I did not audio record my interview with participant #14 and was unable to capture a direct quote. However, the participant confirmed the accuracy of my notes on our interview and provided additional detail. Therefore, the paraphrase provided is not a direct quote, but the participant has acknowledged it as an accurate representation of the content of our conversation.

precipitation at Maurice Bishop International Airport during the drought was the lowest on record. These authors report precipitation was 50 percent of normal in March – September 2009; between 19 and 37 percent of normal in October 2009 – January 2010; and in February 2010, essentially no precipitation was observed, representing 0.03 percent of normal precipitation. Farrell, Trotman, and Cox (2010) further document potable water production decreased due to the drought by up to 60% from normal at some water treatment plants. At the same time, NAWASA shipped 340,000 L (90,000 gal) of water to the neighboring island of Carriacou and brush fires increased 150% from a normal year, many of which were extinguished with potable water. Both of these later factors further reduced water supply.

Water shortages caused by the drought resulted in widespread and prolonged water rationing and presented a crisis which created a sense of urgency for improving water security.[43] However, the drought ended in mid-2010 with no legislative progress with regard to water sector reform. Interview participant #2 commented: "The time to push change through the legislature was when the taps were dry. Residents' memory is short and the opportunity has passed."

Interview participants felt funding issues and political problems in the NDC ruling party prevented passage of water sector reform legislation during the second window of opportunity. Interview participants #8 and #14 discussed funding as the most important sticking point which inhibited legislation. Water sector reform was perceived as expensive to implement in the near term, as it would have created government responsibilities for water resources management and service regulation without a mechanism to expand revenue. Interviewee #14, as quoted above, maintained the increased government expense was not a problem in 2007-08, but funding became a critical issue in the wake of the 2008 financial crisis and ensuing recession. Interview participants #2 and #7 believed individuals in the ruling party wanted to pass water sector reform, but felt political in-fighting and dysfunction in the ruling party diverted precious attention from the issue. In essence, the second window of opportunity closed without passage of water sector reform legislation due to unfortunate panarchy forces which prevented funding, and perhaps due to a dysfunctional political climate in Grenada.

As of 2012, prospects for passing water sector reform legislation had grown more difficult. Funding for reform remained a problem, capacity building through the CARIWIN project ended, and memory of any promises and good intentions toward passing water sector reform legislation tended to

[43] Post-hazard/disaster environments commonly present windows of opportunity such as this. Birkmann et al. (2008) provide evidence that this is common in a post-hazard/disaster environment, and that such windows eventually close.

fade. Perhaps most important, by 2012 political interest in water sector reform had diminished. I discussed this latter point at length with Interview Participant #7; here is one excerpt from my interview:

> Question: Aside from the funding issue, what else is preventing legislation [as of 2012]?
>
> Participant #7: I believe the former Minister [of Works], Mr. Gilbert, had developed a thorough understanding of the issues and would have been a clear ally [to pass water sector reform legislation]. But you know with the politics he was fired and so on [in October 2011].

The participant continued,

> I don't think [the new Minister] or this government, with all of their, shall we just call them challenges, I doubt very much in the current government scenario.

The interview conversation continued:

> Follow-up question: Do you see a way forward or are we just stuck?
>
> Participant response: Right now the ruling party is at war with itself. I cannot see Minister [of Works] Modeste having the time or interest in promoting this. Elections are next year [2013], we may get some sort of reconstituted version of the existing ruling party with stronger leadership. Or we may get the opposition party [NNP].
>
> My own personal view is [NNP] will not have much interest in pursuing this. Because it is just too challenging and difficult. The water policy was done under [NNP, before they were defeated by the current NDC party in 2008], but it was done in a hurry and done to free up $20 million [EC, $7.4 million CAD] in funding. It is not particularly attractive as projects go. It is not the kind of thing where you can tie a ribbon from here to there and have an opening ceremony to cut the ribbon and take pictures. That is not water sector reform.

Comments from two additional interview participants spoke to the general difficulty in passing water sector reform legislation. Interview participant #2 said "the costs are high and immediate. Returns are low and largely in the future. Our political concerns are immediate and numerous." When asked why legislation is difficult in Grenada, Participant #11 replied, "It isn't. It just is for environmental legislation. Environmental issues are not seen as a big deal compared to other issues such as criminal issues."

To summarize the discussion in Section 5.1.2, formal attempts to improve the system by passing water sector reform lost momentum and were in danger of failure because of an inability to seize windows of opportunity. Even when events unfold favorably, windows of opportunity tended to be brief and the key actors in the system were either unprepared or acted improperly to seize them. With each missed opportunity, time passes and the system tended to become less prepared for the next window of opportunity. In the Gunderson (2000) ball and cup heuristic of social-ecological

system stability (Figure 1.2), the state of the system (the ball) moves slowly and the lip of the cup dividing stability domains only lowers to a passable height for a short period of time.

5.1.3 Influences of Panarchy

In explaining the failure of system interventions to precipitate change, Section 5.1.2 documents three panarchy influences which contributed to inhibiting water sector reform legislation. First, political instability caused by a change in ruling party from NNP to NDC delayed the passage of water sector reform legislation at a critical time. Second, funding shortfalls, caused indirectly by the global financial downturn of 2008, eroded political will to pass water sector reform legislation. Third, ineffectiveness within the NDC political party may also have stifled political interest in passing water sector reform legislation.

The panarchy influence of residents on water sector reform was negligible and was a key missing driver for water sector reform. Interview participant #2 noted a lack of a push for water sector reform from residents and cited it as one factor preventing change in Grenadian water management. As was considered more fully in Section 4.1, discussion with residents and survey data show residents were not against water sector reform, but rather, were unaware of it. First, the Grenada-based NGO community has largely failed to advocate for residents on water issues and residents themselves do not view NGOs as an effective ally in addressing water problems.[44] Second, not one newspaper story collected during the study described any aspect of water sector reform or the issue of fragmentation of water management,[45] suggesting residents may be unaware of any potential benefits of water sector reform. Third, survey data show between 49% and 67% of residents in the four classifications were satisfied with NAWASA, suggesting most residents are content with the existing system.[46] However, with regard to an open-ended question to describe what they would change about water management in Grenada, one survey respondent expressed frustration at not knowing enough to answer the question, stating:

> I think the biggest problem here in Grenada, be it NAWASA, the government, the electricity utility, they don't educate the public about why things are the way they are.

Interview participants #2 and #18 indicated cultural factors also contributed to a lack resident influence on water sector reform. Interview participant #2 responded bluntly when asked if residents were pushing for any kind of water resources planning, [the resident perspective is essentially] "You've got to be joking, pass the next rum punch, please." Beyond simple disinterest in water

[44] See Section 4.1.7 Issues of Empowerment and especially Figure 4.18.
[45] See Section 4.1.7 Issues of Empowerment
[46] See Section 4.1.6 Cost of Water Service and Resident Satisfaction with NAWASA and Figure 4.17.

management, interviewee #18 offered robust commentary on a lack of resident involvement being related to a pervasive top-down social environment in Grenada which has origins in plantation rule during slavery and colonial times. Interviewee #18's explanation suggests residents may not be "looking up" to people in power for ways to contribute to water management, and are reflected in the words of one resident survey participant, "In Grenada here they don't take advice from small people." After describing why residents may not be "looking up" for opportunities to participate, interview participant #18 continued the discussion on the top-down character of Grenadian society and offered additional insight as to why professionals higher in the system may not necessarily be "looking down" for input from residents:

> the sad thing is when people (from Grenada) grow up and pass through university, they feel they have nothing (remaining) to learn. They are brought up that if you are in a position to give to others, they have to listen. [Grenadians] have been accustomed to that sort of autocratic behavior. And it is entrenched very deeply into the whole situation we have going on.

Questionnaire data reveal most residents regard NAWASA as the beginning and the end of all things water in Grenada (Section 4.1). I told one interview participant within NAWASA, #18, the questionnaire data revealed overwhelmingly that residents identify NAWASA as the single entity which handles water issues in Grenada and I was unable to locate any NGOs which champion the resident voice with regard to water management. Participant #18 replied:

> I would say they are right about this. We are the 'go to.' And we have accepted that we are the go to. In November [2011] we had a media briefing and we asked them to use us as the ultimate resource for anything water related in Grenada. We are not just a bunch of pipe fitters, we have engineers and many other professionals and we want them to use us to get the correct water information.

As long as residents consider NAWASA to be 'all things water,' it is reasonable they would be unaware of fragmentation of the water sector and the need for water sector reform.

While conducting interviews I sensed many residents had potential to create political pressure to legislate water sector reform *if they understood the need for it.* Although I did not ask a specific question in this regard, some of the questionnaire data support my perception. First, I found many residents (between 21% and 27% of respondents in each of the four classifications) were unsatisfied with NAWASA. Many of these residents engaged me in conversation far beyond the scope of the questionnaire and expressed substantial interest in water issues. Second, I found many residents (between 7% and 29% of respondents in each of the four classifications) already felt comfortable contacting their elected representatives if they had problems with their water. This finding led me to suspect that a grass-roots campaign to educate residents and promote legislation to reform the water

sector could motivate a substantial number of residents to engage their elected representatives to support reform legislation. However, no such effort to mobilize residents existed and residents were completely unaware of water sector reform (Section 4.1).

5.1.4 Believing in Change

Evidence from interviews and the document review indicates Grenada-based water and NGO professionals generally accepted the idea that changing the structure of water management was desirable. Interviewee #16, who was in the political field, expressed a nuanced view in this regard. This interviewee felt the existing framework of water sector legislation was desirable, but stressed the need to govern the existing system in a better manner than was being done (in 2012). Interviewee #16 was the only one who felt the existing system should not be restructured. However, some stakeholders were relatively neutral on the issue, as I discuss below.

Patterns emerged regarding which stakeholders supported change most passionately and what they felt change should look like. Water professionals outside of NAWASA were the most enthusiastic supporters of 'water sector reform,'[47] with very few exceptions. Within NAWASA, interviewees perceived problems with current water management arrangements such as conflicts of interest and the absence of holistic management of water resources. These professionals were all agreeable to water sector reform, albeit with less enthusiasm than water professionals outside NAWASA were. In interviews, NGO professionals expressed displeasure with "A disjointed and misguided management system." as stated by interviewee #18. However, NGO professionals expressed little enthusiasm for water sector reform and, in interviews, discussed issues quite different from those addressed by water sector reform. Interviewee #17 went as far as to say enforcing water sector reform would be a huge problem and passing it would not mean anything. Residents who participated in the questionnaire were almost completely unaware of the existence of water management beyond NAWASA and no respondent expressed any opinion or knowledge of attempts to change how water was managed in Grenada[48] (see Section 5.1.3).

Stakeholders expressed a range of views on the potential for change in Grenadian water management. Interviewee #3 felt the Grenadian Legislature would act if funding for water sector

[47] Water sector reform was the term used by interviewees to describe potential or proposed legislation with the specific intent of implementing the 2007 water policy. See Section 4.3.

[48] The questionnaire did not directly address water sector reform, but did ask open-ended questions which allowed residents to comment on issues such as water sector reform. Residents were asked, "If you were in charge of all water supply in Grenada, would you try to change anything? If yes, how?" 72% of residents (130 out of 180) stated they would change something and provided 29 specific changes. All of the 29 proposed changes concerned *water service* rather than the institutional arrangements of water resources management.

reform could be secured. Interviewee #2 believed the legislature needed an urgent financial incentive to motivate action, stating "We need a crisis. And this crisis has to have immediate financial and /or economic consequence to inaction." Interviewee #17 felt high-level political will was needed to move Grenadian water management forward. Interviewees #18 and #19, both associated with Grenada-based NGOs, spoke of eroding a societal 'top-down mentality' to bring about change in water management. Conversations I had with interviewees within NAWASA, particularly #7 and #12, illuminated many traits of water sector reform that are undesirable from a political point of view (see Section 5.2.6). These participants felt political action was possible if these politically undesirable aspects of water sector reform can be resolved. Interviewee #10 also discussed aspects of water sector reform which were politically unappealing but did not express optimism for resolving these issues. The interviewee dismissed water sector reform efforts as being, "an academic exercise, just a piece of paper."

At least four documents reflect stakeholder attitudes toward the need and potential for change in the water management. The 2007 water policy (Government of Grenada 2007c) and three documents drafted to support development and implementation of the 2007 water policy (CEHI 2007; Government of Grenada 2007a, 2007b) support the view that change in the water sector is needed, possible, and that water sector reform is the appropriate instrument to bring needed changes. While these reports do provide insight about perceived shortcomings of the existing system and rationale for reforms, it should not come as a surprise that documents drafted to support water sector reform express optimism for it. One academic paper addresses change in water management throughout the Caribbean (Cashman 2012) and supports the view that water sector reform is significant, needed, and very close to happening. No documents reviewed for this study held a pessimistic position with regard to the potential for change in the water sector.

5.1.5 In Their Own Words: Participant Perspectives on Capacity Building

Considerable discussion is provided in Chapter 4 and in preceding sections of this chapter on participant views regarding rigidity in water management. The intent of this subsection is not to repeat or summarize those discussions, but rather to serve as a backstop to those discussions and present additional views relevant to the study not already captured above.

When discussing capacity building to support IWRM in Grenada, participants acknowledged the following efforts as particularly influential on the thinking among water professionals in Grenada:

- GWP-C (interviewees #2, 12, 13, 7, 14),
- various efforts promoted by CEHI, such as the GEF-IWCAM project (interviewees #1, 2, 14),[49]
- the CARIWIN project[50] for promoting IWRM (interviewees #1, 2, 4), and
- financial backing by the UN-FAO[51] (interviewees #2. 7).

However, interviewee #2 expressed skepticism about the product of capacity building efforts. This interviewee said the product of this influence sensitized many people about *the need for* water sector reform, but has not *precipitated the change*, because change is easily impeded by poor leadership. Interviewee #2 also discussed capacity building as having sensitized persons who show up to workshops, but not necessarily the right persons to bring about change.

5.1.6 The Extent of Maladaptive System Traps in Grenadian Water Management

From the above information, summarized in Table 5.1, I conclude Grenadian water management was and is in a maladaptive system trap, defined in Section 2.2.1 as a "persistent and undesirable state," acknowledging that both 'persistent' and 'undesirable' are relative terms. Grenadian water management is 'persistent' in that the basic structure of legislated fragmentation of water management responsibilities has persisted for as long as water has been managed on the island by a government and has resisted attempts to move to a more integrated structure.[52] The 'undesirability' of the system is marked by widespread discontent over fragmentation of water management responsibilities and poor transparency which hinders effective management of water resources. Assignment of 'undesirable' also assumes the current system has negative consequences for resident well being with regard to water, relative to more integrated arrangements.

Holling (2001) defines the 3-axes of potential, connectedness, and resilience in the adaptive cycle framework, which provide the basis for classifying types of maladaptive system traps (see Sections 1.1 and 2.2). Based on the 3-axis adaptive cycle framework I describe the water management system as being in a *rigidity trap*, characterized by high potential, high connectedness, and high resilience. I judge the system has high *potential*, defined in Section 1.1 as determining the limits of what is possible, or the options for the future. Capacity such as accumulated water professionals, an

[49] CEHI is an acronym for the Caribbean Environmental Health Institute. GEF-IWCAM is an acronym for the Global Environment Facility-funded Project on Integrating Watershed and Coastal Areas Management in Small Island Developing States of the Caribbean.
[50] CARIWIN is an acronym for Caribbean Water Initiative.
[51] UN-FAO is an acronym for the United Nations Food and Agriculture Organization.
[52] Interview participant #16 argued that the former ruling political party (NNP) administratively arranged Ministries with complementary water management responsibilities to foster integration of water management. However, such arrangements were not stable and the 'ruling party to ruling party' variability in water management has persisted over time.

established water authority and governance structure, and infrastructure provides many options for how Grenada may manage water resources in the future. I judge the system has high *connectedness*, defined by Holling (2001, p. 394) as "the degree to which a system can control its own destiny," because much of its potential is internal. That is, the system does not need to rely on outside sources to make decisions on water management. Finally, I judge the system has high *resilience* defined in Holling (2001, p. 394) as "how vulnerable the system is to unexpected disturbances and surprises" because the basic structure of the water management system is resistant to attempts to change it. In terms of the Gunderson (2000) 'ball in cup' heuristic, the system resists moving to a new 'cup.'

Despite assigning the academic label 'rigidity trap' to Grenadian water management, system persistence is far from extreme. System persistence is better described as moderate, lasting decades overall and having survived organized attempts to change it in the last 10 years. In addition, the system has showed signs of moving toward transformation. For example, many potential obstacles to transformation are absent or fading. Water managers in different agencies appeared to empathize with one another and were not antagonistic or noticeably territorial, even when they had reason to be. Most stakeholders in the Grenadian water management system, other than some politicians and the public, are knowledgeable of water resources management and the consequences of structural fragmentation in the current system. Most of these stakeholders suggest a solution to transform the system to a more desirable state exists in water sector reform, and this solution has widespread support to varying degrees among water professionals. Many of these characteristics, which suggest a system open to transformation, are a product of capacity building and a testament to the quality of human capital within the system (see further discussion on this topic in Section 5.4.2, Capacity Building). The remaining obstacles which frustrate transformation are political and financial, yet these do not appear to be insurmountable.

Grenadian water management is acknowledged above to be in an undesirable state, but there are many positive aspects and the situation is far from a worst-case scenario. While Chapter 4 documented clear potential to improve water service, most residents enjoy piped connections supplying safe, clean water nearly full time and report water service to be improving. In addition, individual parts of Grenadian water management such as NAWASA and the Ministry of Agriculture are remarkably functional, *within their narrow mandates.* Much potential exists within the existing system, both in built infrastructure and in water professionals working within the system. Unfortunately, because of the legislated fragmentation in the current system, the effectiveness of the whole is less than the sum of the parts.

From the prior two paragraphs it is apparent not all rigidity traps are equal; trapped systems vary in their persistence and in their degree of undesirability. To complicate matters further, neither persistence nor undesirability are static properties. Unfortunately, the academic literature lacks nomenclature to describe trapped systems in detail. There have been no proposed methods or terms to describe the relative severity of a trap, in general terms or in terms of 'persistence' or 'undesirability.' Furthermore, the literature provides no guidance on differentiating a system moving toward greater or lesser undesirability or persistence. As discussed in Section 2.2.6, this gap prevents differentiating severely trapped systems from more manageable systems. It also hinders assessing the effectiveness of interventions to promote transformation and important trends regarding movement of a system into or out of a trap. I propose the following model to describe trapped systems and to help frame discussion of how to free such systems.

1. Explicitly identify the type of trap a system is in
   and then describe:
2. The degree of persistence of the system
3. If, and how, persistence is changing
4. The degree of undesirability of the system
5. If, and how, undesirability is changing

Applying this model to Grenadian water management, the system is (1) in a rigidity trap, (2) characterized by moderate (3) but weakening persistence (the current system has lasted decades, but showing signs of potential change). In addition, the system is (4) moderately undesirable and (5) stable in this regard. This description helps identify Grenadian water management as a prime candidate for breaking the rigidity trap and helps frame the discussion of how we might do so (Chapter 6).

5.2 Transformability

This section evaluates Grenadian water management with regard to transformability, by developing an evaluation framework to assess transformability and applying the framework to answer the second research question:

2. To what extent is Grenadian water management transformable?

A series of six questions were developed and presented in section 3.2.1 to judge the transformability of Grenadian water management. Each of these six questions is answered in the following six subsections. In the final subsection, a framework, based on the Olsson 3-phase framework of

transformation (Olsson, Folke, and Hahn 2004), is presented for assessing and describing the extent of transformability of a system and applied to Grenadian water management.

5.2.1 Historical transformations

Five key questions[53] were developed in Section 3.2.1 to assess historical transformations in water management systems. After applying these questions to Grenadian water management, I was unable to identify any historical transformations. The structure of the present system had not changed since at least 1990 when NAWASA was founded and the fragmented and incomplete character of water management may have originated during British colonial rule.[54] Rather than being a process of transformation, interview participant #14 described development in water management as an evolution rather than a product of sudden change. Review of the 14 statutes relevant to water management also suggests the current arrangement is the product of ad hoc legislation being enacted to meet perceived needs which rose to political prominence over time (Section 4.2.1).

Although past transformations in water management were not detected, relatively recent developments contributed to transformability of the system. Data relevant to this recent change in transformability are presented in discussions of SES traps (Section 5.1), the water management system (Section 4.2.3), interventions to improve transformability (Section 5.3.2), and points of breakdown in transformation (Chapter 6). Rather than repeating other discussions, Table 5.2 below provides a brief summary of relevant discussions to each of the five key questions for judging historical transformations.

[53] These 5 'key questions' are intended to verify and describe historical transformations, which together will help answer the first of six questions intended to judge the transformability of Grenadian water management.
[54] NAWASA was legislated into existence in 1990 and became the central fixture in Grenadian water management (see Section 4.2.2). However, interview participant #14 described the founding of NAWASA as "window dressing" what already existed as a water authority, especially from a water resources management perspective. The founding of NAWASA did change how water business was done, but not how the water resource was managed.

Table 5.2. Summary of discussions relevant to judging historical transformations of Grenadian water management.

Key questions for Judging Historical Transformations	Answer	Relevant Sections
Have new named and identifiable entities emerged which were intended to facilitate a positive and meaningful change in how water was managed?	Yes. NGOs such as GWP-C, CEHI, and CARIWIN emerged to conduct capacity building efforts and advocate for changes to water management	4.2.3 5.1.5
Had attempts at facilitating a positive meaningful change in how water was managed failed or succeeded?	Failed.	5.1.5 5.3.2
To what degree had these new entities displayed flexibility, adaptiveness, and an ability to foster incremental and transformative change in how water is managed?	Capacity-building efforts did foster incremental improvements of transformability, but failed to be flexible and adapt in critical ways.	4.2.3 5.3.2 Chapter 6
To what degree had these new entities improved water supply conditions?	Minimal.	5.1.5 4.1
Had the new entities become a stable part of water management in Grenada?	GWP-C and CEHI established a long-term influence on water professionals, but without a water management role. GEF-IWCAM and CARIWIN were finite projects.	4.2.3 5.1.2

5.2.2 Fresh Ideas

Fresh ideas and perspectives relevant to water management were plentiful in some portions of the Grenadian water management system. Notably, IWRM ideals underpin significant parts of the 2007 water policy (Government of Grenada 2007c). In addition, some documents were written specifically to develop and implement IWRM in Grenada (CEHI 2001, 2007; Government of Grenada 2007b, 2007a; CARIWIN 2009a; Thompson, Senecal, and Madramootoo 2012). Interview data revealed a concomitant emergence of enthusiasm for IWRM among water professionals. Interviewees #1, 2, 6, 7, and 14 credited relatively highly funded regional and international capacity-building efforts for sensitizing water sector professionals to IWRM (see Section 5.1.5). These projects and efforts offered

"free" water projects, management tools, and training of Grenada- and Caribbean- based water sector professionals. Regional capacity-building efforts directly enlisted the assistance of water professionals in Grenada and throughout the Caribbean, forming a core of enthusiastic IWRM supporters.

Knowledge and support for IWRM flowed from the core supporters and capacity-building efforts, described above, to other parts of the water management system with variable success. The strongest IWRM supporters were generally outside of NAWASA, but these persons persuaded professionals within NAWASA to recognize potential value of IWRM in Grenada. All seven interviewees within NAWASA supported IWRM to varying degrees. However, support for IWRM among these interviewees appeared to be conditional on IWRM serving to help NAWASA achieve its mission, and not be a financial or administrative burden. Comments made by interview participants #9 and 10, discussed in Section 5.1.2, expressed guarded optimism regarding IWRM which helped me articulate the rationale for NAWASA's support for IWRM. Furthermore to this point, NAWASA does not appear to be planning any type of IWRM implementation in the near future. Mention of both IWRM and the 2007 Grenada water policy (Government of Grenada 2007c) are notably absent from the NAWASA 5-year strategic plan (NAWASA 2009). Relative to the penetration of IWRM concepts and support within NAWASA, the political level was much less affected, as discussed in Section 5.1.1. Finally, residents had no detectable knowledge or influence of IWRM or water sector reform.

A second source of fresh ideas and perspectives within the system was the relatively recent empowerment of young, energetic, female voices with prominent water and environmental management roles. Historically, positions of power in Grenadian businesses and Ministries were delegated via gender and seniority to eschew foreign influence and ensure subordination. One anonymous resident I spoke with at length claimed to have formerly worked for NAWASA and described great frustration with seniority-based hiring practices when he worked at NAWASA, many years before:

> The system doesn't attract youth. It rewards seniority. If you leave to get educated and return you lose ground to those that stayed. And then you are over qualified compared to those above you. You can try to change it and you just keep hitting walls. After a while you either leave or learn to stay quiet.

The anonymous survey participant stressed the problem was not isolated to NAWASA and exists throughout the island, "Other places your supervisor can see your performance and pass you on to a higher level. Here you die with your talents." Interview participant #5 confirmed the anonymous resident account of NAWASA hiring practices:

> That's right, and that's exactly the case of how it is in NAWASA [as of 2010]. I encountered that time and time again, people who were highly educated and motivated just unable to make a difference because they come up against a wall of seniority.

When asked about the resident comments above, participant #15 provided additional insight:

> Yes. I would agree with that 110%. I think that mediocrity is the order of the day. And when you return [from pursuing foreign education] you just have to pay your dues. [People in positions of power] figure that you must have been coasting out there, carousing. And now you want to come back and, having lived foreign, you want to come and show everybody [how things work]. And as a result there is a lot of hostility. Particularly from people who did not get the opportunity [to study abroad]. Never mind they don't have the capacity to do it. You are quite right. And I think that contributes a lot to why the government is so slow.
>
> It is important, because as a mechanism, you would anticipate that the people who are returning [from studying abroad] would be important catalysts for moving things forward. And this is not the case. This is absolutely not the case.

Participant # 15 provided two examples of talented young professionals in solid waste management who pursued education abroad and had difficulty after returning to Grenada. This participant later continued, "Change, anywhere in the world, change is resisted. But people here in particular. And having gone through a revolution[55] [contributes to] a suspicion of people who come from outside."

Later in data collection, I observed a notable exception to the above-perceived pattern of seniority- and gender-based hiring, suspicion of outsiders, and resistance to change. In 2010, consultants hired to support institutional development as part of the EU-funded Southern Grenada Water Supply Project (see Section 4.2.2) recognized the existing customer relations structure of NAWASA was unsustainable and recommended the addition of a communications unit in the organizational structure of NAWASA to facilitate improved customer relations (NIRAS 2010). Rather than being received with skepticism and hostility as an 'outsider' opinion, the consultant findings precipitated reorganization within NAWASA. NAWASA took decisive action and added a communications unit. In addition, NAWASA went much further toward genuine change by hiring a young, energetic, female professional from outside the organization to manage the new department. This person had a vibrant personality, did not hesitate to speak when she disagreed, was foreign educated, and was previously dismissed from another Ministry, allegedly for challenging the status quo.

[55] Grenadian leadership was toppled by a violent coup in 1981 that claimed the lives of Prime Minister Maurice Bishop and much of his Cabinet. The coup was widely perceived to be the product of a Soviet and Cuban attempt to spread communism to Grenada. The coup prompted swift military response from the United States and a coalition of Caribbean forces that purged Cuban military forces from Grenada and restored democratic rule.

Within one year of hiring the new communications unit manager, NAWASA designed and released a Customer Service Charter. The Charter is a new policy guiding customer relations and promotes NAWASA's "mission of continuous improvement within the organization" (NAWASA 2012a). The Charter outlines a series of policies and standards of service which NAWASA pledges to maintain with customers. The policies and promises described in the Charter are customer-focused, relatively ambitious, highly professional, and go considerably beyond what is offered from other utilities on the island. In addition, since hiring the new communications unit manager, NAWASA began using Facebook, Twitter, a blog, and a YouTube channel to communicate with customers.

5.2.3 Planning

Planning in the Grenadian water management system is addressed in three prior discussions, specifically of water governance (Section 4.2.1), NAWASA (Section 4.2.2), and influences of panarchy (Section 5.1.3). To summarize these discussions, no long-term (decades) or holistic planning of water resources has occurred in Grenadian water management. Resource managers were observed to place little importance on multi-decade planning, but did appear to maintain at least a mental list of 'things that need to be done' to prioritize projects.

One notable advance toward resource planning on a shorter (sub-decade) time scale occurred during the study. In 2009, NAWSA published its first ever planning document, a 5-year strategic plan (NAWASA 2009). The strategic plan is a modest, but significant, first step toward greater use of planning. The topics considered in the strategic plan are appropriate for the scope of NAWASA's water management functions. However, NAWASA is limited by a relatively narrow legal mandate and does not engage in holistic water resources planning, which is reflected in the scope of the strategic plan.

Interview participant #2 added insight to the scope of poor or limited planning, stating a lack of planning is present throughout the Caribbean, is not unique to water resources, and is particularly noticeable in social and institutional planning. Interview participant #2 continued to state governments in the Caribbean have little or no idea if the instruments currently in place, such as laws and government agencies, are adequate for future needs. In the water sector, this participant stressed the capacity for long range planning is also absent:

> For example, take climate change. The discussion right now is all about meteorology. Nobody has transferred that to dialog about what it means for water resources. Grenada, as many other Caribbean islands, is dependent on surface water. As a hydrologist, you could probably do some nice work on what the likely impacts of climate change could be for the surface water resource. But until somebody actually does that, how can we plan for it? We can't.

5.2.4 Is There a Need for Change?

The views of stakeholders regarding the need to change the current system of Grenadian water management are discussed in four prior sections:

- Section 5.1.2 Resistance to Change,
- Section 5.1.3 Influences of Panarchy,
- Section 5.1.4 Believing in Change, and
- Section 5.1.6 The Extent of Maladaptive System Traps in Grenadian water Management.

To summarize these prior discussions, many types of stakeholders[56] acknowledged the need to change the current system of water management in Grenada. There were, however, two notable exceptions. First, residents were disenfranchised with regard to water management beyond their interactions with NAWASA. Second, politicians did not necessarily agree the existing system needed to be changed. Interview participant #16 described flexibility in the current system to allow the ruling political party to bundle multiple Ministries administratively under the direction of one Minister. This interviewee claimed that by arranging Ministries carefully, some degree of integration of decision making is already possible under the existing system. The participant believed good leadership was the key to making the existing system work and therefore change to the structure of the system was not necessary.

5.2.5 Influences of Panarchy

Change in intermediate scale adaptive cycles can serve to enhance transformability of a system or to enhance adaptability and simultaneously decrease transformability.[57] One example of each of these two possibilities was discovered. First, efforts to enhance adaptability within NAWASA were effective and may have unwittingly reduced transformability of the existing system. Second, the existence of an informal network of system actors, particularly at regional conferences, served to facilitate the flow of fresh ideas throughout the system.

NAWASA introduced intermediate adaptive cycles within itself, in the form of limited bureaucratic changes, in a manner similar to what has been observed in the corporate world to foster adaptability (Scheffer and Westley 2007) and in doing so may have unwittingly reduced

[56] The 'many types' of stakeholders referred to are: Researchers, foreign and domestic consultants, persons within the Grenadian government both inside and outside NAWASA, and persons associated with resident-focused NGOs.

[57] By enhancing adaptability, the undesirability of the system is relieved, which often decreases pressure to change the system. See Section 1.1.

transformability of the system.[58] An institutional review of NAWASA was conducted by foreign consultants as part of the Southern Grenada Water Supply Project (NIRAS 2010). The final report of the institutional review recommended a moderate restructuring of the company, including the addition of a Chief Engineer and a Communications Unit. NAWASA acted on both of these recommendations, which have resulted in substantial positive changes in how NAWASA interacts with the public, including adding the Customer Service Charter as described in Section 5.2.2.

Section 4.1.7 documents evidence describing the culture of NAWASA as being focused on continually striving for excellence and improvement with regard to the resident experience with water. Resident opinion from all four groups surveyed shows a widespread perception that water service is improving over time (Section 4.1.2, 4.1.3). It is possible the adaptability of NAWASA, even within its relatively narrow legal mandate, reduces the perceived severity of challenges to the system and dampens the urgency to overhaul the existing structure of water management. Stated another way, the more adaptable NAWASA is, the less apparent the need to restructure or otherwise transform the water sector.

Second, the presence of an informal network of system actors and idea-exchange venues such as workshops and conferences was seen as important to transformability of the Grenadian water management system. Interview participant #10 stated, "It is a small country. There is no official arrangement (of the network of system actors), but everybody knows everybody." Many interview participants cited conferences as the primary arena for informal networks to emerge and operate.

Interview participants #8, 11, and 15 cited conferences, in a general sense, as being a place in which informal groups of system actors mingle, exchange ideas, and learn from one another. Participant #1 cited workshops conducted by the CARIWIN project as being especially notable for the exchange of ideas among system actors. However, these venues were not without problems. Interviewee #1 provided robust description of interactions among water managers within informal networks at workshops and conferences and offered pointed criticism of their interactions; persons holding PhD degrees and coming from larger islands, tended to unjustly assume higher status and 'importance' to the exclusion of persons without advanced degrees and coming from small islands such as Grenada. Interview Participant #2 described the Caribbean water professional community as relatively small, and regularly observed that persons from GWP, CEHI, IWCAM, NAWASA, CWWA, and other regional water managers meet and mingle at the CWWA conferences. Participant

[58] Section 1.1 provides discussion of academic literature on adaptability and transformability and explains how, in the ball-and-cup heuristic, adaptability focuses on keeping the ball in a specific stability domain while transformability does the opposite; it focuses on moving the ball to a new domain.

#2 also noted part of GWP's purpose is to provide an arena to allow this type of group interaction. When asked if this informal group had power, Participant #2 replied the groups had influence, but not power due to their informal nature.

5.2.6 In Their Own Words: Participant Perspectives on Precipitating Change

Considerable discussion is provided in preceding sections and in Chapter 4 on participant views regarding transformability in water management. The intent of this subsection is not to repeat or even to summarize those discussions, but rather to serve as a backstop to those discussions and present additional views relevant to the study not already captured above.

Study participants identified two sources of growing capacity within the water management system to promote positive change. First, Participant #1 described great potential for a Caribbean-wide web platform, similar to the Grenada Water Information System web tool, to allow regional information flow and coordinated development and use of management tools such as mapping suitable zones for specific types of agriculture. Second, I spoke at length with Participant #13 about the ability of NAWASA to engage residents when needed, including soliciting the assistance of a local church to assist NAWASA personnel to clear a water supply dam of debris following a land slide which had rendered the dam and a key water intake inoperable.

In addition to the sources of improving capacity described above, interview participants spoke strongly to the need for good leadership to guide the system through transformation. Participant #5 stated, "First and foremost it is going to take some very high level government will. I've seen that as always being the #1 factor or constraint (to change)." Participant # 1 stated, "You need to have good people in place, starting with leaders. If you have the right system in place, that will attract the right people to promote change." Speaking about change in the agriculture sector, interview participant #4 stated, "It comes at a higher level. Political understanding and will. Acknowledging that up-front costs have a long term payoff."

Discussion with participant #5 illuminated a remarkable and recent change in the adaptability of NAWASA. This participant was concerned about the financial stability of NAWASA:

> Eventually, the company will collapse if it continues to be managed like it was when I was there (2009). It will just run out of money or the government will stop stepping in to subsidize it and say it needs to go through the big shakeup. It can't go on (like this) indefinitely. I'm surprised it hasn't happened yet. When I was there I didn't give them more than a couple of years before something was going to happen.

When I told this participant about relatively recent (since 2009) revenue-increasing measures NAWASA had taken, including raising water tariffs by approximately one third, clamping down on delinquent accounts, and removing public standpipes, the participant observed:

> These are huge steps in the right direction and a clear indication that [NAWASA General Manager] Christopher Husbands has been empowered to overcome some of internal obstacles to moving the company forward.

The 2010 increase in water tariffs, known as water 'tariff reform' among study participants, had significance beyond improving the operation of the water authority; it served as an example of enacting politically contentious legislation in the water sector. All water tariff adjustments must be proposed by NAWASA and approved by the legislature. Prior to 2010, water tariffs had not been increased since 1992 (17 years), due largely to a political climate which viewed increasing water tariffs as a tax increase. However, in 2010 the legislature approved a tariff increase of 33-34%.

Successful passage of water tariff reform legislation demonstrated strongly supported, but politically unsightly, water legislation is possible to pass in Grenada. I engaged in lengthy discussions with some interview participants to draw lessons learned from navigating the legislative process for water tariff reform to apply to the broader water sector reform context. Participants #7, 10, and 12 had particularly useful insight and provided information which allowed me to triangulate regarding the similarities and differences between water sector reform and water tariff reform (Table 5.3). Differences between the two reforms offer insight to the difficulty facing water sector reform and are discussed further in Chapter 6.

Some interview participants close to the water sector reform situation were prepared to accept the need for a 'game changer' or a crisis to motivate the legislature to act. Participant #6 was hopeful for continued efforts by GWP-C but agreed a severe drought might also stimulate the legislature to act on water sector reform. When asked what it would take to move water management forward in Grenada, Participant #2 replied, "We need a crisis. And this crisis has to have immediate financial and /or economic consequence to inaction." During an exchange about what has gone wrong with water sector reform, interview participant #7 described a bleak outlook for the future of water sector reform legislation. I commented to the participant, "Unless there is another $20 million project to push (legislation)?" Participant #7 replied, "That is the point of view I have been tending toward for some time now."

Table 5.3. Key differences and similarities between water tariff and water sector reforms.

Water Tariff Reform	Water Sector Reform
Similarities	
Legislation was politically unattractive	Legislation was politically unattractive
Had strong support from upper level (NAWASA) management	Had strong support from upper level water sector professionals
Differences	
Increased government revenue	Increased government expenses
Key policy entrepreneur was successful in motivating the Minister of Works to promote legislation in Cabinet. Policy entrepreneur was possibly more politically powerful	Key policy entrepreneur(s) have been frustrated in attempts to gain Ministry-level support for legislation. Policy entrepreneur(s) are possibly less politically powerful
Benefits of action were clear, made NAWASA financially solvent	Benefits of action were ambiguous, linking holistic water management to water service is difficult for political leaders to perceive
Consequence of inaction clear, short term	Consequence of inaction ambiguous, long term
Motivation was high, threatened government interests (Financial management of NAWASA is somebody's job, if the company becomes insolvent, jobs are lost)	Motivation was modest, did not threaten government interests (WSR is not somebody's job, if it doesn't happen none of the system actors suffer)
Addressed an urgent problem	Addresses a relatively distant problem
Simple to implement	Complex to implement
Promoted by people internal to Grenada	Promoted (largely) by people external to Grenada

5.2.7 The Extent of Transformability in Grenadian Water Management

From the information presented in this section, summarized in Table 5.4, Grenadian water management has many traits of a transformable system. However, research question #2 requires an assessment of *extent of* transformability of Grenadian water management. As discussed in Section 2.2.3, no methods have been proposed to determine the transformability of systems and no guidance is provided on differentiating a system moving toward greater or lesser transformability. These gaps prevent easy identification of systems close to or far from transforming or judging the effectiveness of

interventions. In addition, filling these gaps would make it easier to draw attention to the specific point(s) of breakdown in transformation of trapped systems. To fill these gaps and advance the literature on transformability, I have developed a framework which involves grading the relative capacity of a given system to navigate each step in the Olsson 3-phase framework of transformability (Table 5.5). Furthermore, I applied this framework to Grenadian water management (Table 5.6), described in following paragraphs.

Table 5.4. Summary of answers to six questions regarding Research Question #2.

	Key questions regarding transformability	Answers	See Section
1	Had transformations taken place in the past?	No.	5.2.1
2	Did fresh ideas and perspectives exist within the system? Where? And did these ideas and perspectives flow from stakeholders with little power to those with the most power? Or vertically within the water authority?	Yes. Fresh water management ideas and perspectives flowed from capacity-building efforts to water sector professionals, but were stifled at the political level and did not spread to residents.	5.2.2
3	What planning of the Grenadian water system was being done and has it been effective?	No long-term (multi-decade) planning. Some planning existed on a shorter time horizon (5 years), notably in NAWASA.	5.2.3
4	Did stakeholders identify a need to change the system?	Yes, among water and NGO professionals. No, among residents and politicians.	5.2.4
5	Had there been a reduction, or increase, in the number of intermediate-scale adaptive cycles? Did intermediate adaptive cycles in the Grenadian water management system play a role in adaptability and transformability?	Yes. One case increased adaptability of NAWASA and may have reduced transformability. A second case diffused new ideas through the system and increased transformability.	5.2.5
6	What ideas did study participants have regarding transformability?	Passage of water tariff reform demonstrated passage of water sector reform is possible.	5.2.6

Table 5.5. Framework for assessing and describing the transformability of a social-ecological system.

	Low Capacity		Moderate Capacity		High Capacity
	1	2	3	4	5
Phase 1: Preparedness for Transformation	Based on the three key factors described in Olsson et al. (2006): Building (1) knowledge and (2) trust within the system, and (3) the presence of policy entrepreneur(s) to lead the system through transformation				
	System possesses little knowledge or trust among system actors and no suitable policy entrepreneur(s) have emerged		System actors possess some knowledge and trust; non-ideal policy entrepreneur(s) may have emerged		Relatively high levels of knowledge and trust exist among all system actors and a suitable champion has emerged
Ability to Seize Windows of Opportunity	Based on the ability to 'join the three streams' of problems, solutions, and politics (Kingdon 1995; Olsson et al. 2006)				
	System can join none of the streams		System is able to join 1 or 2 streams		System is able to join all 3 streams
Phase 2: Ability to Navigate Transition(s)	Based on the likelihood the system will assume the form intended by transformation efforts				
	Characterized by an ineffective or absent champion to lead the transition, also resistance through panarchy linkages		Between 'high' and 'low' capacity		Characterized by an effective champion and long-term support through panarchy linkages
Phase 3: Stability of the New System	Based on the potential for a transformed system to revert to its former self or to a less desirable state				
	A low threshold exists to revert to the old system or to a different undesirable system is low		Between 'high' and 'low' capacity		A high threshold exists to revert to the old system or to a different undesirable system is high

Table 5.6. Transformability framework applied to Grenadian water management. The state of Grenadian water management is is shaded.

	Low Capacity		Moderate Capacity		High Capacity
	1	2	3	4	5
Phase 1: Preparedness for Transformation	Based on the three key factors described in Olsson et al. (2006): Building (1) knowledge and (2) trust within the system and (3) the presence of a "champion" to lead the system through transformation		**System actors possess some knowledge and trust; non-ideal policy entrepreneurs have emerged**		
Ability to Seize Windows of Opportunity	Based on the ability to 'join the three streams' of problems, solutions, and politics (Kingdon 1995; Olsson et al. 2006)	**System is semi-successful joining 2 of the 3 streams**			
Phase 2: Ability to Navigate Transition(s)	Based on the vulnerability of transformation to unforeseen obstacles	**Champions to lead the transition have been absent or ineffective in key ways; resistance to transformation through panarchy linkages exists**			
Phase 3: Stability of the New System	Based on the potential for a transformed system to revert to its former self or to a less desirable state			**A moderately high threshold exists to revert to the old system or to a different undesirable system**	

In applying the framework to the case study (Table 5.6), I conclude Grenadian water management has moderate capacity for transformation based on four key judgments. First, I judged the system to have moderate capacity in regard to preparedness for transformation, a 3 on the 1-5 scale. Actors in the system had a high degree of knowledge of needed water sector reforms and trust of one another. However, high levels of knowledge and trust did not extend to political and resident levels of the system. Potential policy entrepreneurs for transformation had emerged, but were not sufficiently effective (as of 2012), to guide the system through transformation.

Second, I judged the system to have a relatively poor capacity to seize windows of opportunity, a 2 on the 1-5 scale. As discussed further in Section 5.3 and especially in Chapter 6, policy entrepreneurs were unable to join the three streams and seize windows of opportunity. This breakdown was the **'point of failure'** in attempts to transform the system. Policy entrepreneurs generated agreement among water professionals on a 'problem' and a 'solution,' but generated very little political support to pass key legislation. Moreover, fundamental flaws in defining the 'problem' may need to be rectified to help generate political support needed to join the three streams and seize a window of opportunity. In addition, despite being frustrated by the legislative system, there was no consideration of shifting strategy and pursuing non-legislative means to achieve the goals of water sector reform. Policy entrepreneurs had little awareness of these faults and no plans to rectify them existed. In my subjective rating, I would have awarded a '3' if significant awareness of these problems existed or a '4' if there were an organized attempt to correct the problems.

Third, I judged the system to have a relatively poor capacity to navigate a transition to water sector reform, a 2 on the 1-5 scale. My largest concern in this regard is that system actors perceive legislation will precipitate transformation. Only one interviewee (#17), who was associated with a resident-focused NGO and relatively peripheral to water sector reform, discussed concern with implementation of IWRM or water sector reform provided they are legislated and funded. Legislation is important, but other elements of implementation exist and can render even the best legislation useless. This point is well made by Brooymans (2011, p. 96) in discussing the Canadian experience with implementing legislation:

> "The Fisheries Act has sometimes been characterized as the most powerful piece of environmental legislation in Canada," de Loe says. "Can you imagine an activity that doesn't affect fish or fish habitat? Good luck." The catch is, you can have all the legislation in the world, but if you fail to put in place all the things that turn legislation from paper into reality, it doesn't really matter, he says. So, for example, if you lack the political will to enforce legislation and you underfund key sections ... the laws become useless.

Add to this, my finding that water sector reform was drafted primarily by water sector technocrats and with little resident or resident-focused NGO involvement (see Section 6.2.1). This raises concern that if water sector reform legislation is passed, it could morph into a new system to empower technocrats rather than improve resident wellbeing.

Fourth, I judged the potential 'transformed' system likely to be relatively stable, a 4 on the 1-5 scale. To a large degree, the relatively high threshold to change the current system would likely apply to changing a transformed system. The largest uncertainties in judging the stability of a transformed system are if a sustainable funding mechanism will be established, and if the system will have the capacity to operate a restructured water sector and IWRM.

Overall, Grenadian water management scores an 11 out of a potential 20 points on the framework described above, indicating the system has substantial capacity to transform but has much to improve upon. This framework also helps direct attention to the weak points of transformability, which may provide insight for designing interventions to enhance transformability.

5.3 Transformation and System Intervention

This section evaluates the effectiveness of capacity building and other intervention efforts in Grenadian water management with regard to advancing the system through the three phases of transformation (see Sections 2.2.2, 5.2) and answers the third research question:

3. Do current and recent interventions effectively foster or utilize transformability?

Interventions such as foreign-funded capacity building and capital improvement projects advanced the system with regard to phase 1 of transformation (preparing for transformation). These interventions also advanced each of the three streams needed to seize windows of opportunity to varying degrees (Kingdon 1995 [2003]; Olsson et al. 2006). Although transformation was not achieved, intervention efforts helped to establish footholds which may lead to seizing a future window of opportunity to pass water sector reform legislation.

5.3.1 Preparedness for Transformation

Interventions contributed to preparedness of Grenadian water management for transformation in multiple ways. Arenas have been created for networks of water professionals to interact safely, build friendships and mutual respect, and learn about new ideas in water management (see Section 5.2.5). Specific examples of such arenas were discussed by interview participants #1, 2, 8, 11, and 15 and included CWWA conferences and training classes or workshops on water management conducted by entities such as CARIWIN and GEF-IWCAM. Although it was not explicitly stated in any interview

or document reviewed, I observed membership and participation in GWP-C provided camaraderie among water professionals.

Trust among water professionals is generally high. For example, persons interviewed within NAWASA were remarkably at ease with water sector reform despite provisions for additional oversight of NAWASA and relocation of water resource management authority from NAWASA to a new, independent entity (see Section 5.1.2). Knowledge of IWRM flowed into the system from regional and international NGOs such as CEHI, GWP-C, and CARIWIN (see Section 5.2.2) and diffused throughout the system. Basic knowledge of IWRM was ubiquitous among the persons I interviewed. In addition, water managers in Grenada broadly recognized structural and conflict of interest flaws in the water sector and most acknowledged water sector reform was a suitable resolution (see Section 4.3.1). Capacity building has also developed or enlisted potential policy entrepreneurs. For example, two Grenadians on the GWP-C steering committee[59] are both well positioned and have expertise which may be useful to champion water sector reform.

5.3.2 Advancing the Three Streams

The three-streams framework for seizing a window of opportunity was presented in Section 2.2.2.2. To summarize earlier discussion, social-ecological systems are most likely to transform when a policy entrepreneur utilizes a window of opportunity to join three 'streams:' (1) recognition of a problem among system actors, (2) formation and revising of policy to address the problem, and (3) political practicalities such as "public mood, pressure group campaigns, election results, partisan or ideological distributions in congress, and changes of administration" (Kingdon 1995 [2003], p. 145). Olsson et al. (2006) termed the three streams **problem**, **solution**, and **politics**, nomenclature I retain here. Failure to join the three streams within a window of opportunity typically prevents transformation. In the Grenadian case, the three streams were never joined and two windows of opportunity were missed. Stated another way, the key point of breakdown in transformation of Grenadian water management was the failure to join the three streams.

Despite the failure to join the three streams of problem, solution, and politics, system interventions cumulatively advanced each of the three streams to varying degrees. With regard to the problem stream, interventions were responsible for building consensus among water professionals that administrative fragmentation of water management responsibilities was a large problem. None of the 18 interview participants or any documents reviewed expressed any doubt that fragmentation of

[59] The two Grenadians on the GWP-C Steering Committee are Trevor Thompson (GWP-C Chair) of the Grenada Ministry of Agriculture and Terrence Smith of T.P. Smith Engineering Inc. and current (2012) Chair of the NAWASA Board of Directors

water management responsibilities was a problem in Grenada. However, enthusiasm for this point was greatest among persons associated with GWP, CARIWIN, and CEHI.

With regard to the solution stream, belief in a need for legislation to integrate management of water resources was widespread. No documents reviewed and only two participants, #16 and #17, expressed skepticism that legislation was useful to remedy fragmentation of water resources management (see Section 5.1.4). Intervention efforts appeared to contribute greatly to a near consensus on the solution. First, regional and international NGOs were relatively united in their definition of problem and solution and provided a constant influence on system actors. Second, intervention efforts funded creation of water management tools, (Senecal and Madramootoo 2012; Thompson, Senecal, and Madramootoo 2012), demonstration projects (CARIWIN 2009a; GEF-IWCAM 2011), and implementation manuals (CEHI 2007; Government of Grenada 2007a; Environmental Advisors 2008; CARIWIN 2009b), which I refer to collectively as 'tools, projects, and manuals.'

Interventions to construct the tools, projects, and manuals directly benefitted many key actors in the system and provided arenas for Caribbean water professionals to interact and learn about IWRM, which further reinforced IWRM as 'the solution' and helped build consensus. In addition, all of the products of tools, projects, and manuals projects were portrayed by their sponsoring agencies and authors as supporting IWRM implementation in Grenada or nearby Caribbean islands. It appears these products may have contributed to phase 3 of transformability by making IWRM more desirable and stable, in the event it is ever implemented.

As discussed in greater detail in Sections 4.3 and 5.1.2, the EU provided EC$20 million ($7.4 million CAD) to install capital improvements in southern Grenada, on the condition Grenada develop and pass a new water policy. This intervention prompted the Grenadian Government to develop, and adopt via legislative action, a new water policy in 2007 (CEHI 2007). While coercive, the arrangement was an effective driver of the political stream. Although the legislature did not establish an additional statute to supersede the existing patchwork of statutes and implement provisions in the 2007 water policy, these events advanced the political stream.

Other intervention efforts aimed at the political stream existed, but were much less effective. First, GWP-C and CWWA collaborate to hold 'Regional Ministerial Meetings', also referred to as 'High Level Sessions' at annual CWWA conferences. These meetings are described in a recent GWP-C press release as "an unmatched regional event, being the only meeting of Water Ministers in the Caribbean to date" (GWP-C 2012, p. 1). However, products from these meetings are generally non-binding agreements recognizing some problem or prescribed solution. I could not verify that any

aspect of water management had changed because of the High Level Sessions. I asked one knowledgeable interview participant[60] about what happens in the High Level Sessions and received a particularly candid and insightful opinion:

> Not very much. Really, I think they are a waste of time in my honest opinion. Don't get me going on that one. It needs a good shake up, I don't think they know what they want to do with (the meeting). It has been recognized, as a result of the 'difficulties' at the last High Level Session, that perhaps a little more structure and forward planning needs to take place. And follow up afterward. At the moment it just seems to be a one-off event that the Ministers get invited to for a couple of days. It doesn't cost them anything to attend and they just need to put in a few words.

I suggested the High Level Session might be a good political event, and the participant continued:

> Yes, it is an event to be seen at. So the way it is constituted at the moment, I really don't see the High Level Event as a good value for the money. And I am not telling you anything I haven't said elsewhere.

Thompson, Senecal, and Madramootoo (2012) provide a more nuanced assessment of the meetings, "this has started Ministers 'talking' at the highest level on issues relating to water but there is need for much greater coordination and communication on water resources issues across the region."

Second, a GEF-IWCAM working group evolved into the Consortium of CARICOM Institutions on Water and was tasked by the CARICOM[61] Council of Trade and Economic Development (COTED) to assist member states with developing and implementing IWRM Plans (Cap-Net, GWP, and UNDP 2005; GEF-IWCAM 2011). Despite much administrative line drawing and acronym drafting, little has come from this group in terms of IWRM implementation (Thompson, Senecal, and Madramootoo 2012).

Third, Environmental Advisors produced a review of policy, legislation and institutional structures in Caribbean nations relevant to implementing IWCAM (Environmental Advisors 2007), followed by a 'toolkit' for institutional, policy and legislative improvements relevant to IWCAM (Environmental Advisors 2008). Both reports were produced through the GEF-IWCAM project and have some relevance to legislative aspects of IWRM in Grenada. While the reports provided insight into the legislative realm of policy change, I was unable to find evidence these products were used to promote water sector reform.

[60] This participant is possibly known to many for expressing this particular view. Disclosing the participant's code number here may compromise the true source of other coded commentary. Therefore, for confidentiality purposes I am withholding the participant's identity number in this one case.
[61] CARICOM is the acronym for the Caribbean Community.

5.3.3 Footholds and Moral Victories

General capacity building and the use of conditional funding for capital improvement projects worked in tandem to sensitize water professionals to the value of adopting IWRM and to motivate the legislature to adopt a concomitant water policy. Although these advances did not bring about any change in the structure of Grenadian water management, they did move the system toward transformation in important ways. In the ball in cup analogy (Figure 1.2), sensitizing water professionals and the adoption of the 2007 water policy represent changes in the shape of the cup, creating a more favorable setting for future transformation. These advances can also be conceptualized in the ball in cup as footholds on the upward slope toward the critical threshold of legislating water sector reform. In the footholds conceptualization, the side of the cup is not smooth, but features points at which the system can rest temporarily and launch further attempts to reach the top of the cup (Figure 5.1). Drawing attention to specific footholds as 'resting points' toward transformation provides an alternative to the more ambiguous task of changing the shape of the cup.

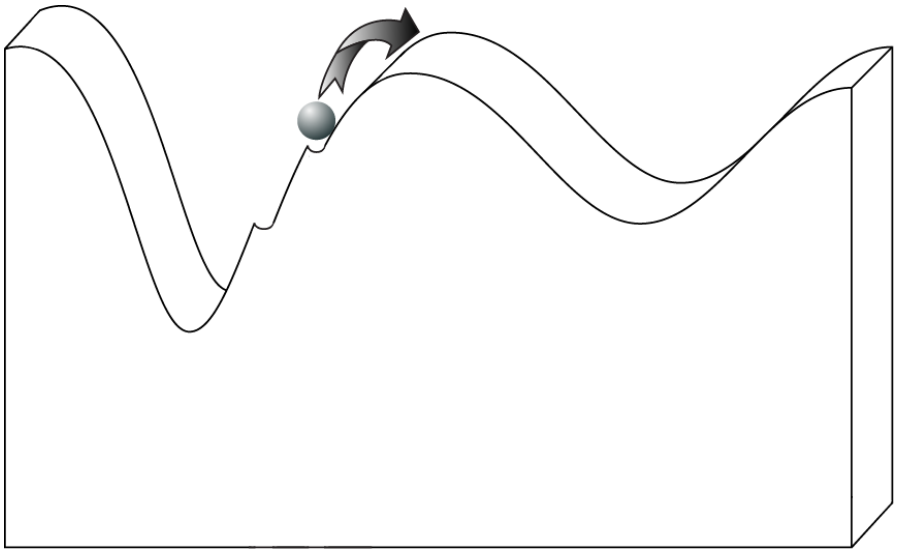


Figure 5.1. Ball-in-cup heuristic, featuring 'footholds' on the uphill slope.

To answer Research Question #3, interventions did foster transformability in Grenadian water management, but not enough to trigger transformation. The system failed to join the three streams of problem, solution, and politics, but is in a better position to do so now (2013) than it was prior to 2007. Thanks to intervention efforts, transformation is not blocked by lack of transformability. The point of breakdown has been advanced to a poor fit among the three streams of problem, solution, and politics. I further pursue the reasons why the three streams were not joined in Chapter 6.

5.4 Summary

This chapter answers the first three research questions, summarized at the end of this section in Table 5.7. With regard to the first research question, I determined Grenadian water management to be in a 'persistent and undesirable state'. The system has been 'persistent' in that the basic structure of legislated fragmentation of water management responsibilities has been highly resistant to change and 'undesirable' in the administrative fragmentation of water management responsibilities. In addition, the system exhibited high resilience, high connectedness, and high potential. Together, these conditions define Grenadian water management as being in a rigidity trap.

Despite the coarse label of rigidity trap, the system exhibited many traits of a transformable system. Unfortunately, the current literature on maladaptive system traps lacks methods or terms to describe the relative severity of maladaptive system traps. Therefore, I propose a model to describe trapped systems more precisely to help frame discussion of how to free such systems. Applied to Grenadian water management, the system is (1) in a rigidity trap, (2) characterized by moderate, (3) but weakening persistence. In addition, the system is (4) moderately undesirable and (5) stable in this regard.

In regard to the second research question, the literature on SES transformability provides no methods or terms to describe the magnitude of transformability in a given system. However, in this chapter I developed and used a framework to assess transformability which involves grading the relative capacity of a given system to navigate each step in the Olsson 3-phase model of transformability. Applied to Grenadian water management, the system has moderate capacity for transformation, but has much room to improve, particularly with its ability to seize windows of opportunity and navigate transitions.

With regard to the third research question, some aspects of transformability were responsive to interventions, particularly with regard to phase 1 of transformation. Conditions placed on receiving foreign funding for capital improvement projects directly resulted in the development and legislative establishment of a new water policy in 2007. In addition, capacity-building efforts effectively spread knowledge and support for water sector reform. However, interventions did not empower water sector reform supporters to join the three streams of problem, solution, and politics and seize two major windows of opportunity for change. Although transformation did not occur, intervention efforts helped establish footholds on the upward slope toward the critical threshold of legislating water sector reform. Figure 5.1 includes a modified version of ball-in-cup heuristic (Figure 1.2; Gunderson 2000) featuring footholds along the side of the 'cup.'

Table 5.7. Summary of answers to the first three research questions.

	Research Question	Summary of Answer
1	To what extent is Grenadian water management in a trap?	Grenadian water management is in a rigidity trap characterized by moderate, but weakening persistence. In addition, the system is moderately undesirable and stable in this regard.
2	To what extent is Grenadian water management transformable?	Grenadian water management is moderately transformable. Specifically, the system has a moderate capacity with regard to (a) Phase 1 of transformation, (b) the ability to seize windows of opportunity, and (c) Phase 2 of transformation as well as a high capacity with regard to (d) Phase 3 of transformation.
3	Do current and recent interventions effectively foster or utilize transformability?	Yes. Interventions advanced the system with regard to phase 1 of transformation and advanced each of the three streams of seizing windows of opportunity to varying degrees.

Chapter 6
Implications and Recommendations

This is the third of three chapters which present and discuss study results, implications, and recommendations. Chapter 4 developed a foundational understanding of the case study. Chapter 5 explained what went right with transformation, answered the first three research questions, and identified the failure to seize windows of opportunity as the point of breakdown in transformation. This chapter explains why breakdown in transformation occurred and answers the fourth research question by providing five recommendations to facilitate transformation of water management in Grenada. A suggested path forward is presented at the end of this chapter.

A key theme in this chapter is the complementary roles of advocacy and brokering in the context of seizing windows of opportunity and the three-streams framework (Kingdon 1995 [2003]). As discussed in Section 2.2.2.2, I use the term advocacy to denote general actions intended to persuade others to accept the merit or need for a policy or idea, in this case water sector reform and IWRM. The term brokerage denotes a distinct set of actions which joins the three streams of problem, solution, and politics to seize a window of opportunity. Brokerage involves unique tactics and strategies, and was a key missing link in efforts to transform Grenadian water management.

6.1 Limitations of Advocacy to Seize Windows of Opportunity

Advocates of water sector reform, and IWRM in particular, initiated dialogue about water management and promoted their proposals and suggestions of how to improve water management in Grenada (CEHI 2007; Government of Grenada 2007c). Interview participants #2, 7, and 14 discussed the cumulative effects of capacity building and referred repeatedly to the "sensitization" of the water management community to the need for changes in water management. Sensitization, in this context was equivalent to 'softening up' as described in Kingdon (1995 [2003]) and discussed in Chapter 2. Although transformation did not occur, sensitization of water professionals has created a dialogue on improving water policy among many key actors in the Grenadian water management system.

Advocacy for water sector reform and IWRM was limited in two important respects. First, advocacy efforts did not reach a broad enough audience, particularly residents (Section 4.1.7) and politicians. Second, as discussed in Section 2.2.2.3, advocacy is fundamentally insufficient to seize a window of opportunity and advance a system to phase 2 of transformation. Seizing windows of opportunity depended on one or more policy entrepreneurs rising up and brokering a proposal through

the legislative process through political maneuvering, deal making, and bargaining, but no such person emerged.

6.1.1 The Opportunity to Expand Advocacy to Residents

Interviewees #2 and 14, who both played central roles with regard to water sector reform, felt residents could serve as a driver for legislative action, particularly during severe droughts when water supply interruptions can be widespread. Despite this perceived need, questionnaire data indicate residents were disenfranchised with regard to water sector reform and IWRM (Section 4.1.7).

Information collected through interviews, document review, and resident questionnaires illuminated a pervasive top-down character of the Grenadian water sector (Section 5.1.3). Interview participants affiliated with local NGOs (#17, 18, and 19) each provided lively commentary on the need to change the top-down culture to address resident needs better. Encouraging evidence of recent softening of the top-down culture within NAWASA was identified (Sections 4.1.7 and 5.2.2), but resident involvement or representation in water sector reform and to a lesser extent in proposed IWRM was slight.

Deconstruction of the Grenada water sector review (Government of Grenada 2007b) provides insight to the extent residents were excluded from shaping water sector reform. The water sector review effectively defined the 'problem' as solved by the 'solution' presented in the 2007 water policy (Government of Grenada 2007c) and implementation framework (Government of Grenada 2007a).[62] Part of the stated purpose of the water sector review (p. 2) was "[t]o report on the problems and critical issues pertaining to the water sector." Page 35 of the water sector review lists 28 stakeholders who were consulted in development of the water sector review, none of whom were residents,[63] NGOs with a mission of advocating for residents, or community groups.[64] Resident representatives are listed in a table describing stakeholder awareness of IWRM (p. 35-36). However, the source of this table was an IWRM 'roadmap' document produced by a regional NGO (CEHI 2007) and resident concerns or perspectives are not explicitly discussed in the water sector review.

Within the water sector review, a "Matrix of Problems and Critical Issues" lists and ranks 18 "critical issues" based on stakeholder consultations (Government of Grenada 2007b, p. 44-45). Two

[62] See Section 4.3 for additional discussion of water sector reform.

[63] My use of the term *resident* denotes people living in Grenada and not holding any other stakeholder perspective.

[64] Government of Grenada (2007b) listed the Petite Martinique Church Council as a stakeholder consulted for the water sector review. However, I can find no additional details of what this organization is, what it was advocating, or even verify its existence. In addition, this group is apparently based on an outlying island of Grenada and falls outside the geographical scope of this study.

issues in particular are relevant to the resident experience with regard to water: water shortages and intermittent supplies, and poor water quality. Poor water quality is rated as one of the three least important issues on the list. This contrasts sharply with resident views presented in Chapter 4, and especially in Section 4.1.3. Remarkably, the list of 18 critical issues rated "poor hydrogeological data" and "potential conflict among users" among the most important issues. Interestingly, the list of critical issues did not include water-borne disease, poorly controlled water pressure, chlorine taste of water, or issues related to poverty such as the economic availability of water, the ability to cope with water supply problems, or gender issues. The marginalization and absence of issues which affect residents in profound ways indicates resident well being was not the focus of water sector reform. Had resident well being been the focus, poor water quality would not have rated as less important than availability of hydrogeological data. Poor resident participation and focus on water sector reform contributed to a peculiar or narrow problem definition, an idea considered further in Section 6.2.1, and weakened the potential for residents to act as a driver for political action (Section 5.1.3).

Authors of a plan to implement IWRM in Grenada (CEHI 2007)[65] made an attempt to incorporate resident views but were not necessarily successful in this regard. CEHI (2007, p. 40) acknowledged "the historical norm that management of water is the responsibility of the national water provider utility is still embedded in and foremost in the minds of people." The passage also stated a need exists to engage the public to create "public support for, and appreciation of, the concept, principles and values of IWRM." Also, development of the IWRM roadmap included leaders of at least two resident-focused local NGOs. However, comments of the secretary general of one of these two NGOs indicate an early perception of, and objection to, poor resident involvement in water sector reform and IWRM planning for Grenada. From p. 75 of CEHI (2007):

> **Comment: Judy Williams, Grenada Community Development Agency (GRENCODA)**: Since 1983 when the beautiful process of developing a national Forestry Policy began I have been involved. In 2007 we are still waiting for a National Land Use Policy. Now we are doing this [planning IWRM for Grenada] because we need a National Water Policy to access EU funds. I don't see how it can be meaningfully done in 6 months. I disagree that we have a wide cross-section of stakeholders here.

Interview data provide further insight to the gap between residents and attempts to promote water sector reform and IWRM. Interview participant #18 offered lively commentary on a lack of resident focus in water sector reform being related to a pervasive top-down social environment in Grenada. To paraphrase interview participant #18, professionals higher in the system tend not to 'look

[65] CEHI (2007) details a roadmap to implement IWRM in Grenada which is distinct from water sector reform. The IWRM roadmap focused on incorporating IWRM in water management, whereas water sector reform focused on restructuring the water sector to enhance oversight of the water sector and separate water resource management from water service responsibilities.

down' for input from residents, and residents do not necessarily 'look up' to provide input (also see Section 5.1.3).

Advocates for water sector reform and IWRM did not promote these proposed solutions among residents, nor were local NGOs approached to carry out advocacy at the resident level. I did not identify any newspaper articles describing water sector reform, no questionnaire respondents had heard of water sector reform, and no interview participant expressed any knowledge of promoting water sector reform among residents. Interview participants #2, 7, 15, 17, 18, and 19 acknowledged local NGOs could play a role in advocating for residents in the future. However, document review and interview data show no attempt to fund or otherwise engage local NGOs to take an active role in promoting water sector reform or IWRM. This finding may support the notion that water professionals higher in the system were not looking down for input from the resident level, as comments by interview participant #18 suggest. The combination of not including residents in defining the problem or identifying solutions, and not engaging residents in advocacy efforts, effectively squandered an opportunity to create political pressure for legislative action. Without political incentive for action, the three streams were not joined and transformation of the water sector did not occur.

This analysis leads to my first recommendation to facilitate transformation of Grenadian water management:

> **<u>Recommendation #1</u>:**
> **Future interventions should engage residents as part of a vision to create political pressure for proposed water management solutions.**

In pursuing my first recommendation, two key assets to facilitate engaging residents are (a) an abundance of funding at the regional and international level for advocacy and (b) untapped capacity of local, resident-focused NGOs to deliver the water management message to residents. It is difficult to quantify the magnitude of funding which flowed into the Caribbean for improving water governance. However, conversations with interview participants #2 and 3 and extensive internet-based research suggest funding totaled more than $10 million (CAD) annually in the English-speaking Caribbean, since at least 2008, explicitly for the purpose of improving water governance. To date, little of this funding has trickled down to local NGOs to engage residents. I asked interview participant #19 what access their organization has had to foreign funds and received this response:

> It is interesting to hear there is that money out there. We don't know about it, and we certainly don't have access to it. The work we do comes with very, very meager resources. That funding is not something we have access to or even knowledge of.

This needs to change. Local NGOs have unique ability to engage residents in Grenada on water issues. Providing funding to local NGOs to engage residents directly on water management issues could lead to crucial political pressure to motivate legislative action to improve water management.

Engaging residents in water sector reform and creating political pressure for legislative action could be facilitated by reframing the problem stream to permit consideration of solutions more attractive to residents. As first steps, future interventions should explicitly abandoned the top-down mindset in defining water sector issues and future water sector reform proposals should be redesigned with substantial resident and local NGO input. Doing so may increase the flexibility of policy entrepreneurs to join the three streams, an opportunity explored further in Section 6.2.1.

6.1.2 Why Advocacy Was Not Enough

Section 2.2.2.2 provides an explanation of the three-streams framework for seizing windows of opportunity (Kingdon 1995 [2003]). The complementary, but distinct, roles of advocacy and brokerage in seizing windows of opportunity are particularly important to the case of Grenadian water management. In the three-streams framework, a system is prepared for transformation by *advancing the streams through advocacy*. When a window of opportunity occurs, policy entrepreneurs are then able to *join the streams through brokering*.

In Section 5.2.7, I identified the point of breakdown in transformation of Grenadian water management as the inability to join the three streams of problem, solution, and politics. In this chapter, I explain how a lack of brokerage was the most likely cause of the breakdown. In addition, I explain how pursuing brokerage may be the key to freeing the system from its rigidity trap.

Interview, document review, and observation data indicated brokerage was particularly deficient in efforts to transform Grenadian water management. I was unable to detect any coherent strategy for how to achieve passage of legislation to implement water sector reform or IWRM beyond advocacy. Notably, the Framework for Water Policy Implementation (Government of Grenada 2007a) defined a solution to Grenada's water management problem, but did not address how to harness political support for implementation. The Roadmap Toward IWRM Planning for Grenada (CEHI 2007) comes the closest to presenting an implementation plan sensitive to the need for brokering. The Roadmap document contains basic elements of brokering such as assessing the political support for reform. However, strategies and tactics for how to harness political support necessary to pass legislation were not addressed. I engaged interview participant #2 in discussion of academic concepts of policy implementation, such as punctuated equilibrium theory, advocacy coalitions, and the participant's observations of how multiple factors such as a crisis and key persons with the ability to

move an idea forward, must align for policies to be implemented. Toward the end of this discussion, I asked interview participant #2:

> Question: So, are any of these other ideas seeping into the road-mapping, the IWRM plans, are any of these governance ideas seeping into the discussion anywhere?
>
> Response: No.

In the Grenadian case, advocacy effectively coaxed water professionals into general agreement of the solution and the problem. However, political support for implementation was fleeting. Reasons for the failure to generate political support are discussed in other sections and include: not extending advocacy to residents (Section 6.1.1); engaging politicians was brief, occasional, and poorly executed (Section 5.3.2); a lack of honing the solution (6.2.1); and poor anticipation of crises (6.2.2). In summary, space exists to advance advocacy marginally, but brokerage is needed to seize a window of opportunity and advance Grenadian water management to the transition phase of transformation.

6.2 The Brokerage Niche

My single most important finding with regard to explaining why Grenadian water management failed to transform is the large and unfilled need for brokerage to seize windows of opportunity to transform Grenadian water management. In the following sub-sections, I discuss dimensions of the brokerage niche in terms of 'why, what, how, when, and who' and recommend specific actions to help join the three streams. Section 6.3 serves to synthesize recommendations and provide one example of a path forward.

6.2.1 The Opportunity to Reframe the Problem

In his description of the problem stream, Kingdon (1995 [2003]) differentiates between 'conditions' and 'problems.' **Conditions** are features of daily life and become **problems** when we acknowledge something should be done about them. Many aspects of Grenadian water management can be considered a problem, depending on one's perspective. For example, intermittent water service is a condition for many Grenada residents. This condition presents a problem for many impoverished residents who go without water until service is restored. However, the condition may not warrant elevation to a problem for residents who own large water storage tanks and pumps to augment home water supply during service interruptions (Section 4.1.5).

From a brokerage perspective, decisions must be made on which conditions to elevate to problem status. It would likely be impossible to create a proposal which does something about every condition, and harnessing political support for such a proposal would be impractical. Thus, it is

necessary to be selective in elevating conditions to problem status. The political consequence of problem definition is profound. One example seen in Grenada's attempt at water sector reform (Section 6.1.1) was defining poor hydrogeological data availability as a 'critical issue' in the Grenada Water Sector Review (Government of Grenada 2007b, p.45), while overlooking water-borne disease, poorly controlled water pressure, chlorine taste of water, and issues related to poverty such as the economic availability of water, the ability to cope with water supply problems, and gender issues. This problem definition encouraged consideration of solutions which benefited one subset of people disproportionately (e.g., water professionals) relative to others (e.g., residents).[66]

Interview participant #10 perceived problems of mismatch between the proposed solution of water sector reform and reality. As the participant saw it:

> We talk a lot, in our case, IWRM, we were focusing on potable water and water for agriculture and irrigation. When this paper came out on reform in the water sector [the water sector review], I asked what is the objective of the reform. Is it because a [water management] style now exists [is now in vogue] that separates water management from service provision or have you really seen a difficulty in Grenada under the present system? And they couldn't tell me. All I was told was basically NAWASA controls all the water, including agriculture. But agriculture has no problem. Agriculture has never had a problem getting water for irrigation. I said, 'do you have a plan, a project for an expansion in agriculture that would be using a lot of water?' And they couldn't answer.

The balance of winners and losers which emerges from the problem definition has important implications for which proposed solutions are considered and, in turn, for political support for action. To continue the example from above, the problem definition led to a proposed solution that offered little incentive for support beyond the water professionals who defined the problem. The take-home point with regard to joining the three streams is that problem definition can be manipulated to favor different solutions and to facilitate political support for action. This analysis leads to my second recommendation to facilitate transformation of Grenadian water management:

<u>Recommendation #2</u>:
Future interventions should frame the problem with substantial resident input and focus.

Doing so will dovetail with my first recommendation to engage residents with advocacy efforts and creates a greater incentive for residents and resident-focused NGOs to pressure the legislature for

[66] Two issues were defined as "critical" in the Water Sector Review (Government of Grenada 2007b, p.45) that residents identified as problems in my questionnaires: intermittent water supply and poor water quality. However, poor water quality was rated as one of the three least important "critical issues" of the 18 listed.

action. Framing the problem differently also provides greater flexibility to craft solutions to fit the political stream, discussed in Section 6.2.2.

6.2.2 The Opportunity to Improve the Fit Between the Solution and Political Streams

In terms of fit between the solution and political streams, the solutions proposed through water sector reform (Government of Grenada 2007c) and IWRM (CEHI 2007) did not conform to political reality. Comparison of water sector reform, which failed to be legislated, with water tariff reform, which was successfully legislated (Table 5.3), provides insight into the degree to which water sector reform was incongruent with political reality. Water sector reform proposed to increase government expenses, had ambiguous benefits of action, had ambiguous and long-term consequence of inaction, and was complex to implement. In contrast, water tariff reform proposed to increase government revenue, had clear benefits of action, identified clear and short-term consequences of inaction, and was simple to implement. To facilitate joining the political and solution streams, either the proposed solution needed to change to fit political reality, or the political reality needed to change to fit the proposed solution.

Funding restrictions were one key unresolved mismatch between prescribed solutions and political reality. The 2007 water policy was expensive to implement relative to political will to fund the actions proposed under the policy. Notably, implementing the water policy would have required funding to allow: administrative restructuring of the water sector; creation of a new water resources unit; addition of 6 new positions, and; upgrading 2 existing positions (Government of Grenada 2007a).The Framework for Water Policy Implementation (Government of Grenada 2007a) recognized the problem of funding, recommending (p. 22) "additional external funding be sought to facilitate the establishment and implementation of the [new Water Resources] Unit." Interview participants #8 and 14 perceived a lack of funding to be the most important impediment to passage of water sector reform legislation. Regardless of merit, the proposed solution needed be 'free' to the government or offer a cost savings to be seriously considered. No source of external funding emerged and no attempt was made to refashion the water sector reform proposal to be more politically palatable, according to data examined during document review. However, I discussed the somewhat elaborate nature of IWRM being promoted since 2007 with interview participant #2 and asked if the participant was aware of any discussion about toning down the current vision of IWRM or changing the approach, and received this response:

> [The IWRM that has been promoted] is a bit of a Nirvana type of concept, a Shangri-La, something that we would all like to move to but without having something that it is latched on to as an issue. That has been part of the problem [preventing implementation] and it has been recognized that there is more traction in trying to not be so ambitious and looking at some of the more concrete

> things that could be addressed rather than trying to do the whole thing. But that is more of an internal discussion; you won't find that in any documentation.

Although the proposed solutions were not tailored to political reality, the possibility remained to bend political reality to the proposed solutions. There are many ways to manipulate the political stream, and I consider two options here. First, large foreign investments with legislative conditions were observed to stimulate a cooperative spirit in the Grenada legislature (e.g., requirements related to the Southern Grenada Water Improvement Project, see Section 4.3). I discussed the prospects of passing water sector reform legislation in its existing form at length with interview participant #7, who expressed frustration with political inaction on water sector reform and agreed another large funding opportunity may be needed to motivate the legislature to act. However, no such project emerged and the legislature did not act on water sector reform legislation. Second, residents could have been mobilized by reform proponents and resident-focused NGOs to create political pressure for action to improve water governance. However, this option was squandered by excluding residents from participating in defining the problem and subsequently by not pursuing residents with advocacy efforts (Section 6.1.1).

This analysis led me to my third recommendation to facilitate transformation of Grenadian water management:

> **Recommendation #3:**
> **Future interventions should craft solutions which take advantage of political realities.**

Many options exist to take advantage of political conditions at any given point in time, and I resist the temptation to outline a 'best' path forward in this section in favor of discussing four considerations in fitting the solution and political streams. Following sections provide recommendations for specific solutions to facilitate joining the three streams and triggering transformation.

First, a proposed solution must be viewed as politically feasible. Kingdon (1995 [2003], p. 132) describes the word "actually" as commonly used to discuss feasibility by policy makers. Examples include, "Will it actually accomplish what we want to accomplish?" and "Can it actually be administered?" Fortunately, advocacy efforts popularized a perception of IWRM as a feasible solution in many parts of the system. To facilitate a political perception of feasibility, future proposals should retain a normative focus on IWRM. However, to further aid political perception of feasibility, an explicit attempt should be made to simplify future proposals. One critique of the Framework for Water Policy Implementation (Government of Grenada 2007a) and the IWRM Roadmap (CEHI 2007) is that they were relatively elaborate related to their implementation. The Framework for Water

Policy Implementation involved creating a new administrative unit and redrawing administrative lines, while the IWRM Roadmap featured a 20-page description of 100 distinct activities necessary to implement IWRM in Grenada (p. 48-67). Stated another way, opportunity exists to improve political perception of feasibility by scaling the complexity of future proposals to the degree of political ambition for change in the water sector.

Second, funding constraints served to block proposals to transform water management, but could be harnessed to promote new proposals if they are viewed as money-saving endeavors by legislators. Strategies to reduce the perceived cost of proposed solutions to the government are wide ranging and combinations of strategies can create many possible solutions. For example, outside funding could be secured to offset any additional cost to the government. Also, politically less-objectionable ways to raise revenue, such as charging water bottlers' extraction fees, could be pursued to offset costs of a proposed solution. A third option is to scale down proposals to be less costly to the government. The key is to create the perception among legislators that implementing a given proposal will not cause a financial burden for the government.

Third, political incentives to implement a given solution could be created. Simply stated, political acceptance, and thus implementation, is more likely when individual legislators perceive either a personal political gain from implementing a given solution or a personal political risk from not supporting a given solution. As is the case with other aspects of brokering, many ways exist to create political incentives. Reframing the problem can be one tool to create political incentives for action (Section 6.2.1). Enlisting and funding local NGOs to advocate for proposed solutions could also create political pressure to implement a proposed solution (Section 6.1.1), as can providing proposals for politicians to use to their political advantage in times of crisis (Section 6.2.3).

Fourth, and finally, if political reality precludes any legislative action, consideration should be given to pursuing avenues which do not require it. A basic contention of Mitchell (1990, p. 8-16) is that aligning all the ideal ingredients for implementing IWRM is unlikely and, by necessity, water resources managers must proceed as best as possible in each case. Ideally, IWRM in Grenada would have a statutory foundation. However, non-legislative instruments for environmental management exist (Gouldson et al. 2008) and could provide a way to 'plow around the stump' when political difficulties are insurmountable.

6.2.3 The Opportunity to Prepare for and Anticipate Crisis

Rham Emanuel, former White House Chief of Staff for President Barack Obama, is noted as saying, “Never waste a crisis. It can be turned to joyful transformation” (Buiter 2009, p. 1). However, seizing

upon a crisis and turning it into "joyful transformation" generally requires great preparation, anticipation, and skillful brokering to join the three streams of problem, solution, and politics (Kingdon 1995 [2003]). Thus, my fourth recommendation to facilitate transformation of Grenadian water management is:

Recommendation #4:

Anticipate and prepare for crises.

Not all windows of opportunity result in joining the three streams. Windows of opportunity are notoriously brief and if policy entrepreneurs fail to act quickly and make critical couplings the window may shut and the opportunity for transformation lost. For example, as discussed in Section 5.1.2, a severe drought reduced potable water production and triggered widespread water service interruptions in Grenada in 2009-2010. This drought crisis elevated the lack of resilience of water service to problem status, and created political interest in doing something about the problem, thus opening a window of opportunity to pass legislation to implement water sector reform and/or IWRM. However, no formal proposal was presented to join the problem with political interest to act and the crisis passed without action occurring (Section 5.1.2). Interview participant #2 commented, "The time to push change through the legislature was when the taps were dry. Residents' memory is short and the opportunity has passed."

Fortunately, some aspects of windows of opportunity can be predicted. For example, it is possible to anticipate the form of many windows of opportunity and prepare accordingly. In the Grenadian case, severe droughts can reduce water supply and cause water service interruptions. This type of crisis elevates the normally uninteresting 'condition' of water supply resilience to 'problem status' in the eyes of many. Politicians may sense an opportunity for personal political gain by supporting proposals viewed by their constituency as addressing the problem. Conversely, politicians may sense personal political risk in not supporting proposals viewed as addressing the problem (Kingdon 1995 [2003]). By anticipating a severe drought, proposals can be crafted years in advance which can be promoted opportunistically as addressing the specific problem of water supply resilience to drought. The hook to draw in support from legislators is the consequence of political gain or risk relative to supporting the proposal. Other aspects of preparing to advance proposals during a drought crisis are considered further in Section 6.3.

The timing of many windows of opportunity can also be anticipated. Many opportunities occur regularly, such as the generally ambitious environment for political action following elections. In the Grenadian case, drought was a crisis which triggered windows of opportunity (Section 5.1.2). It is impossible to know exactly when the next drought will occur, but one will likely occur every 10 years

or fewer and probably in connection with an El Niño/La Niña–Southern Oscillation event (Giannini, Kushnir, and Cane 2000; Stephenson, Chen, and Taylor 2008; Gergis and Fowler 2009). Anticipating the timing of a window of opportunity will help structure and prioritize preparations and provide a better opportunity to seize the moment of crisis when it comes.

The greater the variety of crises which policy entrepreneurs are prepared for, the greater the chance they will be able to seize the next window of opportunity, whatever it looks like. Accumulating plans to push proposals during drought and following hurricanes, elections, or infrastructure failures adds greatly to the potential for policy entrepreneurs to join the three streams when the next crisis occurs. Interview participant #2 stated, "The time to push change through the legislature was when the taps were dry." To this, I add, "The time to develop suitable proposals and solicit political alliances is when the taps are running."

This section provides a limited discussion of key aspects of seizing windows of opportunity. The full range of actions policy entrepreneurs employ to prepare for and anticipate crisis is enormous relative to what is presented here. The point of this section is not to provide an exhaustive discussion on anticipation and preparation for crisis, but rather to convey their importance and highlight these activities as a critical gap in current efforts to bring about "joyful transformation" in Grenadian water management.

6.2.4 The Opportunity for a Broker

Section 6.2 discusses the single most significant finding with regard to transforming Grenadian water management, the wide and unfilled brokerage gap in efforts to transform water management in Grenada. Previous sections describe 'the why, what, how, and when' of brokerage. In this section I discuss difficulties in finding a 'who' to perform brokerage tasks and suggest ways to recruit persons to perform critical brokerage functions.

Addressing the gap in brokerage is complicated because persons currently engaged in advocacy are unlikely to assume a brokerage role for three reasons: (1) the opportunity costs of engaging in brokerage; (2) a contrast in ideal skill sets for brokerage and advocacy; and (3) path dependency. First, shifting the role of persons currently engaged in advocacy to brokerage risks impairing advocacy efforts. Advocating for improved water governance in Grenada is a complex task which requires a special skill set. Advocates who I interviewed were highly trained in water management issues, were recognized by others as experts, and were able to persuade others to see the value in their preferred water management styles. Advocates designed or managed projects which built knowledge and trust among local actors, such as demonstration projects, conducted seminars on water

management, and participated in organizations such as GWP-C. In addition, without effective advocacy, brokerage is not likely to succeed. Diverting limited expertise from advocacy to improve brokerage may not offer a net benefit with regard to transformation.

Second, skills needed for effective brokerage contrast with skills needed for effective advocacy. Few advocates make effective brokers, and vice versa. Kingdon (1995 [2003], p. 183) states, "Sometimes [advocacy and brokerage] are combined in a single person; at other times, [policy] entrepreneurs specialize, as in the instance of one pushing from an extreme position and another negotiating the compromises." I engaged interview participant #3 on aspects of the governance literature which suggest value in skill sets which do not necessarily align well with skills of hydrologists and engineers. Interview participant #3 commented:

> Actually [the need to involve people with different skill sets] has been at the center of a lot of conversations too. There are a lot of different skill sets that you need because the common perception of water is water services supply. Who actually is most involved in that? Engineers at water utilities. Those are not the guys who think about how to structure national programs to raise awareness of interconnectedness of water resources. They don't have that orientation. So the question becomes then, which other partners do you engage with, recognizing your resource constraints.

Toward the end of our discussion on the need for diverse skill sets, interview participant #3 talked about difficulties in selling the concept of improving water governance to the public across the Caribbean. The participant noted the people who are professionally engaged in water management, such as engineers, do not necessarily have good communications skills for selling water governance approaches to the public. "You need champions, and those champions are not really forthcoming as such."

Third, path dependence may also play a role in preventing present advocates of water sector reform and IWRM from assuming the role of broker. Changing emphasis from advocacy to brokering will require a change in thinking and little evidence suggests such change is forthcoming. In interviews, participants #2 and #3 demonstrated an emerging awareness for the need to broaden the general approach of advocacy. In particular, participant #3 stated:

> To get the needed [legislative] response, until somebody is literally every day going to their job and from the time they get to work until the time they go home their job is IWRM, drafting policy statements that need ratified, drafting cabinet memos that mandate x, y, and z, or making amendments to the legislation as needed. Until that is somebody's job, it rests nowhere. That is what we have seen, what we are realizing.

However, no reviewed documents recognized a need to broaden the strategy to promote change in water governance and interview participant #2 stated no such change in approach had appeared in any document.

Given current advocates will not likely assume brokering roles, my fifth recommendation to facilitate transformation of water management in Grenada is:

Recommendation #5:

Enlist one or more people or organizations to serve as brokers.

Two likely candidates exist to lead an effort to enlist a broker. First, international funding agencies such as GEF or CIDA could call for proposals for brokerage-oriented projects. Second, agencies that are already actively engaged in efforts to transform Grenadian water management, such as GWP-C or CEHI, could make a conscious effort to recruit potential brokers to collaborate on future projects. However, this latter case will require a fundamental shift in the mindset of how these organizations view transforming water management.

Once recruited, brokers need to be empowered and retained. To this end, structures used to retain advocates could easily be adapted to retain brokers. For example, brokers can be recruited for participation in prestigious steering committees and boards of directors. Brokers could also be recommended for consultancy projects which generally fell to advocates. Funding could be extended to brokers to design and participate in projects to promote improved water governance. With regard to how the actions of brokers might be coordinated with advocacy efforts, interview participant #1 spoke to the need for institutional capacity at the regional level to be flexible and ambitious:

> You can ... find institutions that have a culture, a certain culture that fosters positive energy. Like, for instance CEHI. I don't know how much contact you have had with them, but they make things happen. You never, never hear negative things from anyone about CEHI. It's always, 'What can we do, how can we make it work, what is the next step, where are we headed?'. Patricia Aquing [Executive Director of CEHI] is a phenomenal force of positive energy. Christopher Cox is a wonderful professional, very positive, gets things done. He is fortunate to work in an organization with a phenomenal leader who is very positive, and wants to make things happen, is open to working with people, is aware of what is going on and positions the institution within the other major stakeholders in the region and tries to create a culture of making things happen.

An opportunity exists to tap capacity among NGOs to provide an environment for brokers to work alongside advocates.

6.3 A Path Forward

Five recommendations to facilitate transformation of Grenadian water management were discussed in previous sections of this chapter and are summarized in Table 6.1. Considerable flexibility exists in how these recommendations are applied and the appropriateness of alternatives will shift from situation to situation and over time. Nevertheless, this final section of Chapter 6 provides one example of how the recommendations could be applied.

Table 6.1. Summary of opportunities and recommendations to facilitate transformation of water management in Grenada.

	Recommendation	Section
(1)	Future interventions should engage residents as part of a vision to create political pressure for proposed water management solutions	6.1.1
(2)	Future interventions should frame the problem with substantial resident input and focus	6.2.1
(3)	Future interventions should craft solutions which take advantage of political realities	6.2.2
(4)	Future interventions should anticipate and prepare for crises	6.2.3
(5)	Future interventions should enlist one or more people or organizations to serve as brokers	6.2.4

My recommended path forward begins with realistic expectations for transformation in terms of outcome, timeframe, and funding needed. With regard to *outcome*, transformation is an imperfect game. Transformation depends largely on fit among problem, solution and political streams, not necessarily on how 'good' a solution may be. Often, excellent solutions for how to improve a system are untenable politically and therefore unattainable. Proposing a solution based on merit and without regard to fit with the problem and political streams will likely result in achieving little or nothing.

Expectations for a *time frame* to achieve transformation of Grenadian water management should also be realistic. The primary factors to consider are: (a) the time required to prepare for seizing different types of windows of opportunity, and (b) the time it takes for a suitable window to occur. While projects to prepare for windows of opportunity can be molded to the popular five-year project cycle for foreign funding, transformation ultimately depends on the occurrence of a suitable window of opportunity, which likely will not coincide with year four of a five year transformation project. However, given the historical frequency of crises of droughts, changes in ruling political

party, and funding crises, a reasonable expectation for success is within a decade of when suitable transformation plans are in place.[67] Interestingly, the time frame for achieving transformation may not be strongly related to the magnitude of the transformation. Given the right set of circumstances, radical organizational change can occur quickly.

A reasonable expectation of *funding needed* for a brokerage-oriented project to facilitate transformation of Grenadian water management is $200,000 - $400,000 CAD annually. This figure assumes 2 to 5 full-time employees devoted to the project and is much less than the $10 million CAD cited in Section 6.1.1 as spent annually in the English-speaking Caribbean explicitly for improving water governance. Also, funding requirements are sensitive to the scale of project and the desired timeframe for success. For example, a fully funded team of 10 or 15 political strategists and water resources experts backed by local NGOs funded to advocate for change in the water sector can be expected to work more quickly than a team of two or three individuals.

I envision a multifaceted, ongoing project utilizing a mix of persons with Grenada-based expertise in community organizing, political strategizing, and water resources management. The first component of the project is to engage residents with an eye toward facilitating political pressure for action to improve water management. Information needs to be gathered from residents to aid defining problem(s) in a way which favors adoption of solutions residents are likely to support politically. Residents also need to be persuaded to take interest in water management issues and be empowered to create political pressure for action. Methods to engage residents could include the academic staples of mining the literature for relevant datasets or conducting town-hall style meetings, focus groups, surveys, and interviews. However, engaging residents may also be done more creatively. For example, a weekly newspaper column could be maintained to address resident water concerns. Interview participant #3 advocated the use of social media to engage residents and NAWASA already uses Facebook, Twitter, YouTube, and a blog to interact with residents.

The second project component is to reframe the problem in a way to maximize political pressure for action. It is important to include a balance of political interests in defining the problem, including, but not limited to, residents or resident advocates, technocrats, and business interests. In the short term, the problem can be defined based on professional advice of NGOs, political strategists, and existing relevant datasets. In the longer term, the problem definition should be revised as understanding of the positions of politically-relevant stakeholders improves.

[67] The estimate of 10 years is admittedly somewhat speculative. However, between 2006 and 2013, potentially suitable crises included: one drought which caused widespread water rationing; two changes in ruling political party; and a funding crisis which caused Grenada to default on foreign debt payments.

The third project component is to craft solutions (e.g., proposals) which fit well with the problem and political streams. The task here is to devise solutions which are politically palatable, but still perceived to address specific problems sufficiently to facilitate support from groups such as residents, business interests, and technocrats. Also, multiple solutions need to be devised to facilitate strategies to seize different types of windows of opportunity. In the Grenadian setting, solutions should be devised to address problems related to drought, poverty, business needs such as installing a new bottling plant or juice manufacturer, and disease outbreak. Solutions should also be altered for different levels of funding availability. The point of the third project component is to provide options for brokers to devise strategies to join the three streams. Text Box 6.1 describes one vision for a plan to improve Grenadian water management, and publications such as Environmental Advisors (2007, 2008) contain discussion relevant to development of solutions.

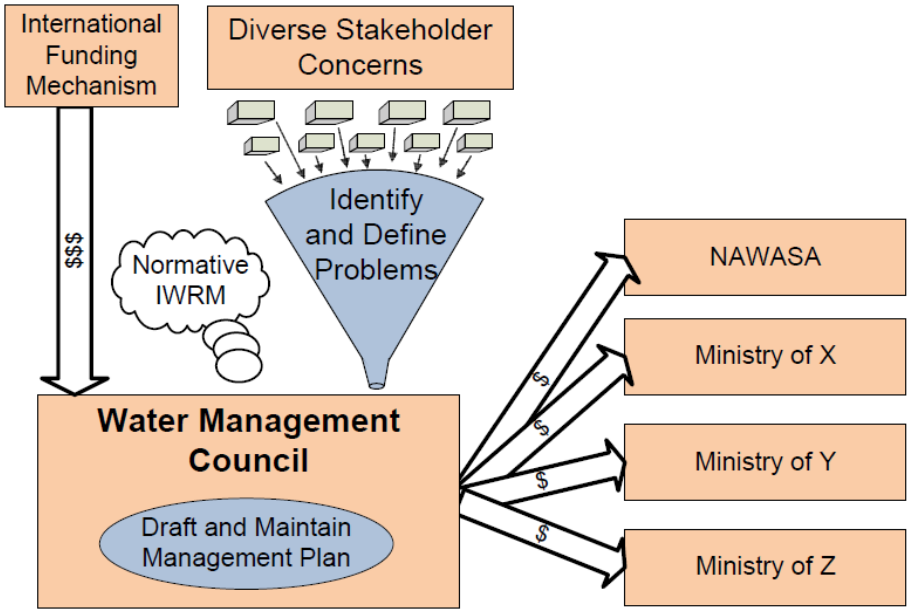
The fourth and final project component is to anticipate and prepare for crises as described in Section 6.2.3. The types of crises anticipated can inform development of draft proposals in the third project component, as well as strategies for brokering. For example, preparations can be made to build support for a proposed solution by building connections with media outlets and outlining potential press releases and talking points for anticipated crises. In addition, legislators can be engaged in advance to inform brokering strategies. The point of the fourth project component is to facilitate fast action to join the three streams when windows of opportunity occur. The time to develop strategies is not when the taps run dry.

Finally, the project outcome is limited in two important ways. First, it does not necessarily produce transformation within a set time frame; rather it prepares policy entrepreneurs to spring into action and broker transformation when the next opportunity occurs. Second, the project focus is on seizing windows of opportunity. This outcome will free the system from its current rigidity trap and move the system to the next phase of transformation. However, seizing a window of opportunity does not guarantee successful transformation.

This chapter has defined the limitations of advocacy and the need for brokerage in efforts to transform Grenadian water management. In addition, I provide recommendations to facilitate transformation and outline a potential path toward seizing windows of opportunity. The following chapter concludes the thesis and synthesizes the study findings.

Text Box 6.1: One Vision for Improving Grenada Water Management

Over $10 million (CAN) flows annually to the English-speaking Caribbean to fund projects with an explicit purpose of improving water governance (Section 6.1.1). To date, no significant IWRM proposals have been adopted beyond a few small catchment demonstration projects and only one nation, Jamaica, has implemented significant water sector reforms of any kind (Cashman 2012, 2013). Funding restrictions were identified as one reason measures to improve water management in Grenada were not legislated. One solution is to divert a portion of foreign funding to establish and maintain a semi-autonomous water management council to consider stakeholder concerns and normative aspects of IWRM, develop and implement a water management plan, and provide oversight of government actions with regard to water management.



In the beginning, the Council would function to coordinate the efforts of government agencies with regard to water. Over time, integration of water management could be pursued. Two mechanisms would give the Water Management Council meaningful authority. First, the Council would distribute funding to individual agencies to assist implementation of recommendations. Second, the government of Grenada would grant the Council limited statutory authority over individual government agencies in exchange for infusion of funding and provision of a service for no charge.

The Council's authority could be limited to water resources management issues and to 'reasonable' measures. Details of how to carry out Council directives could be left to each agency. Enforcement mechanisms could mimic those of environmental legislation elsewhere. For example, if

a citizen or group believes an agency is not complying with Council directives they could file a lawsuit to force the agency to comply. In turn, if the agency believes Council directives are not 'reasonable' it could sue to force the Council to revise the directive(s) in question.

The point of developing a draft proposal for ideas such as the one described here is not to devise a 'best' or even a detailed solution, but rather to give brokers something to promote and negotiate should an appropriate scenario emerge. This draft solution considers the scenario of a funding crisis coinciding with foreign funds being made available to facilitate transformation of water management. Other draft proposals should be created to address other scenarios. Many details of the arrangement described here are intentionally left to negotiation and refinement to aid brokering and facilitate political acceptance. Negotiation points include Council membership and oversight, what constitutes 'reasonable,' the magnitude of funding to the Council and to individual agencies, the scope of Council directives, and enforcement mechanisms.

Chapter 7
Summary and Conclusions

The goals of this study are to: (1) advance understanding of SES transformations and MS traps, (2) provide insight about if and why Grenadian water management is resistant to change, and (3) generate recommendations to precipitate change. To fulfill these goals, four research questions were presented in Chapter 1 and subsequently answered in Chapters 5 and 6 (Table 7.1). This chapter brings resolution to my dissertation by:

- synthesizing study findings and discussing them in light of literature discussed in Chapter 2,
- discussing strengths and limitations of the research,
- identifying and discussing contributions to academic knowledge, and
- providing recommendations for future investigation.

Table 7.1. Summary of answers to the four research questions.

	Research Question	Summary of Answer
1	To what extent is Grenadian water management in a trap?	Grenadian water management is in a rigidity trap characterized by moderate, but weakening persistence. In addition, the system is moderately undesirable and stable in this regard.
2	To what extent is Grenadian water management transformable?	Grenadian water management has many traits of a transformable system. However, the system has relatively poor capacity to seize windows of opportunity and to navigate a transition to water sector reform. The system scored an 11 out of 20 potential points on the framework described in Section 5.2.7.
3	Do current and recent interventions effectively foster or utilize transformability?	Yes, but with key deficiencies. Interventions helped the system prepare for transformation, but did not effectively help the system seize windows of opportunity for change.
4	Which interventions should be pursued to facilitate transformation of water management in Grenada?	Future interventions should focus on seizing windows of opportunity to advance transformation by brokering political action to facilitate holistic water management.

7.1 Synthesis of Findings

Water management in Grenada is incomplete, fragmented, and poorly coordinated in some cases. The water management system is in a rigidity trap characterized by moderate, but weakening, persistence. In addition, the system is moderately undesirable and stable. Despite the label of rigidity trap, prospects for transformation are far from bleak. Intervention led by the EU resulted in creation of a new water policy in 2007. The legislature formally 'adopted' the water policy to satisfy the EU, but did not pass legislation to implement any aspect of the policy. System actors widely regarded the new water policy as a positive development, but maintained the key threshold to changing water management was passage of legislation to reform the water sector, which had not occurred as of July 2013.

Intervention efforts focused on water sector capacity building and advocating for specific water policy changes. Advocacy-based interventions persuaded actors throughout the water sector of the merit of proposed reforms. However, intervention efforts also lacked an effective strategy to broker action at the political level and missed two windows of opportunity to pass legislation to support water sector reform. The inability to seize windows of opportunity was the point of failure of transformation, which I also consider to be the cause of the rigidity trap described in Chapter 5.

In Chapter 6, I provide five recommendations to facilitate seizing future windows of opportunity and move Grenadian water management closer to transformation. The five recommendations focus on employing brokerage strategies to join the three streams of problem, solution, and politics to precipitate passage of water sector reform legislation (Kingdon 1995 [2003]; Olsson et al. 2006). One caveat regarding these recommendations is that they are intended to advance the system beyond its current point of failure, and to the second phase of transformation, navigating the transition. The navigation phase has many potential problems and success is uncertain. System actors focused on legislation being 'the' barrier to IWRM and may be underestimating the challenges of implementation.

Study results confirm that the Olsson, Folke, and Hahn (2004) 3-phase framework of transformation had value in explaining transformation of Grenadian water management. In addition, my findings confirm the Kingdon (1995 [2003]) three-streams framework to seize windows of opportunity as useful to identify obstacles to transformation and causes of traps in the Grenadian water management context. The Kingdon framework provided two insights not possible using alternative frameworks. First, this framework illuminated the importance of brokering as a distinct action from advocacy to bring about transformation. Second, the framework provided a lens to view

and describe poor fit between problem and solution, which resulted in poor political support for reform and perpetuated the rigidity trap.

I found synergy exists in considering MS traps and SES transformation together and in applying the two concepts to explain the inability to implement IWRM[68] in Grenada. First, by considering MS traps alone, I was able to verify and describe a rigidity trap in Grenadian water management, but with little insight into the underlying causes of the trap. By considering SES transformation in tandem with MS traps, I discovered the cause(s) of the rigidity trap were the *point(s) of breakdown* in transformation. This led me to view freeing a system from a MS trap as a matter of 'fixing' the point(s) of breakdown in SES transformation, which in turn helped me generate novel recommendations to break the rigidity trap. Second, evaluating a system for MS traps, defined earlier as a persistent and undesirable state, involves explicit consideration of what persistent and undesirable mean and to whom. In the context of Grenadian water management, focusing on the *to whom* part led me indirectly to identify a mismatch between the problem and solution streams and helped me determine a point of failure of transformation. These findings provide the basis of several generalizable contributions to conceptual knowledge of social-ecological system behavior, described in Section 7.3.

7.1.1 Contrast and Resolution with Literature

My results contrast with previous work in various ways. With the notable exception of a 2010 special feature in *Ecology & Society*, transformation literature since Olsson et al. (2006) has shifted its focus away from the three-streams framework (Table 2.3). More recent literature has centered on networks and bridging organizations, and in some cases agency, as important means by which to navigate the first phase of transformation and seize windows of opportunity. However, I found the networks and bridging organizations perspective (Figure 2.7) to have limited use in interpreting my data. I observed active networks of system actors, both formal and informal, operating within safe arenas created by bridging organizations. Among system actors, I found a high degree of knowledge of water management, awareness of the shortcomings of the current water management configuration, and trust among actors in different Ministries, the private sector, and NGOs. In other words, all the ingredients to seize a window of opportunity in the networks and bridging organizations perspective appeared to exist. Nevertheless, windows of opportunity passed and transformation remained elusive.

[68] There were two related efforts to transform Grenadian water management. One was termed 'water sector reform' and focused on implementing the 2007 water policy, which among other things called for implementation of IWRM. The other was an explicit effort to implement IWRM as described in the *Road Map Toward Integrated Water Resources Management Planning for Grenada* (CEHI 2007). To clarify the discussion, I refer to both cumulatively as 'attempts to implement IWRM.'

I devoted considerable effort to interpreting my data using the networks and bridging organizations perspective but could not convincingly explain why Grenadian water management was resistant to change.

I found Kingdon's three-streams framework to be much more useful to explain my data than the networks and bridging organizations perspective (Figure 2.2). After growing frustrated in my attempts to explain my data using the networks and bridging organizations perspective, I revisited the transformation literature. I recognized potential value to interpreting my dataset by using the concept of joining the three streams of problem, solution, and politics to seize windows of opportunity. However, the 'a-ha moment' of my analysis did not occur until I read the full text of Kingdon's 1995 book, *Agendas, Alternatives, and Public Policies*, which provides much insight not captured in the transformation literature.

After applying Kingdon's three-streams framework to my data, I began to understand networks and bridging organizations as playing an advocacy role in my case study. Kingdon emphasizes the importance and difficulties of advocacy to *advance* each of the three streams. However, in the Kingdon framework, the three streams must be joined to seize a window of opportunity. *Joining* the three streams requires a different set of actions described as *brokering*. When I applied these concepts to my data, I discovered extensive advocacy had advanced the three streams, creating a system that appeared poised for transformation. However, I also discovered little evidence of brokering, which helped explain multiple failures to seize windows of opportunity.

My endorsement of Kingdon’s three-streams framework is not to say, however, that networks and bridging organizations were unimportant. Networks and bridging organizations were effective advocates and spread general agreement of the problem and the needed solution among water managers and technocrats. One interpretation of my findings is Kingdon's three-streams framework provides the 'what' needs to be done to seize windows of opportunity in terms of joining the three streams through advocacy and brokerage, while the networks and bridging organizations perspective may provide the 'how' to advocate and broker. I return to this notion in Section 7.4 in my recommendations for future study.

7.2 Strengths and Limitations

Use of a single-case study design with embedded units of study provided an opportunity to conduct an especially rich analysis of the case and move beyond 'what' questions to focus on questions of 'how' and 'why.' However, this also came with the tradeoff of limiting the scope of the study. Consequently, study findings are likely more reliable in describing Grenadian water management, but

may need to be confirmed by future studies before broadly applying the lessons learned. Yin (2009) acknowledges the inevitable tradeoff between depth and breadth of study, and states researchers are justified to use the relatively narrow, but deep, case study method when seeking to understand 'how' or 'why' social phenomenon work. A temptation exists to apply the lessons from this case to explain the failure to implement IWRM throughout the English speaking Caribbean. However, such statements would be speculative. I discuss the potential for future research to explore the general applicability of study findings in Section 7.4.

Use of the three-streams framework for seizing windows of opportunity is also a strength of this study, as it provided crucial insight, but may have limited application to non-legislative types of transformation. In particular, the validity of the three-streams concept depends on the applicability of the garbage can model of organizational choice (Cohen, March, and Olsen 1972). Passage of legislative reforms, the key threshold to transformation considered in this case, is perhaps a best-case scenario for applying the garbage can model. The garbage can model, and thus the three-streams aspect of the MS transformation framework, may break down or not be as effective in other settings.

My use of the SES transformation concept was a strength of the study, in that it enabled the description and explanation of phenomena preventing change in Grenadian water management. However, the transformation concept is also limited in that it does not provide a judgment of the 'goodness' of a proposed transformation. Bad transformations are possible and indeed do occur frequently; legislatures pass bad laws, voters elect poor leaders, and bureaucracies implement harmful policies. Transformation of Grenadian water management is largely a game of legislatively passing whatever reform possible, given political constraints. Whether or not politically palatable reform is beneficial, and to whom, is another matter.

Questionnaire data are limited by low response rates to individual questions, due either to questionnaire participants not answering individual questions or failure to ask the question. The result was to limit the validity of comparisons among classifications of residents. However, the key lesson with regard to resident opinion was the *solution* prescribed by IWRM and water sector reform did not match the *problem* in the eyes of residents. Nevertheless, I was still able to ascertain resident concerns regarding water supply from questionnaire data, and to confirm these findings by triangulating questionnaire results with observations and interview data from persons associated with community-based NGOs. I do not believe low response rates to individual questions adversely affected my findings.

7.3 Contributions to the Literature

Before discussing contributions to the literature, I wish to review how I chose specific segments of the literature on which to focus and disclose to which parts of the literature I am contributing. Given my stated purpose of "determining what interventions are most likely to stimulate transformation of Grenadian water management," I found it was especially important to gain three insights specific to my setting. First, I needed greater understanding of the water management system, including its strengths and its weaknesses. Second, I needed to determine factors contributing to rigidity and change of water management. Third, I needed to learn about past interventions to bring about change and their effectiveness to discover clues to what might stimulate change in water management. I considered many segments of the literature and chose a complex-systems based approach, SES resilience, to guide my study to and pursue my stated purpose. Within the SES resilience literature, I found the concept of 'resilience thinking,' particularly with regard to MS traps and SES transformation, to provide a useful framework to recognize systems which resist change and isolate factors preventing change.

In designing and conducting this study, I encountered boundaries in existing conceptual and empirical knowledge. To overcome these boundaries, it was necessary to expand the limits of academic knowledge to provide the intellectual space to pursue my stated purpose. I overcame some boundaries early; I overcame others later by linking them with empirical evidence collected during the study. Cumulatively, this study makes fundamental conceptual contributions to existing SES resilience literature, particularly with regard to MS traps and SES transformation, and to a lesser degree, to the IWRM literature. This study also makes important empirical contributions regarding the Grenadian water management setting. Based on my understanding of the relevant literature, most of the contributions by this study are 'firsts.' The following sections discuss study contributions and their significance. Table 7.2 provides a summary.

Table 7.2. Summary of contributions of this study to the academic literature.

Conceptual Contributions
• Provides an explicit term, maladaptive system trap, and simple definition to describe systems that do not advance through the adaptive cycle
• Provides a nomenclature and framework to describe the extent of an observed MS trap
• Provides a framework for assessing the extent of SES transformability in a system, by considering 'progress' through the 3-phase transformation process (Olsson, Folke, and Hahn 2004)
• Defines the cause of an observed MS trap as the 'point(s) of failure' of SES transformation
• Identifies a lack of brokering as preventing SES transformation and causing an observed MS trap
• Suggests a strategy of 'fixing' the point(s) of failure in transformation to free a system from an MS trap
• Offers a modification to the ’ball in cup’ heuristic (Gunderson 2000) to include footholds en route to transformation
• Illustrates the merit of considering traps and transformations together
• Explicitly reframes the IWRM 'implementation gap' (Mitchell 2009) as a challenge to overcome an MS trap and foster SES transformation
• Articulates one cause of the IWRM implementation gap as the failure to join the three streams of problem, solution, and politics
Empirical Contributions
• Results support the three-streams framework (Kingdon 1995 [2003]) rather than the network and/or bridging organization perspective of seizing windows of opportunity
• First study of MS traps on SIDS and one of three to apply resilience thinking concepts on SIDS (see Bunce et al. 2009 and Found and Berbés-Blázquez 2012)
• Explains the failure to implement IWRM in Grenada as the result of interventions which lacked an effective strategy to join the three streams to seize opportunities for change
• Provides a strategy to guide future intervention efforts to trigger transformation of Grenadian water management
• Provides a description of the resident experience with regard to water in contrasting water supply settings in Grenada
• Provides the only description of Grenadian water management with regard to resilience-thinking concepts

7.3.1 Conceptual Contributions

This study contributes to conceptual knowledge by establishing a way to discuss systems in 'trapped' states. Prior to this study, the literature provided little in the way of a definition, or even a consistently used term, to describe systems that fail to conform to the adaptive cycle.[69] First, based on the literature, I provide a term, *maladaptive system traps* (MS traps), and definition, *a social-ecological system in a persistent and undesirable state*, for these systems. Second, this study provides a nomenclature and framework to describe the extent of an observed MS trap. It is intuitively apparent that not all MS traps are equal in their severity or persistence; some systems are in worse states than others and escape is more likely in some instances than others. Describing these aspects enables comparisons between and among observed traps and identification of traps that may respond better to intervention efforts. Nevertheless, prior to this study, literature on MS traps lacked nomenclature and advice on how to describe the extent of an MS trap.

Development of a framework to assess SES transformability was crucial to this study and is a key conceptual contribution to the literature. The literature on SES transformation has advanced considerably more than that of MS traps. Notably, the literature provides an accepted term and definition for SES transformation. Nevertheless, prior to this study, the literature lacked methods for assessing the magnitude of transformability within a SES. This study presents a framework to assess transformability, developed through trial and error by interpreting data collected in this case study. The framework essentially considers progress through the Olsson, Folke, and Hahn (2004) 3-phase transformation framework and utilizes the three-streams framework for seizing windows of opportunity (Kingdon 1995 [2003]).

Development of the framework to judge transformation enabled five key conceptual contributions to the literature. First, this study defines the cause of an observed MS trap as the 'point(s) of failure' of SES transformation. Second, this study provides the first description of a lack of brokering, political maneuvering, or anything similar as preventing SES transformation and causing an observed MS trap. Third, this study suggests a strategy of 'fixing' the point(s) of failure in transformation as a way to break free of a MS trap. Fourth, based on empirical observations, this study presents a graphical depiction of 'footholds' in the Gunderson (2000) ball-in-cup heuristic to reflect points on the side of the cup at which the system can rest temporarily and launch further

[69] Prior literature defined four types of 'traps' within the adaptive cycle, but authors avoided referring to traps cumulatively and no consistently used term had emerged to describe traps in a general sense. Additionally, no consistent definition had emerged for these systems. I base my definition on the two traits common to descriptions of trapped systems provided in the SES resilience literature: perceived persistence and undesirability, acknowledging that both terms are relative.

attempts to reach the top of the cup (Figure 5.1). Fifth, these contributions collectively illustrate the merit of considering traps and transformations together.

The conceptual contributions made by this study fundamentally shape the SES resilience literature on traps and transformation. Prior to this study, relatively little work had been done to explain trapped system behavior. Now, nomenclature, methods, and conceptual frameworks exist to explain trapped system behavior and develop prescriptions to free systems from MS traps.

With regard to IWRM, this study provides two conceptual contributions. First, I explicitly reframe the IWRM 'implementation gap' (Mitchell 2009) as a challenge to overcome an MS trap and foster SES transformation. This contribution provides one more 'arrow in the quiver' of researchers and practitioners to reframe the IWRM implementation gap when other approaches break down. Second, this study articulates the IWRM implementation gap in the Grenadian setting as the failure to join the three streams of problem, solution, and politics, which provided insight to bridging the gap. At this time, the value of these contributions to the understanding of IWRM is incremental. However, these contributions may grow in significance if future research validates these lessons in other settings or future practitioners utilize these lessons to bridge real-world implementation gaps.

7.3.2 Empirical Contributions

Empirically, this study makes notable contributions to SES resilience literature. With regard to SES transformation, study results support the three-streams framework of seizing windows of opportunity (Kingdon 1995 [2003]; Olsson et al. 2006) rather than the network and/or bridging organization perspective of transformation which has been discussed more prominently (Section 2.2.2.3). In addition, to my knowledge this study is the first to study MS traps on SIDS and only the third attempt to apply resilience thinking concepts on SIDS (also see Bunce et al. 2009 and Found and Berbés-Blázquez 2012). The significance of these contributions is perhaps incremental, useful to future researchers but not likely to change how researchers think about SES transformation.

Significant Grenada-specific contributions include a post-mortem on why efforts to implement IWRM have failed and recommendations for overcoming obstacles to change. Specifically, this study explains the failure to implement IWRM in Grenada as the result of interventions that were overly committed to advocacy and lacked an effective strategy to join the three streams of problem, solution, and politics to seize opportunities for change. I also present a strategy to guide future intervention efforts to trigger transformation of Grenadian water management. These two contributions are potentially very valuable to a small subset of readers: people frustrated by failures to implement IWRM in Grenada and those interested in how to advance these causes in Grenada in the future.

Additional empirical contributions to the literature involve Grenada-specific observations. This study provides insight to the water-related experiences of Grenadian residents residing in communities with and without water supply shortages and in urban/rural contexts. In addition, this study captures a snapshot of Grenadian water management and describes it with regard to SES resilience concepts. The significance of these contributions is perhaps incremental in nature, of interest to future researchers, but unlikely to change how people think about Grenada.

7.4 Future Research

This study answers one set of questions, but opens new opportunities for future inquiry. One avenue of further inquiry is to pursue transformation in the Grenadian water management setting. In the short term, research could focus on refining and executing strategies to prompt the Grenada legislature to act on water issues. Another option is to pursue 'plowing around the stump' when legislative action is untenable and pursue transformation through non-legislative means. In the longer term, research could evaluate if applying recommendations made here precipitates transformation of Grenadian water management.

A second avenue for future study is to explore the general applicability of this study. Future research could evaluate if my findings are common to other SIDS and beyond water management settings. For example, research could evaluate efforts exist to implement 'better' approaches to many types of management, such as coastal zone management, solid waste management, and healthcare management. In addition, future inquiry could explore if the approach developed in this study to judge trapped systems, identify the point of failure in transformation, and addressing it to help a system break free of a trap has value to research in other settings.

A third avenue for future study also applies broadly to research in settings outside Grenada and outside water management. Future research could refine our understanding of how windows of opportunity are seized and why some windows are missed. Specifically, will research in other settings confirm the Kingdon three-streams framework defines a 'what' needs to be done to seize windows of opportunity, while bridging organizations and networks provide a 'how' to do it? In addition, future research can help define the range of settings in which Kingdon's three-streams framework is valid to explain seizing windows of opportunity for transformation.

7.5 Closing Thoughts

The cumulative effort described in this dissertation may be thought of as building a path of knowledge. Past literature has constructed many well-paved paths for academics and practitioners to follow, each setting out to some faraway destination and each with side paths and intersections.

However, at some point the paths often deteriorate and become impassable. Next to each path lays a pile of bricks, and each brick is differently shaped. The role of the academic community is to utilize the pile of bricks to continue the paths; the role of this individual study was to select a suitable path, follow it as far as possible, and install a few more bricks on that path.

In Chapter 1, I identified a faraway destination, advancing water management in Grenada. Then I chose a path to follow which I hoped would lead to the destination, resilience thinking. In Chapter 2, I carefully followed my chosen path until it deteriorated and became impassible. I examined the gaps in the path, the pile of bricks available, and selected specific bricks likely to fit into the gaps. In Chapter 3, I explained how I would attempt to place my chosen bricks in the path. Chapters 4, 5, and 6 describe my attempts to lay the bricks into place, difficulties encountered in doing so, and how I eventually fit the bricks into gaps in the path. In this final chapter, I explain the cumulative contribution of the bricks placed in the path, how my additions aided me in pursuing my destination, and how others might build upon my contribution.

Advancing the concepts of traps and transformations is potentially of great consequence beyond the setting of this study. Globally, social-ecological systems likely caught in MS traps have frustrated many efforts intended to improve governance. Often, substantial capacity exists within these systems, but change remains elusive. My research shows promise for using the traps and transformations concepts to identify points of breakdown in attempts to transform trapped systems and illuminate ways to tip them toward change.

Appendix A. Semi-Structured Interviews

Appendix A.1. Participant Codes, Classifications, and Date(s) Interviewed.

Code	Classification	Date(s) Interviewed
1	Academic or Researcher	7/12/2012
2	Academic or Researcher	6/18/2012; 4/2/2013
3	Academic or Researcher	4/3/2013
4	Academic or Researcher	7/11/2012
5	Consultant - Foreign	7/7/2012
6	Consultant - Grenada	7/10/2012
7	NAWASA	7/17/2012; 7/26/2012
8	NAWASA	7/18/2012
9	NAWASA	7/18/2012
10	NAWASA	7/18/2012
11	NAWASA	7/19/2012
12	NAWASA	7/24/2012
13	NAWASA	7/26/2012
14	Government (non-NAWASA)	7/2/2012
15	Government (non-NAWASA)	7/10/2012
16	Political Field	8/1/2012
17	Resident-Focused NGO	7/23/2012
18	Resident-Focused NGO	7/27/2012
19	Resident-Focused NGO	4/5/2013

Appendix A.2. Interview Themes and Question Pool.

THEME: System Variables and Drivers First Question: What do you perceive to be the biggest problems facing water SUPPLY in Grenada (or the Caribbean if appropriate) FOLLOW UP: How about the management end? Do you see any particular issues with water management? FOLLOW UP: To what extent do you feel long-range planning (decades) is incorporated into water management? BE SURE TO ANSWER: What sorts of things do you feel have affected the management of water in Grenada (e.g., political changes, hurricanes, foreign funding, internal/external projects, policy changes, etc.)
THEME: Power First Question: To what extent have you thought about issues of power in water management here? (does anyone have power other than NAWASA? Does NAWASA really have power?) FOLLOW UP: Foreign governments and organizations play a considerable role in water management here, particularly with specific projects and general "capacity building." Do you have any opinions on their role or their effectiveness? FOLLOW UP: Have you seen any "informal networks" of people here that have power to influence water management? I'm not speaking of corruption necessarily, I'm thinking of something like an informal network of friends or friendly colleagues. Have you seen any of this? FOLLOW UP: How would you change the system if you were in charge? FOLLOW UP: What do you think it would take to accomplish that change? FOLLOW UP: What do you think is preventing your vision from being realized? BE SURE TO ANSWER: Where the power for change is.
THEME: Governance First Question: How do you view how water is governed in Grenada? FOLLOW UP: What types of needs do you see NAWASA as being responsive to? FOLLOW UP: To what extent do you see IWRM as having an impact on how water is managed? BE SURE TO ANSWER: Governance… As appropriate
THEME: Historical Profile (and Future) First Question: To what extent do you feel this has changed or is changing? FOLLOW UP: Do you see any particular developments as having an impact? Such as Hurricanes Ivan/Emily? Or changes in policy or political leadership? FOLLOW UP: Do you see any changes coming in future years for how water is managed in Grenada? FOLLOW UP: What do you know about IWRM in Grenada? To what extent do you feel that has changed the way water is managed in Grenada? BE SURE TO ANSWER: This is a good place to get into how IWRM came about and if it is "real"
THEME: Thresholds First Question: What do you think it would take to move water management forward in Grenada? FOLLOW UP: Discuss possible future scenarios and backtrack what it would take to accomplish them. BE SURE TO ANSWER: What thresholds might exist

Appendix B. Questionnaire

Date _____	**Grenada Water Management: Gauging Resident Opinions**	Interviewer:
Start time _____		Questionaire ID#

	You and your home	
1a		What is your age? (a) 18-24 (b) 25-34 (c) 35-44 (d) 45-54 (e) 55-64 (f) 65+
1b		What is your gender? (a) Male (b) Female
1c		What is your main source of drinking water? (a) Public, piped into home (b) Public, piped into your yard (c) Public Standpipe (d) Rainwater (e) Other
1d		What type of toilet facilities does your household have? (a) W.C. Linked to Sewer (b) W.C. Linked to Septic (c) Pit-Latrine/V.I.P (d) Other
1e		Does your home have internet access? (a) yes (b) no
	Your experiences with water	
2a		Do you experience water cut-offs in your pipe/tap? (a) Yes, (b) No, (c) not sure
2b		If yes, how often? and how many days/year?
2c		Do you feel this has changed, going back as far as you remember? (a) Yes, (b) No, (c) not sure
2d		If yes, how?
2e		Do you have any idea why it has (or hasn't) changed? (a) yes (b) no
3a		Do you experience dirty water? (a) Yes, (b) No, (c) not sure
3b		If yes, how often? and how dirty?
3c		Do you feel this has changed, as far as you remember? (a) Yes, (b) No, (c) not sure
3d		If yes, how?
3e		Do you have any idea why it has (or hasn't) changed? (a) yes (b) no
4a		Do you have any other concerns about your water? (a) yes (b) no
4b		If yes, do you feel these concerns have changed, as far as you can remember? (a) yes (b) no (c) not sure
4c		If so, how?
5a		Does your home have a water storage tank or cistern? (a) yes (b) no
5b		<u>If yes</u>, what type of water do you store in it? (a) piped (b) rain (c) both (d) other
5c		<u>If yes</u>, is your tank/cistern piped into your home? (a) yes (b) no
5d		<u>If yes</u>, is your tank/cistern water pressurized? (a) yes (b) no, or less than normal
5e		**<u>If NO</u>**, do you think you would be better off with one? (a) yes (b) no (c) not sure
5f		<u>If yes,</u> what is the biggest reason you don't get a tank? (a) cost (b) installation (c) don't know how (d) not sure (e) other (specify)

[Continued next page]

		NAWASA
6a		Recently the water rates went up. Has this caused you any problems? (a) Yes (b) No (c) not sure
6b		If yes, what problems?
6c		If NAWASA improves the water, do you think the rate increase is a good deal? (a) Yes (b) No (c) not sure
6d		If you had to choose between having NAWASA cut the water to your home or the phone company cut your phone for one day, which would you rather have cut? (a) phone (b) water
6e		Do you feel NAWASA would listen & try to respond to a suggestion or a complaint about your water? (a) Yes (b) No (c) I don't know
6f		Overall, are you satisfied with your water supply from NAWASA? (a) yes (b) no (c) not sure
		Other Organizations & Projects
7a		Besides NAWASA, do you know of anyone else you could contact if you have problems with your water? (a) yes (b) no (c) not sure
7b		If yes, how?
7c		Do you know of any community groups or foreign organizations trying to improve water supply in Grenada? (a) yes (b) no
7d		If yes, who?
7e		If yes, do you feel they are effective? (a) yes (b) no (c) not sure
		Resident Views on How to Improve Water
8a		If you were in charge of all water supply in Grenada, would you try to change the current system?
8b		If yes, how?
*		*OBSERVATION ONLY, do not ask.* Type of material of outter wall of dwelling: (a) Wood, (b) Concrete/Concrete Block, (c) Wood & Concrete, (d) Stone, (e) Brick, (f) Makeshift
		Survey Finished Finish Time _____

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