Resilience of social-ecological systems (SESs): A case study of water management in the Iraqi Marshlands

by

Celeste Dempster
B.Sc. (Honours), Queen's University, 2007

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in the Department of Geography

Supervisory Committee

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Co-Supervisor

Prof. Maureen Maloney (Faculty of Law, Institute for Dispute Resolution)
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Abstract

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The draining of the Iraqi Marshlands is an example of the reorganization of a linked social-ecological system (SES) following a collapse. The goal of this study was to examine the utility of resilience as a water management tool through a case study of the Marshlands. Using the Four-Step Framework by Walker *et al*. (2002), it analyzed the Marshlands through the metaphor of the adaptive cycle, explored three possible future scenarios, created two models to characterize the system, and reviewed the implications of the analysis for water management in the Marshlands and resilience. This study found that resilience, and the Framework, could offer new perspectives for managing complex SESs. However, resilience is not useful during times of intense violent conflict, like war. It also found that there are resilient pathways to help the Marshlands reorganize. However, the Marshlands are very vulnerable and require strong institutional support to keep them from disappearing.

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Chapter 1: Introduction

Introduction:

Throughout history, the area known today as Iraq has witnessed the rise and fall of many societies. Ca. 2300 BCE, the Akkadian Empire rose to power in Mesopotamia establishing cities, long distance trade routes, sophisticated agricultural networks and a strong imperial economy (Meyers 2004). Although the Akkadians created a complex society, archaeological evidence shows an abrupt social-ecological collapse in 2200 BCE when cities in the northern Mesopotamia were suddenly abandoned (Meyers 2004). Records show that this mass exodus coincided with a rapid cooling of the climate that led to an increase in aridity in the area (Weiss *et al*. 1993; Meyers 2004). The subsequent reduction in agricultural production and reduced river flows caused a cascading migration that began in northern Mesopotamia and continued as refugees displaced populations further south creating in turn new waves of southerly moving refugees (Weiss *et al.* 1993).[1]

This story is an example of a society that was forced to adapt and reorganize in the face of a social-ecological collapse in order to survive. It is hypothesized that this collapse was the impetus that led some people to begin to eke out a living in the Southern Mesopotamian Marshlands of Iraq (known as the Iraqi Marshlands) on a full-time basis (Ochsenschlager 2004). This resettlement shows the resilience of a group of people and their ability to reorganize and create a new society when faced with a shock. The Marsh

[1] Archaeological evidence suggests that 42 000 to 112 000 people abandoned cities in the north after the climatic shift (Weiss *et al.* 1993).

Dwellers, as these people would come be known, developed a way of life tightly linked to the natural environment that persisted well into the twentieth century (Clark 2003; Ochsenschlager 2004). However, war and persecution from the Iraqi central government beginning in the later twentieth century has left these wetlands destroyed and its people displaced yet again. The future of the Iraqi Marshlands is uncertain. Resilience analysis and management may be one tool that will help this important ecosystem and its people to reorganize and survive once more in the face of social-ecological collapse.

Importance of Wetlands:

The Millennium Ecosystem Assessment Wetlands and Water group estimates that there are more than 1,280 million hectares of wetlands worldwide (Millennium Ecosystem Assessment 2005). However, wetlands all over the world are currently in a state of decline. Article 1.1 of the Ramsar Convention on Wetlands of International Importance defines wetland as "areas of marsh, fen, peatland or water, whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salt, including areas of marine water the depth of which at low tide does not exceed six metres" (Ramsar Convention Secretariat 2006). It is speculated that during the twentieth century, 50% of wetlands in North America, Europe, Australia, and New Zealand were lost (Millennium Ecosystem Assessment 2005). Additionally, there are few remaining intact wetlands in most arid and semi-arid regions (Lemly *et al*. 2000). Historically, wetlands have been attributed little value and have been converted to other lands uses like agriculture or have had their water inputs diverted for irrigation (Adger and Luttrell 2000; Lemly *et al*. 2000). Notwithstanding, wetlands provide habitat for many types of animals, birds, fish, and amphibians (Costanza *et al*. 1997). They can also act as

important spawning grounds for marine creatures and as layover stations for migrating birds (Lemly *et al*. 2000). Society obtains many benefits from wetlands. They provide important ecological functions and services including gas regulation, water regulation, flood mitigation, water supply, and water treatment (Brinson 1993; Costanza *et al*. 1997). Furthermore, wetlands can have valuable cultural uses such as spiritual, educational, and artistic applications that all contribute to human welfare (Brinson 1993; Costanza *et al*. 1997).

Wetland conversion and destruction has consequences for both human and environmental welfare (Adger and Luttrel 2000; Costanza *et al*. 1997; Lemly *et al*. 2000). Once a wetland is drained or its water diverted, the ecological services and values it provided are lost. According to Costanza *et al*. (1997) replacing these lost services and values is extremely expensive. It is also difficult to restore a wetland once it is destroyed (Acreman *et al*. 2007). Therefore, wetland conservation and restoration are worthwhile ventures in order to help maintain and reestablish the valuable ecosystem services and values provided by wetlands. Luckily, attitudes are shifting and the ecological and economic value of wetlands is being recognized (Adger and Luttrel 2000; Acreman *et al*. 2007). This is evidenced by the establishment of the Ramsar Convention, which represents an important shift in wetland management (Adger and Luttrel 2000). Currently, efforts to maintain intact wetlands and refresh damaged wetlands are underway all over the world, although the success of such ventures is varied (see Lemly *et al*. 2000; Eertman *et al*. 2002; Morgan and Short 2002; Pethick 2002; William and Orr 2002; Dickinson *et al*. 2006; Maconachie 2008).

The Iraqi Marshlands:

Before the Iraqi Marshlands were drained, they were the largest wetland complex in the Middle East and Western Eurasia (Partow 2001). They measured between 15 000 and 20 000 km^2 (Partow 2001) which is roughly twice the size of the Florida Everglades (Richardson and Hussain 2006). The Iraqi Marshlands contained very high levels of biodiversity (Richardson and Hussain 2006). They were home to rare bird species and acted as a spawning ground for fish and shrimp as well as other marine species (Richardson and Hussain 2006); the Marshlands also supported the yearly migration of millions of birds between Siberia and Africa (Evans 2003). In addition, the Iraqi Marshlands acted as a natural filter for the Euphrates and the Tigris Rivers (Partow 2001).

The Marshlands have been referred to as the cradle of civilization and are thought by some to be the site of the biblical Garden of Eden (Adriansen 2004; Polk 2005). The Iraqi Marshlands were home to about 500 000 Marsh Dwellers who had lived in this ecosystem for about 5000 years (Partow 2001; Ochsenschlager 2004). The Marsh Dwellers are considered one of the oldest living cultures (Adriansen 2004). They made their homes on reed mounds that were built up above the water line over the millennia and relied on boats as their primary method of transportation (Ochsenschlager 2004). The Marsh Dwellers also used reeds for weaving many objects, including reed mats, baskets, and constructing family homes (Ochsenschlager 2004). The abundant fisheries were also economically valuable and, in the 1980s, the Marshlands supplied 60% of Iraq's total fish catch (Evans 2003). The Marsh Dwellers also raised water buffalo, hunted, and engaged in small-scale farming (Ochsenschlager 2004).

While drainage of the Marshlands can be dated back to the 1950s (Millennium Ecosystem Assessment 2005), the majority of the damage occurred during the 1980s and 1990s. During this time, the national government drained the Marshlands, primarily for military purposes, using a series of canals, dikes, and ditches (Sluglett 2003b). The water quality of the Marshlands was also degraded as waste and chemicals were dumped into the waters (Sluglett 2003b). These actions led to total ecological and cultural devastation. By 2000, less than 10% of the Marshlands remained and the majority of the flora and fauna had disappeared (Richardson and Hussain 2006). Without the water, reeds, fish and other wildlife, the Marsh Dwellers could no longer survive in the Marshlands, leading to an out-migration into nearby cities like Basrah as well as to Iran.

In 2003, the USA launched its military offensive in Iraq and Saddam was removed from power. At this point, the remaining Marsh Dwellers began to break down the water diversion system and some water began to return to the Marshlands (Richardson and Hussain 2006).

Since 2003, the declining state of the Iraqi Marshlands has garnered attention from both the Iraqi and international community.

> "…the Marshlands of Iraq are of international ecological, political, and strategic importance. If for no other reason, they are integral to two large international river basins. This international quality of the Marshes and their inhabitants (human and animal) endow them with particular political, human rights, and environmental significance" (Naff and Hanna 2003, p.138).

Furthermore, "[t]he destruction of the marshlands and the Marsh Inhabitants' distinctive way of life remains even now both a humanitarian and environmental imperative of global importance" (Kazmi and Leiderman 2004, p.23). The Iraqi Marshlands have suffered a social-ecological collapse and the system is now trying to reorganize and

recover. Both the ecological and social components of this system are of national and international importance. Therefore, creating a water management plan for the conservation and restoration of the Iraqi Marshlands is of the utmost importance for their future existence.

Research Questions:

Water is the lifeblood of the Iraqi Marshlands; it supports the socio-economic and ecological components of the system. Any effort to restore life in the Marshlands must include a plan for water management that incorporates both of these components. Given my philosophical underpinnings (see Chapter 3), I chose to approach the issue of water management in the Iraqi Marshlands through the lens of the concept of resilience, which will be discussed in detail in Chapter 2. Resilience is "the ability of linked social-ecological systems to persist, buffer, and adapt to recurrent shocks without fundamentally changing, often unpredictably, into highly altered systems" (Hughes *et al*. 2007, Introduction section, para.3). According to Walker *et al.* (2002), the goals of resilience management are two-fold: First, "to prevent the system from moving into an undesired system configurations in the face of external stresses and disturbances" (Resilience Management section, para.1); and second, "to nurture and preserve the elements that enable the system to renew and reorganize itself following a massive change or shock" (Resilience Management section, para.2).

The concept of resilience, and the use of resilience as a management tool in social-ecological systems (SESs), has gained momentum since its inception in the 1970s. There is an entire journal, *Ecology and Society*, as well as a multidisciplinary research group, *the Resilience Alliance*, dedicated to the study of the dynamics of SES. However,

there is still much work to be done to further this field. For example, more research is needed to understand the ways systems reorganize following a shock (see Berkes *et al*. 2003b). More work is also required to take resilience into regular practice as a management tool. "Despite the apparent appeal of resilience as a framework for sustaining human-environment relations and the theoretical advancements in the field, natural resource managers do not explicitly apply this concept very often" (Marshall and Marshall 2007, Introduction section, para.4). Case studies offer a valuable opportunity to explore the concept of resilience and the application of the resilience approach in the field (Berkes *et al*. 2003a; Walker *et al*. 2006a). Bohensky (2008) calls for researchers in the field of resilience to "continue applying these frameworks, and adapting them to capture variations in social-ecological systems" (Conclusion section, para.2) in the face of "international interest in operationalizing resilience definitions and frameworks" (Conclusion section, para.2). In particular, Bohensky (2008) observes that "[t]he need to understand resilience as it relates to water management systems is recognized as critically important" (Resilience in social-ecological systems: A moving target? section, para.8). By continuing to apply resilience to case studies of various SESs, it will help to work towards operationalizing resilience as a tool in resource management.

The article *Resilience management in social-ecological systems: A working hypothesis for a participatory approach* by Walker *et al*. (2002) proposes a framework (hereafter referred to as the Framework) for analyzing the resilience of SESs in order to use resilience as a management tool in SESs. The Framework, however, is a work in progress and Walker *et al*. (2002) invite suggestions and comments based on "the experiences and results of the process in a number of different SESs" (Walker *et al*. 2002,

The Approach section, para.4). In this context, water management in the Iraqi Marshlands is an appealing case study because of the distinctive character of the region, the impacts of prolonged war, and the uncertain future of the system. Furthermore, it is likely that the Iraqi Marshlands are experiencing irreversible ecological and social change. According to Carpenter and Gunderson (2001), given the uncertainties that exist it is unavoidable that some systems will collapse. Therefore, it is important to take advantage of these opportunities to study and learn from their experience (Carpenter and Gunderson 2001). Furthermore, at present, the *Resilience Alliance* has no active case studies in the Middle East (Resilience Alliance 2009b). Therefore, an analysis of the Iraqi Marshlands has the potential to add to the growing body of knowledge about system resilience and its application to the management of SESs.

This thesis will test the bounds of resilience analysis and management using the Framework put forth by Walker et al. (2002) through the case study of water management (quantity and quality) in the Iraqi Marshlands. To this end, the analysis of the case study of the Iraqi Marshlands will explore the following issues:

1. Can the Framework by Walker *et al*. (2002) be applied to the management of water quantity and quality in the Iraqi Marshlands?
2. Is the concept of resilience analysis and management a useful management tool in the context of the Iraqi Marshlands?
3. What lessons can be learned from the case study of the Iraqi Marshlands about resilience analysis and management?

The Canadian-Iraqi Marshlands Initiative:

Conducting research in the Iraqi Marshlands contains inherent difficulties. As such the analysis of this case study has become closely linked with the work being done by the Canada-Iraq Marshlands Initiative, which will be further discussed in Chapter 3.

The University of Victoria led project entitled 'Canada-Iraq Marshlands Initiative, Phase II' (CIMI-II) is currently working with stakeholders and decision-makers in the Iraqi Marshlands to help improve current conditions and to create a plan for the future management of the Marshlands with due respect for sustainability, gender equality, and human rights. CIMI-II activities can be divided into two components. The first component is the creation of a comprehensive, integrated management plan for the restoration and development of the Iraqi Marshlands. This Management and Development Plan is being created in conjuction with an Advisory Committee. The Advisory Committee is composed of fifteen Iraqis from a variety of backgrounds who broadly represent the interests of the relevant stakeholders in the Marshlands. The Advisory Committee meets about every six months to discuss the Management and Development Plan as well as other related project activities. CIMI-II also consults with other international organizations, like UNDP, that are active in the Marshlands. The last meeting with the Advisory Committee was held on 9-11 July 2009 in Amman, Jordan and the next is scheduled for November 2009 in Beirut, Lebanon.

Complementary to this endeavour is the second component, which involves the initiation and the implementation of subprojects that help to meet some of the basic needs of the Marsh Dwellers. These subprojects help to gather information that will contribute to the Management and Development Plan and also help to build a trusting relationship

with the Marsh Dwellers. Subprojects include: a Women and Health Workshop; Women and Crafts Workshop; and interviews with local experts and leaders. CIMI-II also has an important Geographic Information Systems (GIS) component that consolidates all the data known about the region in order to create maps that are in high demand. CIMI-II now holds the most extensive database of ecological information about the state of the Iraqi Marshlands.[2]

Thesis Overview:

This thesis will be organized into six chapters. The first Chapter has briefly introduced the thesis topic and presented the research questions that this thesis will be examining. Chapter 2 will review the literature on resilience, which will be used as the theoretical framework of this thesis. It will give an overview of resilience, and the role that it can play in the management of SESs. Then, Chapter 3 will present the methodology that will be employed to answer the research questions presented in Chapter 1. Next, Chapter 4 will review the case study of the Iraqi Marshlands. Any discussion of water management in the Iraqi Marshlands would be incomplete without situating the Marshlands within the larger context of Iraq and reviewing the historical development of the Marshlands themselves. Chapter 5 will present the results of the case study analysis of the Iraqi Marshlands. Finally, Chapter 6 will present the key findings of the case study analysis and discuss possible future avenues of research.

[2] For more information on CIMI-II, please visit their website at www.iraqimarshlands.org.

Chapter 2: Literature Review

Introduction:

As stated in Chapter 1, this thesis will address the proposed research questions through the lens of the concept of resilience. Given that it will form the basis for subsequent analysis and discussion, an in-depth discussion of resilience is required.

This Chapter will begin by reviewing the idea of social-ecological systems (SESs). Next, it will discuss the theoretical underpinnings of the resilience approach and briefly review some of the key elements of resilience. Finally, it will discuss the use of resilience as a management tool in SESs.

Social-Ecological Systems (SESs):

Ecological and socioeconomic systems are interconnected across both spatial and temporal scales (Levin 2006). Scholars have used terms like ecosocial systems and socioecological system to describe the interface between the human and ecological elements in a system (Folke *et al*. 2005). However, these terms accurately reflect neither the equal importance of both components nor their integrated nature (Folke *et al*. 2005). The term social-ecological system (SES) was first coined by Berkes and Folke in 1998 in the book *Linking Social and Ecological Systems: Management Practices and Social Mechanisms for Building Resilience* (Folke *et al*. 2005). According to Anderies *et al*. (2006),

> "…SESs are composed of (1) agents ranging from microbes to plants to humans, each with a different degree of information-processing capacity; (2) a set of allowable actions related to their physical or behavioral characteristics; and (3) a physical substrate that includes chemicals, light and water. The interactions among

> these agents and their interactions with the substrate generate dynamic social-ecological systems" (Theory and Social-Ecological Systems section, para.1).

The term SESs is used to convey not only the linkages between the social and ecological dimensions of a system, but also the integrated nature of the two components (Folke *et al.* 2007).

Ecological and social systems are complex (Berkes *et al*. 2003a). Complex systems cannot be described using simplistic linear models and they possess attributes like nonlinearity, uncertainty, emergence, scale, and self-organization that are not found in simple systems (Berkes *et al*. 2003a), which will be explored in Chapter 5. The complexity of SESs is further increased by the interaction between the social and ecological components (Berkes *et al*. 2003a). SESs are also complex adaptive systems (Rammel *et al*. 2007). Complex adaptive systems are able to interact with and learn from other components of the systems as well as the environment, and as a result are able to respond and adapt to changes in the environment (Rammel *et al*. 2007).

Both the social and ecological dimensions of a system must be considered simultaneously in order to grasp the interplay of complex adaptive SESs (Folke 2007; Hughes *et al*. 2007; Rammel *et al*. 2007). If only a single variable or component of the system is considered, decisions made with respect to the management of that system will be flawed (Carpenter and Gunderson 2001; Levin 2006; Hughes *et al*. 2007). Furthermore, SESs contain uncertainties, which makes predicting or forecasting difficult and creates inherent difficulties for managers (Walker *et al*. 2002; deYoung *et al*. 2008). One possible way to overcome these challenges is to approach SES management through the resilience approach.

Theoretical Underpinnings of the Resilience Approach:

The origins of the resilience approach are systems oriented (Anderies *et al*. 2006; Nelson *et al*. 2007); it has also been heavily influenced by complexity theory, which has created a foundation for the resilience approach in complex systems theory (Plummer and Armitage 2007; Folke *et al*. 2007; Walker *et al*. 2002). In recent years, complexity theory has helped to generate complex adaptive systems theory, which is increasingly being incorporated as a theoretical underpinning of the resilience approach (Norberg and Cumming 2008a).

Systems theory focuses on a holistic approach to management by working to understand not only the various components of the system but also how they are interconnected (Berkes *et al*. 2003a). Complexity theory "views the world as continuously adapting and changing in response to environmental feedback" (Plummer and Armitage 2007, p.64). Complexity theory builds on 1970s systems theory by incorporating ideas of emergence, the idea that a system is more than the sum of its parts, and hybrids, being the fusion of seemingly opposite elements like nature and science, qualitative and quantitative, or human and non-human (Gatrell 2005). As such complexity theory works to describe and understand the mechanisms that create change in SESs (Walker *et al*. 2002).

It is this theoretical foundation in complex systems theory that allows the resilience approach to break down binary divides (Gatrell 2005) and bridge the gap between social and physical sciences for the management of SESs (Berkes *et al*. 2003a; Plummer and Armitage 2007). Furthermore, complex systems theory ascribes little utility to reductionist views in the face of uncertainties and surprises of the real world

(Plummer and Armitage 2007) making it critical of management schemes based in prediction and control (Berkes *et al*. 2003a). "The lessons from complex systems thinking is that management processes can be improved by making them adaptable and flexible, able to deal with uncertainty and surprise, and by building capacity to adapt to change" (Berkes *et al*. 2003a, p.9). This notion of adaptive management allows the resilience approach to be iterative, pulling from grounded theory, through experimentation, learning, and feedback (Berkes *et al*. 2003a). Complex adaptive systems theory builds on these ideas focusing explicitly on the capacity of complex systems to adapt and respond to change through self-organization, learning, and reasoning (Norberg and Cumming 2008a).

Complex systems theory is being widely used to study SESs (Gonzalez *et al.* 2008). "While the application of complex systems theory is still in its infancy, this is an exciting and fast-moving frontier in science" (Norberg and Cumming 2008b, p.xiv).

The Resilience Approach:

Resilience:

The idea of ecological resilience was put forth by C.S. Holling in 1973 and has since been applied to the dynamics of SESs (Walker *et al*. 2006a). Support for a resilience approach has continued to grow in subsequent decades. The *Resilience Alliance*, founded in 1999, is a multidisciplinary, multinational research group dedicated to the study of the dynamics of SESs. The journal, *Ecology and Society*, was created in 2004 to disseminate novel research on SESs.

Resilience can be thought of as "the ability of linked social-ecological systems to persist, buffer, and adapt to recurrent shocks without fundamentally changing, often

unpredictably, into highly altered systems" (Hughes *et al.* 2007, Introduction section, para.3). However, Brand and Jax (2007) have criticized current definitions of resilience for being overly vague. Related to resilience is the concept of adaptive capacity, which "is an aspect of resilience that reflects learning, flexibility to experiment and adopt novel solutions, and development of generalized responses to broad classes of challenges" (Walker *et al.* 2002, Terminology section, para.6). Resilience is a precursor to adaptive capacity (Folke *et al*. 2003). It is these properties of resilience and adaptive capacity that allow a system to adapt to change and to reorganize following collapse.

The idea of a ball on a surface has often used to illustrate the concept of resilience (for example see Beisner *et al*. 2003; Scheffer and Carpenter 2003; Carpenter and Gunderson 2001; Peterson 2000), where the ball "represents the state of the system and the surface represents the forces acting to change that state" (Peterson 2000, p.325-326). Valleys in the surface, also termed basins of attraction (Scheffer *et al*. 2001) or stability domains (Gunderson 1999; Olsson, *et al*. 2004), represent stable states where the current system is preserved (Peterson 2000). Hills, on the other hand, represent the strength of the forces pushing the system in a particular direction and potentially into a new configuration (Peterson 2000). The ball moves across the surface or settles in a valley depending on the resilience of the system and the force of the stressors acting on the system. The size of the basin of attraction can be thought of as the resilience of a system (Scheffer *et al*. 2001; Beisner *et al*. 2003). Therefore, the larger the basin of attraction, the more resilient the system and the more difficult it is to push the system into a state of upheaval.

A system may have several basins of attraction (Scheffer and Carpenter 2003; Scheffer *et al*. 2003), which are termed alternative stable states (Scheffer *et al*. 2001). Multiple stable states result from the complex nature SESs (Anderies *et al*. 2006). Alternative stable states are not always easy to identify, nor is it easy to pinpoint thresholds where a system to flip from one alternative stable state to another. From an ecological perspective, alternative states are neither desirable nor undesirable (Nelson *et al*. 2007). Rather it is the social component of the system that attaches the label of desirable or undesirable to certain configurations (Nelson *et al*. 2007).

The concept of resilience is an integrated approach that has been developed by ecologists, economists, and social scientists in order to understand the dynamic behaviour of SESs (Holling 2003; Plummer and Armitage 2007). The resilience approach promotes interdisciplinarity in order to be able to address both the social and ecological components of a system (Folke 2007). As such, the resilience approach does not seek to replace other partial theories but rather to create a space where ecological, economic, and social theories can be brought together and integrated with new ideas from resilience in order to better understand SESs (Yorque *et al*. 2002; Anderies *et al*. 2006). This also allows it to explore interactions of SESs that might be missed when these partial theories are applied in isolation from each other (Anderies *et al*. 2006).

It is important to note that the resilience approach has evolved into a "framework for systematically thinking about the dynamics of SESs" (Anderies *et al*. 2006, Theory and Social-Ecological Systems section, para.3) rather than a well defined theory (Norberg and Cumming 2008a; Anderies *et al*. 2006). To some this has been perceived as a weakness (Brand and Jax 2007). However, SESs are so complex that using a theory to

describe and predict their behaviour becomes questionable (Anderies *et al*. 2006). This is true not only of the resilience approach, but in general of theories that are used to describe complex SESs (Anderies *et al*. 2006). Given the enormity and complexity of the task, a complete theory governing SESs "does not exist today, and may well never exist" (Anderies *et al*. 2006, Theory and Social-Ecological Systems section, para.1). The classical scientific approach is not easily applied to SESs, but with a combination of theory development and qualitative analysis of case studies, it is possible to use a resilience approach to increase our understanding of SESs (Anderies *et al*. 2006; Walker *et al*. 2002; Walker *et al*. 2006a).

The Adaptive Cycle:

The adaptive cycle is at the core of the resilience approach (Redman and Kinzig 2003; Anderies *et al*. 2006) and is its most important ecological contribution to complexity theory (Walker *et al*. 2002). The adaptive cycle can be thought of as a metaphor for interpreting SESs (Holling and Gunderson 2002). The adaptive cycle was first used by C.S. Holling to describe ecological systems. There are two requirements that must be met in order for the adaptive cycle to be applied to non-ecological systems (Nkhata *et al.* 2008): First, the system must be dynamic, and second, it must be able to move to multiple states. Nkhata *et al.* (2008) argues that most dynamic human processes meet these conditions. The adaptive cycle is widely used to describe the dynamics of social-ecological systems (Walker *et al*. 2002; Walker *et al*. 2004).

The adaptive cycle can be visualized as a figure eight (see Figure 1).

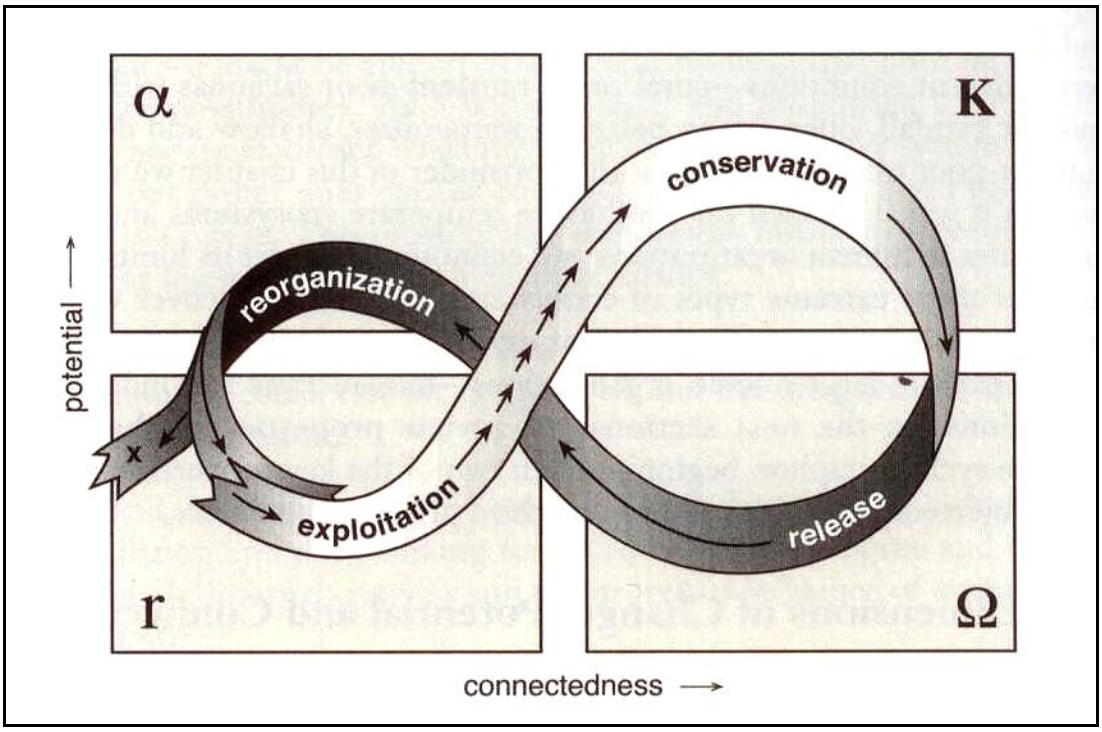

Figure 1: The adaptive cycle. A representation of the adaptive cycle showing the four phases (exploitation, conservation, release and reorganization) and the transition between them. The long arrows show quick changes while the closely spaced arrows show slow changes. The 'x' in the bottom left-hand quadrant indicates where potential may leak away from the system and a transition to a less desirable state may occur (Holling and Gunderson 2002, p.34).

The adaptive cycle has four phases: exploitation (r), conservation (K), release (Ω) and reorganization (α) (Holling and Gunderson 2002). Competition is high in the exploitation (r) phase as biota and entrepreneurial pioneers vie for space and resources that have been made available due to the disruption of the previous regime (Holling and Gunderson 2002). As the cycle proceeds from the exploitation (r) phase to the conservation (K) phase, winners begin to establish themselves and the interconnectedness of the system increases allowing potential to accumulate. As potential accumulates the system becomes more stable and easier to predict (Holling and Gunderson 2002). However, as the system becomes more rigid it loses resilience, which inhibits its capacity to deal with surprise. "One paradox of this concept is that a more resilient system implies more flexibility and hence less tight controls, but resilient systems are also defined as those

able to maintain their controls and structure" (Redman and Kinzig 2003, The Paradoxes of Resilience and Adaptive Capacity section, para.1).

The system will move from conservation (K) phase to the release (Ω) phase in response to a trigger, (that is potentially random and external), that destabilizes the system by disrupting regulatory controls causing the accumulated potential to be released (Holling and Gunderson 2002). During the shift from Ω to the reorganization (α) phase, uncertainty is high and the predictability of the system is low (Holling and Gunderson 2002). Holling and Gunderson (2002) argue that at this point system resilience is high as linkages are loose and controls of the system are weak. However, Anderies *et al*. (2006) argue that there is no clear connection between connectivity and resilience. In this phase, the reorganization of the system is determined by its adaptive capacity. α is a time where unpredictable events, like invasive species, and actors, like new entrepreneurs, are able to foster novelty and potentially direct the reorganization of the system in new and different directions (Holling and Gunderson 2002).

The front-loop of the system (r to K) is characterized by slow growth and accumulation, and relative predictability, while the back-loop (Ω to α) is characterized by rapid change and uncertainty (Holling and Gunderson 2002). Traditional natural resource management focuses on the front-loop of the adaptive cycle, seeking to reduce variability and increase efficiency, while ignoring the release and reorganization phases (Berkes *et al*. 2003a; Walker *et al.* 2002). Such command-and-control approaches are functional in the short term but over the long term destroy the resilience of a system and make it vulnerable to uncontrollable and unanticipated events (Berkes *et al*. 2003a). The adaptive cycle embraces the seemingly opposite, but actually complementary attributes, of growth

and renewal (Berkes *et al*. 2003a, Walker *et al*. 2002; Holling and Gunderson 2002). By doing so, it creates a more holistic and sustainable approach for managing SESs.

Because almost all the attention has been focused on the front-loop of the cycle, few resources have been allocated to investigating and managing the back-loop (Walker *et al*. 2002). Researching the back-loop is important in order to gain a better understanding not only of the adaptive cycle but also how SESs deal with change, uncertainty, reorganization, and renewal (Berkes *et al*. 2003a). Holling (2003) suggests that the world is currently experiencing enormous changes during which time the conditions of the back-loop will dominate. Therefore, in order to create a foundation for handling this change, focus needs to be on the back-loop rather than the front-loop of the adaptive cycle (Holling 2003). One option is to generate models that increase understanding of back-loop dynamics (Anderies *et al*. 2006). By doing so it is possible to learn valuable lessons about the dynamics of SESs and how they deal with change (Holling 2003).

In complex SESs, processes operating at different scales can be represented by fast and slow adaptive cycles (Redman and Kinzig 2003). "The term panarchy is used to capture the dynamics of adaptive cycles that are nested within one another across space and time scales" (Berkes *et al*. 2003a) (see Figure 2). **Error!**

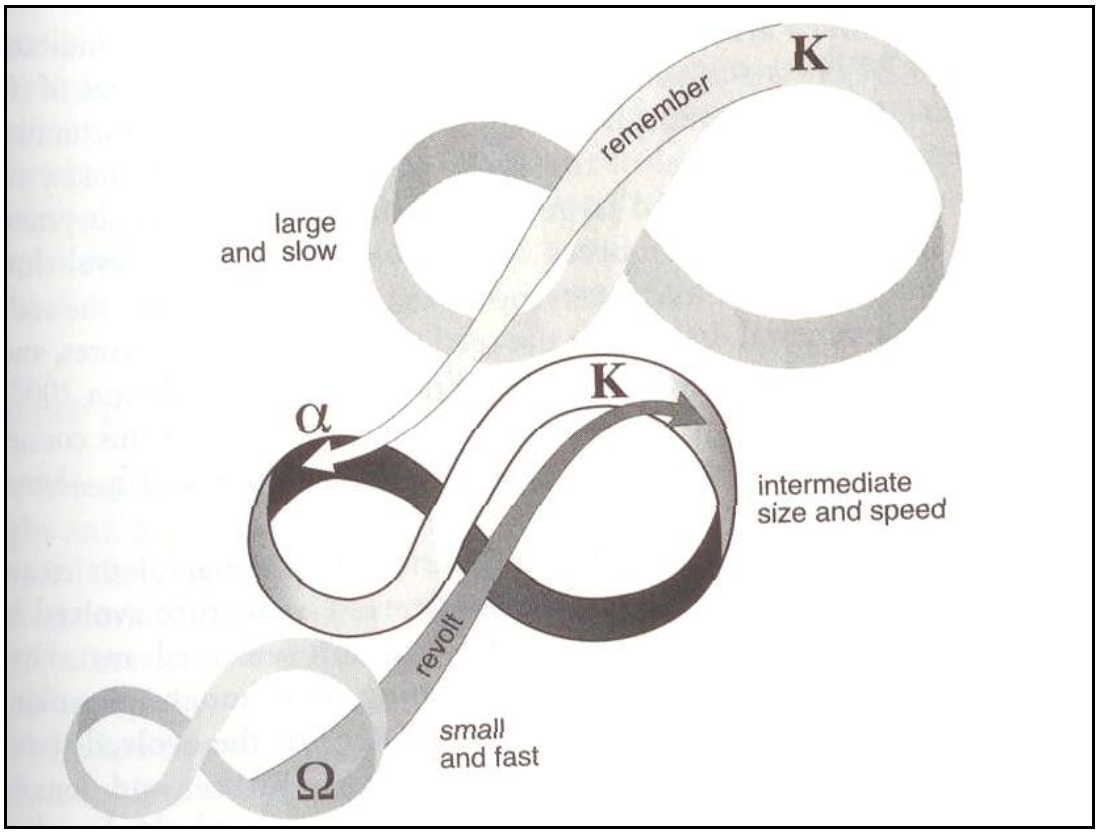

Figure 2: Panarchy. The concept of panarchy links adaptive cycles operating at different scales (Holling *et al.* 2002, p.75).

Adaptive cycles operating at different scales are connected, most significantly, by the ideas of 'Revolt' and 'Remember', which are especially important during times of change (Holling *et al*. 2002; Berkes *et al*. 2003a). The 'Revolt' connection represents the process by which changes at the small, fast scale accumulate and cascade to overwhelm events at the larger scale (Holling *et al*. 2002). The 'Remember' connection represents the process by which changes at the larger scale constrain events and processes at the smaller scale (Holling *et al*. 2002). This connection can also be useful during times of reorganization by "drawing on memory that has been accumulated and stored in a larger, slower cycle " (Berkes *et al*. 2003a). The concepts of the adaptive cycle and panarchy, however, are not unique to the resilience approach as they have developed independently in fields like archaeology and economics (Redman and Kinzig 2003). Panarchy and the

adaptive cycle can be used to characterize and understand SESs. They can also be used to help determine management actions that are appropriate for a SES depending on its status within the adaptive cycle.

Reorganization and Catastrophic Regime Shifts:

According to the resilience approach, change is inevitable (Redman and Kinzig 2003). SESs are dynamic and are constantly encountering surprises. As such, there is still much research that needs to be done regarding regime shifts and how systems respond to change (Norberg and Cumming 2008b). It is often difficult to pinpoint what will trigger the release phase of the adaptive cycle, and the form that subsequent reorganization of the system will take. There are many unresolved questions surrounding thresholds, and further study is hampered by a paucity of data (Walker and Meyers 2004). Diverse triggers can cause the disintegration of a stable state, but systems are usually made vulnerable beforehand by an antecedent, and often unrecognized, loss of resilience (Scheffer *et al*. 2001; Gunderson *et al*. 2006). The resilience of a SES can be negatively affected through the addition of foreign elements to the system, the removal of key elements from the system, the manipulation of key processes in the system (Gunderson 2003), and the accumulation of rigidities in institutions and organizations (Holling *et al*. 2002). As a system loses resilience, the size of its basin of attraction is reduced, and the system becomes more vulnerable to disturbances (Gunderson 2003). Thus, it becomes easier for surprises to overwhelm the system and trigger the release phase of the adaptive cycle (Gunderson 2003).

Not all surprises will destabilize a SES (Gunderson 2003). However, if the system is unable to respond and manage the surprise, a surprise will become a crisis

(Gunderson 2003). For example, organizational and institutional rigidity will inhibit societal response to surprises (Holling *et al*. 2002). A crisis can trigger the release phase of the adaptive cycle and subsequent reorganization of the system. These regime shifts can be catastrophic and sudden (Scheffer *et* al. 2001), and sometimes irreversible (Scheffer *et al*. 2003). It is important to recognize that restoring SESs to their exact original state following a regime shift is always difficult and often impossible (Resilience Alliance 2009c; Hughes *et al*. 2007). The idea of catastrophic change is being explored in a special feature of *Ecology and Society* that is currently in progress (Ecology and Society 2009). There are also popular books, like Shock Doctrine, Collapse, and the Upside of Down, that explore this topic.

The ways that SESs cope with surprise and crisis is of increasing interest to researchers (Gunderson 2003). The transition between stable states (from release to reorganization) is not well understood due to the high uncertainty that is characteristic of the back-loop of the adaptive cycle (Olsson *et al*. 2006). One question that is drawing increasing attention from the research community is why systems can become mired in the reorganization phase of the adaptive cycle (Carpenter and Brock 2008; Gunderson *et al*. 2002). "If an adaptive cycle collapses because the potential and diversity have been eradicated by misuse or an external force, an impoverished state can result with low connectedness, low potential, and low resilience, creating a poverty trap" (Holling *et al*. 2002, p.95-96) (see Figure 3). Resources, both natural and/or social, may be abundant in the poverty trap but the capacity to harness them to create change is low (Carpenter and Brock 2008). As times goes on, the resilience and adaptive capacity of the system will continue to fall, trapping it in a perpetually degraded state (Carpenter and Brock 2008).

It is also possible for a system to become trapped in the front-loop of the adaptive cycle where potential, connectedness, and resilience are all high (Holling *et al.* 2002). The rigidity trap is often characteristic of large bureaucracies and dictatorships (Holling *et al.* 2002) (see Figure 3).

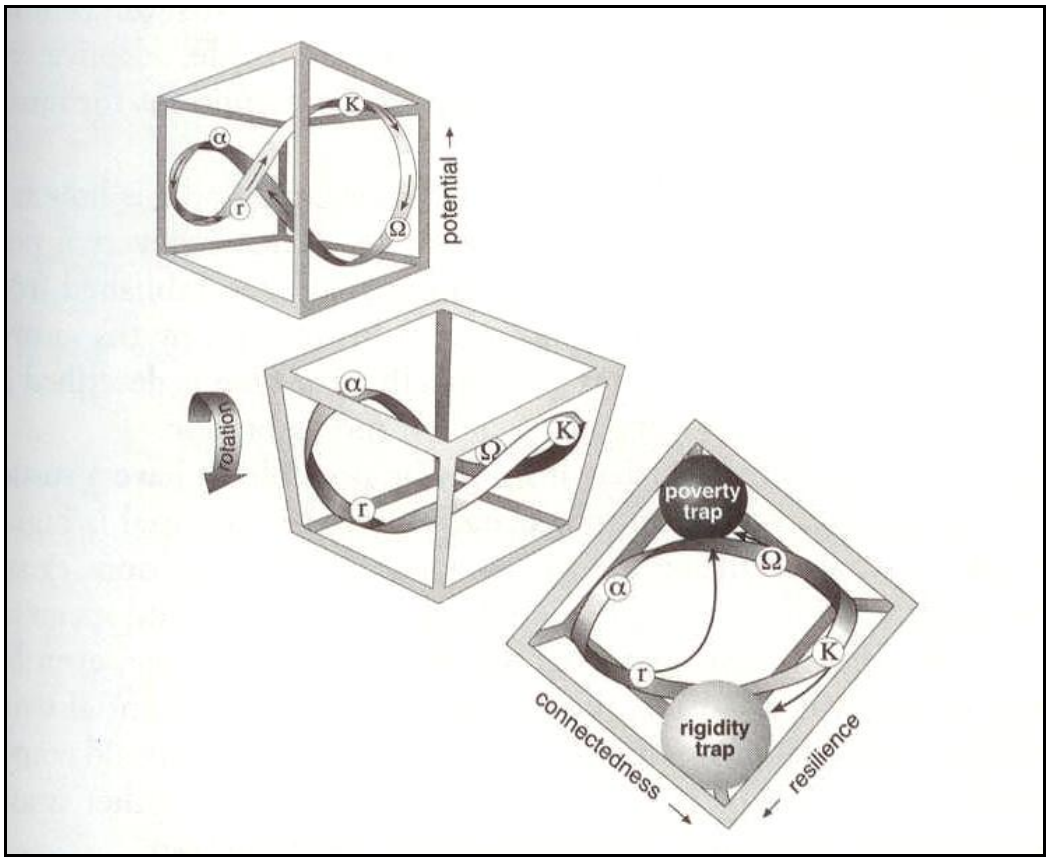

Figure 3: Maladaptive cycles. Illustrates two types of maladaptive systems, the poverty trap and the rigidity trap, which can disrupt the flow of the adaptive cycle (Holling et al. 2002, p.95).

Understanding how systems can escape from these maladaptive cycles, or traps, is an important subject for future research (Carpenter and Brock 2008). In the case of the rigidity trap, the overuse of control will likely eventually to lead to a breakdown in the system, which could propel the system back into the adaptive cycle (Carpenter and Brock 2008); however it could also push the system into a poverty trap or cause the system to totally disappear if the collapse is significant enough (Carpenter and Brock 2008). It is

possible that changes in internal dynamics or external shocks could help to force the system out of the poverty trap (Carpenter and Brock 2008). "These windows can be a result of environmental crises, policy failure, fiscal crises, activist groups, lawsuits, or slowly changing institutional structures" (Olsson *et al*. 2006, Windows of Opportunity section, para.9). Such windows of opportunity can help boost the adaptive capacity of the system allowing the transition between states to occur (Olsson *et al*. 2006; Carpenter and Brock 2008).

Resilience as a Management Tool:

Among resilience researchers there is a consensus that traditional resource management techniques are inadequate for dealing with the complexities inherent in SESs. Furthermore, they predict a paradigm shift away from these methods to an approach that is able to deal with complexity, surprise, uncertainty, and scale-interactions such as the resilience approach (Walker *et al*. 2002; Anderies *et al*. 2006; Carpenter and Gunderson 2001, Berkes *et al*. 2003a; Yorque *et al*. 2002).

As an alternative to traditional management methods, Walker *et al*. (2002) suggests trying to maintain the ability of a system to cope with stress through **resilience analysis and management** (Walker *et al*. 2002). The goals of resilience analysis and management are two-fold. The first "is to prevent an SES from moving into undesirable configurations" (Walker *et al*. 2002, Resilience Management section, para.1); while the second goal is "to nurture and preserve the elements that enable the system to renew and reorganize itself following a massive change" (Walker *et al*. 2002, Resilience Management section, para.2). However, the ultimate goal of resilience analysis and management is sustainability (Walker *et al*. 2002). In terms of the ball-and-cup

metaphor, resilience management strives to increase the size of a desirable basin of attraction (Walker *et al*. 2002). "This is different from guiding the system toward a target on the basis of forecasts. Instead, we attempt to strengthen the feedbacks that tend to maintain a particular desired configuration" (Walker *et al*. 2002, Resilience Management section, para.1). Resilience management helps a system to maintain the ability to cope with stressors and thus prevent the system from moving into an undesirable state (Walker *et al*. 2002). Managing for resilience can also help the system move to a new stable state when the present one becomes undesirable or unstable (Walker *et al*. 2002).

Traditional management relies on forecasting and prediction, which are often ineffective in complex systems where there are many uncertainties and unknowns (Walker *et al*. 2002). Instead of attempting to rigidly control various elements of the system, resilience management focuses on maintaining the functionality and capacity of the system (Walker *et al*. 2002). By concentrating on the coarse-grained features of a system, it is possible to diminish the white noise of uncertainties and find resilient pathways (Walker *et al*. 2002). These pathways help to suggest actions that will increase the overall resilience of the system (Walker *et al*. 2002).

In order to analyze the resilience of a system as a basis for managing system resilience, Walker *et al*. (2002) has proposed a four step framework (hereafter referred to as the Framework) that is laid out in the article *Resilience Management of Social-ecological Systems: A Working Hypothesis for a Participatory Approach.* This Framework grew from a research project conducted by the *Resilience Alliance* to explore the ways that management can alter the resilience of a SES (Walker *et al*. 2002). The Framework allows stakeholders to analyze a system and decide how to best increase the

resilience of a system therefore giving it the greatest chance to persist and recover from perturbations (Walker *et al*. 2002).

The Framework has four steps (Walker *et al*. 2002). The first three steps are used to analyze the current resilience of the system while the fourth step utilizes this information for managing the future resilience of the system (see Figure 4).

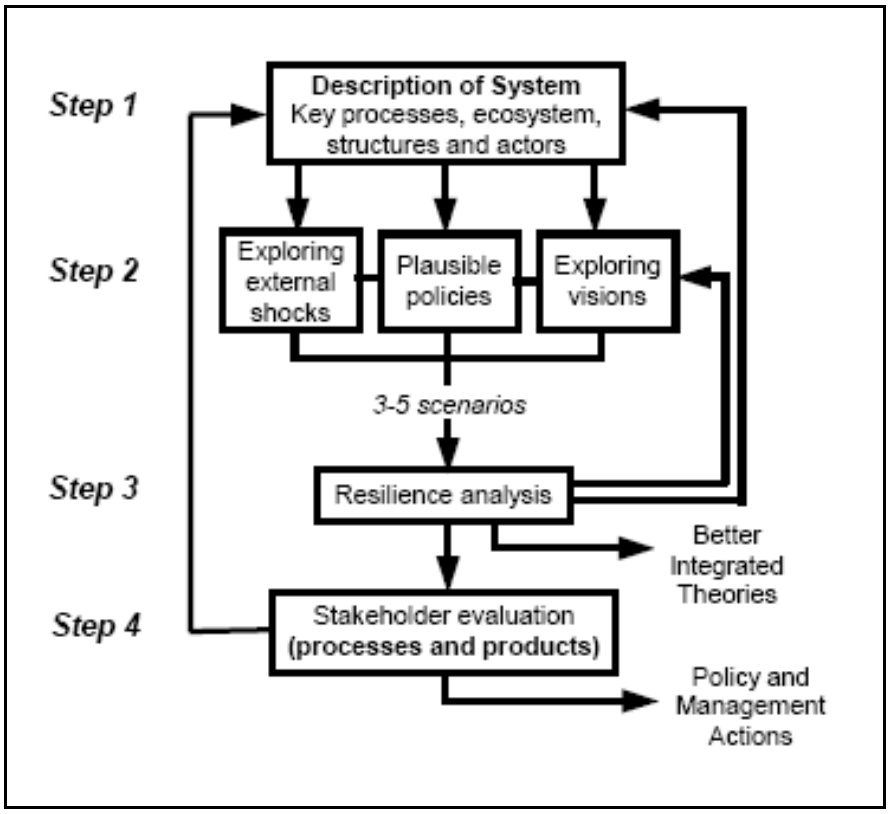

Figure 4: The Framework. The Framework laid out by Walker *et al.* (2002) has four steps designed to analyze the current resilience of the system in order to determine appropriate management actions that will increase the future resilience of the system (Walker *et al*. 2002).

Step 1 of the Framework involves an in-depth analysis of the historical and current state of the system in order to gain an understanding of the various components of the system and how they interact. It may also give clues as to the main drivers of the system as well as uncertainties about how the system may respond to change. Step 2 of the Framework entails creating a limited range of scenarios (usually three to five) that

describe possible future trajectories of the system. In this context, a scenario is defined as "a plausible exploration of the future, to be used in combination with other scenarios to explore the robustness of diverse models and choices" (Walker *et al.* 2002, Step 2 section, para.1). In Step 3, the information gathered in Step 1 and the future scenarios from Step 2 are combined to create simple models that help link the current state of the system, possible futures, and management decisions (Walker *et al.* 2002). These models are used to explore the dynamics of the SES under varying conditions and how this affects system resilience. The outputs from Step 3 can help decision-makers, and other stakeholders envisage how their actions will impact the resilience of and the future state of the system. The Framework considers that "a model is any representation (art, writing, music, or mathematics, for example) that allows people to manipulate or understand abstractions" (Walker *et al.* 2002, Step 3 section, para. 2).

Finally, Step 4 involves a review of the entire process and a discussion of the "the implications of the emerging understanding for policy and management actions" (Walker *et al.* 2002, Step 4. section, para.1). While Steps 1 through 3 help to clarify the factors at work in the system, Step 4 is concerned with creating a set of actions for managing the future of the system. These actions are not meant to keep the system on any predicted developmental path but "[r]ather, the policies are aimed at a set of rules (incentives and disincentives) that enhance the system's ability to reorganize and move within some configuration of acceptable states, without knowing or caring which particular path the system might follow" (Walker *et al.* 2002, Step 4 section, para. 1). However, maintaining this capacity can be costly and to the detriment of short-term economic gains (Anderies *et al.* 2006). As such, the long-term vision of resilience can be at odds with the

short-term vision of politicians and other officials and this needs to be reconciled (Anderies *et al*. 2006).

All steps of the Framework proposed by Walker *et al*. (2002) for resilience analysis and management are meant to be completed using extensive stakeholder participation in order to increase the legitimacy of the final outputs. Therefore identifying the relevant stakeholders at the beginning of the process is critical (Walker *et al*. 2002). Finding consensus is always challenging but the actual process of completing the Framework can be helpful by gathering the relevant people, creating a common understanding of the system, and discussing the reality of the future of the system. The Framework, however, is a work in progress and Walker *et al*. (2002) invite suggestions and comments based on "the experiences and results of the process in a number of different SESs" (The Approach section, para.6).

The Framework laid out by Walker *et al*. (2002) was used by Gonzalez *et al*. (2008) in the article *Rethinking the Galapagos Islands as a Complex Social-Ecological System: Implications for Conservation and Management* to explore resilience analysis and management in the Galapagos Islands. The Galapagos Islands are an important ecological hotspot and offer the opportunity to study the early stages of social-ecological interactions due to relatively late colonization by humans (Gonzalez *et al*. 2008). The environment of the Galapagos Islands is deteriorating due to population pressures and invasive species (Gonzalez *et al*. 2008). Despite significant efforts from the government and international financial support "social-ecological problems persist and seem to resist resolution, as does the establishment of a firm sustainability plan for the islands" (Gonzalez *et al*. 2008, Introduction section, para.6). Gonzalez *et al*. (2008) use resilience

analysis and management to explore ways the system can overcome the current crisis and transition towards sustainability (Gonzalez *et al*. 2008).

Gonzalez *et al*. (2008) perceive that part of the problem may be that in the past management of the Galapagos Islands has been approached sectorally, which ignores the complex nature of the system. Therefore, the resilience approach can act as a useful tool to create an integrated management scheme for the Islands (Gonzalez *et al*. 2008). To explore this idea, Gonzalez *et al*. (2008) followed the Framework laid out by Walker *et al*. (2002). First, they explored the historical and current context of the Galapagos Islands. Then, three future scenarios were created and a conceptual model was designed to explore the links between the current state of the system and the three possible futures. The model used Odum's emergy symbols to visualize the interactions of the three scenarios and various system drivers using tourism as the main indirect driver. Subsequently, Gonzalez *et al*. (2008) used this analysis to explore and contrast current management practices and those based on a resilience approach.

Gonzalez *et al*. (2008) found that "[d]espite limitations, the view of Galapagos as a social-ecological system (SES) from the resilience perspective has proven to be a useful tool to gain an understanding of the dynamics and overall functioning of the archipelago, as well as to identify the primary historical and current drivers of change" (Conclusions section, para.1). They also found that the resilience approach could serve as a tool to link stakeholders conflicting over the human-nature debate, which is badly needed in the Galapagos (Gonzalez *et al*. 2008). Finally, they found that the current crisis has the potential to act as a window of opportunity to move the system towards a more sustainable future (Gonzalez *et al*. 2008). However, it is up to decision-makers and other

stakeholders to garner momentum and move the system into a new, desirable configuration (Gonzalez *et al*. 2008).

SESs are inherently complex and change is inevitable, and not always predictable (Hughes *et al*. 2007). Furthermore, ecological and societal values are bound to shift and evolve over time (Bohensky 2008). In the face of these inexorable uncertainties and the reality of increasing global environmental change, managers and decision-makers need a framework that is flexible and able to cope with complexity. Therefore, a resilience approach seems to be the most pragmatic framework for managing SESs rather than traditional approaches (Anderies *et al*. 2006).

Conclusion:

This Chapter introduced the concept of the resilience approach which will be used as the theoretical framework of this thesis. It gave a brief overview of resilience, and the role that it can play in the management of SESs. Resilience is a valuable approach for exploring the dynamics of SESs (Peterson 2000). However, it is clear that more research is needed in the field of resilience in order to explore ideas like regime shifts and reorganization following release.

Chapter 3: Methodology

Introduction:

The goal of this study is to examine the resilience of social-ecological systems (SESs) using the case study of the Iraqi Marshlands. Chapter 3 will review the methodology that will be employed to answer the research questions presented in Chapter 1.

This Chapter will begin by locating myself within the research. It will then outline my research methods. Finally, this Chapter will discuss the types of data that will be used to analyze the case study of the Iraqi Marshlands and the difficulties associated with data collection in Iraq.

Positionality:

As researchers, "we bring a set of assumptions, beliefs, theoretical orientations, and expectations to our research" (Jackson 1999, p.268). These preferences will impact all stages of the research process (Jackson 1999). This subjectivity can affect the direction of research and introduce bias. Therefore, before undertaking this study, it is important for me to position myself within my research and explore my values and biases.

I am a Canadian woman with no ancestral ties to the Middle East. I do not speak Arabic, nor have I spent any significant amount of time in the Middle East. I have been employed as a research assistant for the Canadian-Iraq Marshland Initiative, Phase II (CIMI-II) since October 2007. Through this affiliation I have had the chance to read and write extensively on Iraq and the Iraqi Marshlands on the topics of the natural

environment, economic activity, community services, decision-making, and peace and conflict. Through CIMI-II I have also had the occasion to meet and speak with CIMI-II Iraqi project managers and been able to sit in on CIMI-II team meetings. Most importantly, I had the opportunity to go to Amman, Jordan in July 2009 to attend a three-day meeting between CIMI and the Iraqi Advisory Committee. Given the current security situation in Iraq it was not possible for me or any Canadian CIMI-II members to visit the Iraqi Marshlands.

I completed my undergraduate degree in Physical Geography and Environmental Studies. This juxtaposition of science and social science led me to value breaking down dichotomies like nature and society, and qualitative and quantitative. I strive to distance myself from human-environment dualism because I feel that resource management issues cannot be addressed without considering both. I feel that unless both aspects are addressed, there is no hope to finding solutions to our environmental problems and moving towards sustainability. Furthermore, I believe that this requires a flexible approach that responds to current conditions and available resources.

My choice to use the resilience approach as the basis of my analysis has clearly been influenced by my positionality. As discussed in Chapter 2, the resilience approach recognizes that social and ecological systems are inextricably linked and cannot be successfully managed in isolation from each other. As such it works to break down the human-nature divide.

The resilience approach also advocates taking the time to fully understand a system before acting. Given the complex nature of the Iraqi Marshlands, this is an important step. Newman (2007) notes that without an integrated approach that considers

all the elements of the system, it will not be possible to restore the Iraqi Marshlands in any way.

Furthermore, the resilience approach promotes flexibility in planning, decision-making, and implementation. It allows for a "muddling through" approach that focuses on the best use of available resources and re-evaluating activities as the situation changes (Wollenberg *et al.* 2007). An approach that can respond to changing local conditions could be especially important in a context, like the Iraqi Marshlands, where the situation is uncertain and volatile.

Given my background, I would never claim to fully understand the situation in the Iraqi Marshlands, or be willing to impose my ideas on others. This could perpetuate colonial sentiment and traditions of western dominance. However, by applying a new analysis framework to the case study of the Iraqi Marshlands, this research can offer alternative perspectives on the situation and can contribute to the greater body of literature regarding the analysis of SES.

Research Methods:

The Iraqi Marshlands, SESs, and Resilience:

The resilience approach is used to explore the dynamics of SESs. Therefore, to apply the resilience approach to water management in the Iraqi Marshlands, I must first demonstrate that it is a SES.

To do this, I use the definition of a SES presented by Anderies *et al*. (2006) complimented with commentary from Berkes *et al*. (2003a, p.1-7). The book *Navigating Social-Ecological Systems* by Berkes, Colding and Folke (2003) emerged from "the Resilience Project, a 5-year international project to develop integrative theory for

sustainable systems and to propose integrative practice that can be tested within developed and developing regions" (Holling 2003, p.xvi). Scientists, scholars, and practitioners from around the world collaborated to generate four central themes for the Resilience Project, which were turned into books, of which *Navigating Social-Ecological Systems* is one (Holling 2003).

The Framework:

Once it has been established that the Iraqi Marshlands are a SES, I then use the Framework by Walker *et al*. (2002), which was described in detail in Chapter 2, to examine the case study of the Iraqi Marshlands. As previously discussed, the Framework uses four steps in order to analyze the current resilience of the system as a basis for future management using a resilience approach.

Step 1 of the Framework involves an in-depth analysis of the historical and current state of the system in order to gain an understanding of the various components of the system and how they interact. Chapter 4 will discuss the history of the Iraqi Marshlands while placing them in the broader context of events in Iraq. Then in Chapter 5, the context of the Iraqi Marshlands will be further analyzed by situating it within the adaptive cycle.[3] Such an analysis can help to better understand how past events have led to the current situation (Gonzalez *et al*. 2008). Although this process can be quite subjective, Gonzalez *et al*. (2008) contends that it is a valuable exercise and can help increase understanding of a case study.

Step 2 of the Framework entails creating a limited range of scenarios (usually three to five) that describe possible future trajectories of the system. For my analysis of

[3] The adaptive cycle is a metaphor for interpreting the dynamics of SESs through a cyclical pattern of exploitation, conservation, release, and reorganization (see Chapter 2).

the Iraqi Marshlands, I will be using a set of three scenarios that were developed by CIMI-II in conjunction with the Advisory Committee. These three future scenarios represent a best case, an intermediate case, and a worst case with respect to future Marshland extent (CIMI-II 2009).

The likelihood of bringing about each of the three scenarios is based on the management outcomes of nine key drivers: dams on the Tigris and Euphrates by Turkey and Syria, dams and dykes in Iran, dams on the Tigris and Euphrates by Iraq, tidal flow, wastewater and pollution, competition for water, drought, community responsibility, and population and economic development (CIMI-II 2009). The scenarios and key factors were developed by CIMI-II and reviewed and discussed by the Advisory Committee at the meeting in Amman, Jordan on 9-11 July 2009. The three scenarios will form the basis for Step 2 of the case study analysis of the Iraqi Marshlands.

In Step 3, the information gathered in Step 1 and the future scenarios from Step 2 are combined by creating simple models that help link the current state of the system, possible futures, and management decisions. I will be creating two qualitative conceptual models in order to characterize the situation in the Iraqi Marshlands. A qualitative conceptual model is a visual summary of a system, accompanied by a written explanation, that shows the components of a system and the links between them (Dresner 2008). Conceptual models are useful tools for representing complexity and visualizing the relationships and interaction between the components of a system (Dresner 2008). They are also useful for creating a continuing dialogue about the components of a system and their relationships and interactions (Soullière *et al*. 2001). Conceptual models can also be used to help planners and managers make decisions about the system (Thom

2000). Both models in Step 3 will emphasize the integration of ecological and social interests in order to create a holistic visualization of the Iraqi Marshlands. The components of the models will be chosen based on the analysis of Step 1 and Step 2 of the Framework.

The first model will focus on the interactions between the international, national, and local scales while the second will focus exclusively on characterizing the Marshlands. The second model will be built around the three future scenarios. State-and-transition models are used to represent alternative stable states for a system (Briske *et al*. 2008). They also show the thresholds between the stable states (transition from desired state to undesired state) as well as the pathways to restoration (transition from undesired state to desired state) (Briske *et al*. 2008). As such the second model will utilize state-and-transition models as a framework for organizing the three scenarios within the conceptual model and showing the links between them. Archetypal systems models will be used to organize the components of the system within each future scenario (or alternative stable state) and show the relationships between the different components of the system (see Bennett *et al*. 2005). "These archetypal systems models are general, formal, flexible, simple, and largely qualitative. They can be used as templates for the development of specific models suited to particular cases" (Bennett *et al.* 2005, p.950). The models will also draw from the experience of Gonzalez *et al.* (2008) in the Galapagos Islands. These two conceptual models will then be used as the basis for the discussion of policy implications in Step 4 of the Framework.

Finally, Step 4 involves a review of the entire process and a discussion of the "the implications of the emerging understanding for policy and management actions" (Walker *et al*. (2002).

I will be using the four steps of the Framework to analyze the resilience of the Iraqi Marshlands as a basis for managing the future resilience of the system. Through this exercise I hope to determine if the Framework can be applied to the Iraqi Marshlands and if resilience analysis and management is a useful management tool in this SES.

Lessons Learned:

As previously discussed, case studies can help increase understanding of SESs and resilience. They offer valuable opportunities for learning and helping to operationalize resilience as a management tool. The case study analysis of the Iraqi Marshlands can offer insight into the use of the Framework, and resilience analysis and management that can potentially be applied to other SESs. Therefore, I will present the lessons learned from the analysis about the Framework and resilience analysis and management and discuss how these findings may be useful for other SESs.

Data Collection and Sources:

It is common knowledge that Iraq is currently experiencing violent conflict and that the security situation is unstable. In 2004, the Canadian Department of Foreign Affairs advised that no Canadians travel to Iraq. Therefore it was not possible for me, or any of the Canadian CIMI-II members, to visit Iraq or the Marshlands. Given these restrictions, data had to be acquired using more creative methods.

An extensive literature review, from a variety of secondary sources, provided valuable background information for the case study. I was also able to utilize CIMI-II data that had been gathered by Iraqi assistants in the field as well as meetings and discussions with the Advisory Committee.

Working remotely:

The inaccessibility of the study area has had implications for my research in general and for the implementation of the Framework that I have chosen to use to analyze my case study.

In the Framework laid out by Walker *et al.* (2002), each step is completed using participant participation. However, given the restrictions of the study site it was not possible for me to organize this as suggested by Walker *et al*. (2002). Therefore, as discussed in the above section, it was necessary to use other methods to obtain information and feedback from stakeholders. Furthermore, arranging and conducting the full range of participatory sessions goes well beyond the scope of a Masters thesis, especially given the difficulties that it takes to gain consensus as well as cultural and linguistic barriers. Instead, local voices were heard through interaction with the Advisory Committee, CIMI-II Iraqi team members, and data collected by CIMI-II assistants through workshops and interviews.

Studies using indirect data collection "account for a large amount of the work done by social scientists" (Jackson 1999, p.159). Furthermore, secondary data analysis is a common technique used (Jackson 1999). While far from ideal, it is not always possible for researchers to visit a study site. This should not make these sites any less worthy of receiving research time and attention. Resource management problems will not resolve

themselves if they are ignored. Instead, difficult circumstances should be viewed as an opportunity to exercise creativity to find effective and innovative methods to address the challenges at hand. The resilience approach recognizes that managing SESs is neither easy nor simple. Therefore, it embraces a "muddle through" approach, which allows for a flexible process that makes the most of available resources (Wollenberg *et al*. 2007).

Additionally, it is always important to consider who the most appropriate person is to carry out research in a specific location or on a certain topic. In the case of the Iraqi Marshlands, for example, it may be beneficial to have local assistants conducting interviews as they are already well known and respected in the community, speak the language, and are familiar with local customs. While working as the Deputy Governorate Coordinator of Maysan in 2004, Rory Stewart (2006) found that even with the advantage of being on location and good translators, "it was often difficult for us to understand Iraqi guests and for them to understand us" (p.230). Moreover, it is important not to propagate neocolonial attitudes. As such, partnering with local institutions and networks can help to gain legitimacy, acceptance, and respect in local communities. CIMI-II has been working with local people and institutions, as well as international groups, since 2007 which has helped them to gain legitimacy and a reputation for doing good work. CIMI-II has created valuable resources and connections that could not be built up over the course of a Masters thesis. Therefore, association with such a well-respected project helps lend legitimacy to my own work even though I am not able to visit the study area.

Given the larger research goals in the field of resilience management mentioned earlier, it is important to test theories and frameworks by applying them to a variety of case studies. This can help to discover limits for the application of the resilience

approach and gain more insight into its practical application. As discussed in Chapter 1, resilience does not lend itself well to field experimentation so when an opportunity to study large-scale reorganization occurs it is important to take advantage.

Conclusion:

Chapter 3 presented the methodology that will be used to answer the research questions presented in Chapter 1. First, this Chapter presented my positionality. Next, it outlined my research methods. Finally, this Chapter discussed the types of data that will be used to analyze the case study of the Iraqi Marshlands and the difficulties associated with data collection in Iraq.

Resilience "and its utility to practical management remains substantially underdeveloped" (Marshall and Marshall 2007, Introduction section, para.4). It is my hope that the analysis of this case study will contribute to efforts to operationalize resilience analysis and management as a useful management tool in SES.

Chapter 4: The Iraqi Marshlands

Introduction:

This Chapter will review the context of the Iraqi Marshlands. The Marshlands are a unique, complex system that is nested within the socio-political realm of Iraq as a whole. Any discussion of water management in the Iraqi Marshlands would be incomplete without situating the Marshlands within the larger context of Iraq and reviewing the historical development of the Marshlands themselves. To be successful, water management plans must consider the historical and ecological evolution of the Marshlands in order to properly understand and incorporate the components and relationships acting in this complex system.

This Chapter will begin by giving an overview of the pre-drainage ecology and culture of the Iraqi Marshlands. Next, it will give a brief history of the Marshlands while placing them in the broader context of events in Iraq. Then the current ecological, economic, and cultural state of the Marshlands will be discussed. Finally, this Chapter will review some of the concerns for the future of water management in Iraq and the Marshlands.

While this Chapter places the Marshlands within the greater context of Iraq, due to the transboundary nature of the Euphrates and Tigris Rivers, water management in the Marshlands will also be heavily influenced by the actions of its upstream neighbours (Turkey, Syria and Iran); however, detailed discussion of these impacts is beyond the scope of this thesis.

Pre-Drainage Conditions of the Marshlands:

Before the Iraqi Marshlands were drained, they were the largest wetland complex in the Middle East and Western Eurasia (Partow 2001). They measured between 15 000 and 20 000 km^2 (Partow 2001) which is roughly twice the size of the Florida Everglades (Richardson and Hussain 2006).

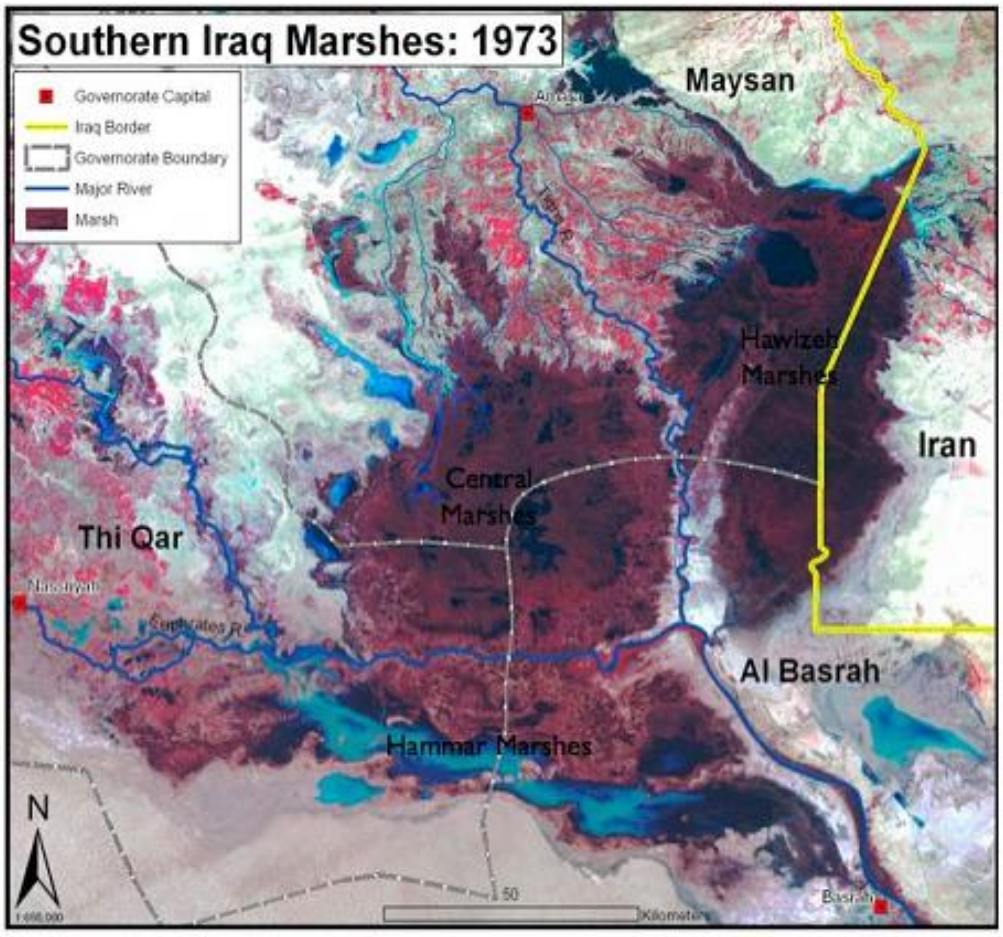

Figure 5: Southern Iraq Marshes, 1973. Map of the pre-drainage extent of the Marshlands (CIMI-II 2009, p.5). The names of the three main marshes (Hammar, Central, and Hawizeh) have been added.

The Marshlands cross the borders of three Iraqi governorates: Thi Qar, Maysan and Basrah. The Marshlands are very flat and consist of an interconnected network of

shallow lakes, backswamps and marshlands (Partow 2001). The Marshlands are fed by the Euphrates and Tigris Rivers, which have their headwaters located mainly in Turkey but also Syria, Iran and northern Iraq (Partow 2001). The spring flood occurs between February and May due to snowmelt in Turkey and the Zagros mountains (Partow 2001). This seasonal pulse causes extensive flooding which is important for maintaining the marsh system (Partow 2001). Alternatively, areas of the Marshlands may dry up due to high temperatures and evaporation in the hot summer months (Partow 2001). About 25% of the Marshlands used to be permanently flooded (Naff and Hanna 2003).

While this thesis will be considering the Iraqi Marshlands as a whole, they are actually a marshland complex and are often subdivided into a number of smaller, interconnected marshes. They can be roughly divided into three main areas: the Hawizeh Marshes, the Central Marshes, and the Al Hammar Marshes (Partow 2001) (see Figure 5). Iraq depends on the Euphrates and the Tigris for the majority of its water (Polk 2005). However, the three marshes rely on different tributaries as their source of water. The western portions of the Hawizeh Marshes depend on tributaries of the Tigris River (Partow 2001) while the eastern portions are also fed by the Karkheh River, which originates in Iran (Partow 2001; Maxwell 2006). This explains why the Hawizeh Marshes have been able to persist somewhat while the rest of the Marshlands were decimated (Maxwell 2006). However, Iranian hydrological development of the Karkheh River will have serious ecological consequences for the Hawizeh Marshes (Partow 2001; Maxwell 2006). The Central Marshes primarily receive water from several tributaries of the Tigris River with the Euphrates River contributing to some parts of the southern portion of the marshes (Partow 2001). The Al Hammar Marshes are mainly fed by the

Euphrates River (Partow 2001). However, water overflowing from the Central Marshes during seasonal flooding also contributes to the Al-Hammar Marshes (Partow 2001). Furthermore, due to its close proximity to the Persian Gulf, the Al Hammar Marshes are slightly brackish (Partow 2001).

Before they were drained, the Iraqi Marshlands supported a high level of biodiversity (Richardson and Hussain 2006). Vegetation is dominated by *Phragmites australis* and the Marshlands have been described as a "river of grass" (Richardson and Hussain 2006). Both freshwater and marine fish species were present in the Marshlands and the Marshlands acted as an important spawning and nursery ground for marine creatures, like shrimp (Richardson and Hussain 2006). There were also about forty different types of mammals present in the Marshlands of which few species now remain (Evans 2003); they also sustained a plethora of bird species, some of which, like the Iraqi Warbler, were only found in the Marshlands (Richardson and Hussain 2006). The Marshlands were also important for birds undertaking their annual migration between Siberia and Africa (Evans 2003).

Furthermore, the Marshlands acted as an important filter for the water of the Euphrates and Tigris Rivers before they were discharged to the Gulf (Partow 2001). The diversion of water from the Marshlands has degraded the coastline of Kuwait due to changes in flooding and sedimentation patterns (Partow 2001).

The Marshlands were traditionally home to a unique group of people called the Marsh Dwellers who had been living in the Marshlands for over 5000 years (Ochsenschlager 2004). Archeological evidence has shown that the lifestyle of the modern Marsh Dweller is comparable to that of ancient times (Ochsenschlager 2004). By

this token, it is possible to give a general description of traditional life in the Marshlands based on what is known about the people who lived there in the years before the Marshlands were drained (Clark 2003). The changes that the traditional culture of the Marsh Dwellers have undergone due to increased contact with mainstream Iraq will be investigated in the section *History in Five Periods*.

The Marsh Dwellers built their houses on marsh islands or on human-made platforms made of alternating layers of reeds and silt (Ochsenschlager 2004). The Marsh Dwellers engaged in fishing with spears, hunting and also raised water buffalo (Ochsenschlager 2004).[4] The water buffalo were highly prized and used for their milk, butter and hides (Partow 2001). Boats were also a very important component of marsh culture and were used for traveling, hunting, fishing and gathering reeds (Thesiger 1964; Ochsenschlager 2004). Every family had at least one boat, which were usually made out of wood and covered with bitumen (Ochsenschlager 2004).

The Marsh Dwellers utilized reeds (*Phragmites australis*) for a variety of purposes including constructing family homes and *mudeifs*[5], baskets, and mats (Thesiger 1964; Ochsenschlager 2004; Stewart 2006). The Marsh Dwellers also made everyday objects out of mud including house walls, dishes for cooking and baking, storage containers, musical instruments, toys, and ammunition (Ochsenschlager 2004). Using the materials that were available to them, the Marsh Dwellers were traditionally able to lead a totally self-sufficient lifestyle (Ochsenschlager 2004). However, the Marsh Dwellers

[4] It is interesting to note that other tribes, like the Bedouin and the Beni-Hasan, find the practice of keeping water buffalo disgusting and looked down on the Marsh Dwellers for doing it (Thesiger 1964; Ochsenschlager 2004). .

[5] A large reed house used as a meeting place or guest house.

typically had few possessions (Ochsenschlager 2004) and life in the Marshlands could be very harsh.

The Marshlands were, and still are, tribal in nature with families deferring authority to a tribal sheikh (Ágoston and Masters 2009). Furthermore, the Marsh Dwellers are Shi'i Muslims (Sluglett 2003a) and traditionally adhered to a strict code of religious and moral conduct (Ochsenschlager 2004). The Marsh Dwellers lived in relative isolation from mainstream Iraq well into the twentieth century (Ochsenschlager 2004). However, changes in marsh culture were beginning to be seen in the 1950s (Thesiger 1964; Ochsenschlager 2004) and by the mid-1980s the traditional way of life in the Marshlands had all but been destroyed (Ochsenschlager 2004).

History in Five Periods:

This section will discuss the history of the Marshlands and place them within the wider context of Iraq. The region known today as Iraq has always been a contested landscape and control of this area has been fought over since ancient times. Polk (2005) divides the history of the region into five periods based on political administration: Ancient Iraq, Islamic Iraq, British Iraq, Revolutionary Iraq and American Iraq.

The five periods suggested by Polk (2005) will be used to recount the history of the Marshlands and place them within the wider context of the region of Iraq. Each of these time periods will discuss the political evolution of Iraq, while relating these events to water management, the state of the Marshlands and the culture of the Marsh Dwellers. This historical account of the Marshlands will help to explain the current configuration of the system in order to better understand future water management in the area.

Ancient Iraq: 14 000 BCE-637 CE

The Sumerians were the first people to arrive in the region of modern day Iraq about 14 000 years ago (Polk 2005) with the first settlements along the lower Euphrates appearing about 3000 BCE (Stewart 2006). It is believed that the present day Marsh Dwellers can trace their origins back to these first Sumerian settlers (Stewart 2006). While the origin of the Marsh Dwellers is not well documented, it is generally accepted the Marsh Dwellers have been living in the area for about 5000 years. Ochsenschlager (2004) also hypothesizes that people started to eke out a living from the Marshlands after the quality of the environment in the areas adjacent to the Marshlands began to deteriorate (see Chapter 1).

Iraq changed hands often in ancient times with many different groups, like the Assyrians, the Babylonians, the Persians, the Parthians, the Romans and the Greeks, fighting for control over the area (Ochsenschlager 2004; Polk 2005; Stewart 2006). However, due to the harsh environment and isolation of the Marshlands, the Marsh Dwellers remained relatively insulated from the various conquests of Iraq. Polk (2005) describes the climate of Southern Iraq as "one of the harshest in the world" (p.23). The isolation created by the unique environment allowed a unique culture to develop and persist in the Marshlands that remained unchanged well into the twentieth century (Ochsenschlager 2004).

Islamic Iraq: 637 CE-1914

Battle for control over the region of Iraq continued. Iraq was conquered by the Muslims at the Battle of Qadisiyyah in 638 CE (Bogle 1998). The proceeding era known as the Abbasid Caliphate, which lasted from 705 CE to 1258, was the Golden Age of

Islam and during this time Iraq flourished (Ágoston and Masters 2009). However, towards the end of the Abbasid Caliphate, Iraq's irrigation-based agriculture fell into disrepair (Ágoston and Masters 2009). Furthermore, water provision began to fail as the canals, such as those built to support the desert holy cities of Najaf and K'arbala, silted over (Ágoston and Masters 2009). During the decline of the Abbasid Caliphate, the central government also attempted to increase revenues by a variety of dubious means. "We have no contemporary records of how the common people reacted, but the record shows that they did all they could then and until the present to avoid any contact with government. For them, government always equated to taxes and often meant ruin" (Polk 2005, p.53).

In 1534, the Ottomans began their conquest of Iraq in Baghdad and by 1546 had extended their territory all the way to Basrah (Ágoston and Masters 2009). However by this point in time, Iraq's circumstances were severely diminished and the Ottomans showed little interest in involving themselves in Iraq or the Marshlands (Polk 2005). Like many of the Empire's other remote territories, the Marshlands "had never been under more than the nominal control of the central government in Istanbul for much of almost four centuries of Ottoman rule" (Sluglett 2003a, p.223).

During the nineteenth century, two important trends emerged in Iraq. The first was the spread of Shi'ism through the efforts of missionaries from the holy cities of Najaf and K'arbala who converted both non-Muslims and Sunni Muslims (Ágoston and Masters 2009). By between the nineteenth and twentieth century, the Shi'is formed a majority in Iraq (Nakash 1994). This would exacerbate the Sunni-Shi'i tension that had

existed since the Abbasid Caliphate[6] (Ágoston and Masters 2009). Iraq will continue to be plagued by tensions between the ruling Sunni minority and the majority Shi'i until the present day. During his time with the Coalition Provisional Authority (CPA) between 2002 and 2003, Rory Stewart (2006) would note that "the ruling class in Baghdad was from the Sunni minority, and they saw the Shia as backward and superstitious at best and, at worst, heretics" (p.44).

The second major trend was the rapid tribalization of the rural population (Polk 2005; Ágoston and Masters 2009). The magnitude of this phenomenon was unique to Iraq with almost the entire rural population deferring authority to the tribal sheikhs (Sluglett 2003a; Ágoston and Masters 2009). The tribes in the south could be divided, based on livelihood provision, into "camel breeders, sheep breeders, cultivators, and buffalo-breeding marsh dwellers" (Nakash 1994, p.444). Furthermore, "[a] system of hierarchy based on the mode of subsistence developed, with the camel-breeding tribes at the top, sheep breeders below, peasants below them and marsh dwellers at the bottom of the scale" (Jabar 2000, p.28). The reputation of the Marsh Dwellers did not improve over the centuries. When legendary explorer William Thesiger ventured out on this first visit to the Marshlands in 1951, his host, a leader of the Al bu Muhammad tribe living at the edge of the Marshlands, expressed his surprise at Thesiger's wish to spend time there saying, "You English are strange people! One night in the Marshes is enough for me when I have to go there on the Sheikh's business" (Thesiger 1964, p.19). Furthermore, during his archeological excavations between 1968-1990, Ochsenschlager (2004) observed that

[6] The Abbasid Caliphate was the first example of a strong Sunni government and would be used as the model for future governance by the British (Agoston and Masters 2009).

> "[o]ccasional allusions, in passing, characterized the [Marsh Dwellers] individually or collectively as dirty, lazy, venal, and not too bright. Feelings were strong enough that it appeared better to separate men of the [Marsh Dwellers] from those of the Beni Hasan on work teams, and visiting officials would regularly denigrate the [Marsh Dwellers] and the way they made a living. I had a vague feeling that the [Marsh Dwellers] were being targeted for unfavorable propaganda" (p.11).

Overall, the Ottoman government had little administrative control over Iraq and was unable to even register or accurately count the inhabitants (Sluglett 2003a). They did contribute infrastructure like the Husayniyya Canal for date grove irrigation in K'arbala and the Hindiyya Canal in 1803 to support Najaf (Ágoston and Masters 2009). The Ottomans also built the cities of Amara and Nasiriyah in the second half of the nineteenth century (Stewart 2006). However, the most lasting legacy of the Ottoman Empire was their attempt to implement the Land Law of 1858 (Sluglett 2003a). While never fully implemented, "[w]hen the Ottomans attempted land reform after 1868, the tribal sheikhs became the predominant landowners of the country as the peasants deferred to their authority and did not seek to register land in their own names. This strengthened the economic as well as political hold of the sheikhs over their tribesmen" (Ágoston and Masters 2009, p.282). The tribal nature of the region will continue to be exploited by Iraq's governmental leaders from the Ottomans and the British (Sluglett 2003a), to Saddam (Jabar 2000) and the present-day authorities in order to entrench their own power and control by co-opting tribal leaders into state service.

However, during this period life in the south of Iraq continued much as it had in ancient times. In his description of life in rural Iraq Polk (2005) states that "[t]he Ubaidian would not have felt alien in the Iraq of 1900. Using the same tools, the modern

Iraqi dug in the same soil, planted the same crops, ate the same food, and marched to the same rhythm of seasonal flood" (p.23).

British Iraq: 1914-1958

On November 5, 1914, Britain declared war on the Ottoman Empire and the invasion of Iraq began the next day (Polk 2005). By 1916 Britain had captured Nasiriyah and Amara, and by 1918 occupied all of Iraq (Stewart 2006). The British-Indian forces advanced through Iraq along the Tigris and Euphrates Rivers (Satia 2007). Prior to this mission no maps had ever been made of the Marshlands and "[b]oth official intelligence summaries and private reports described rivers that shifted course daily, unnavigable marshes, and homes and villages whose locations were fleeting at best" (Satia 2007, p.10).

Operations in Iraq were exceedingly expensive for the British and in an effort to reduce costs they tried to stimulate local food production in order to supply their army (Polk 2005). By the end of World War I, 1300km^2 of desert were being cultivated producing 50 000 tons of grain (Polk 2005). In order to accomplish this feat, areas of desert had to be irrigated which meant diverting water from the Euphrates and the Tigris Rivers. Furthermore, the ideological mantra of the campaign became the regeneration of the 'fallen Garden of Eden' and the glory of ancient Babylon (Satia 2007), which only added to Britain's determination to 'improve' Iraq through hydrological development:

> "Modern technology was the linchpin of this vision of the work of the British empire. Irrigation works seemed the appropriate antidote to the indiscipline of the nomad terrain that the cradle of civilization had become. The dams and canals ravaged by the Mongols, on which 'some fifty centuries of prosperous civilization had been based', would be restored, read a post-war article in the *Times*" (Satia 2007, p.230).

From 1920-1936, Iraq was under an official British mandate (Stewart 2006). However, Britain "continued to exercise strong influence over Iraqi governments until the revolution in 1958" (Sluglett 2003a, p.228) and thus were able to pursue their own agenda for Iraq (Sluglett 2003a). Planning and construction of irrigation and flood control systems began after 1950 (Altinbilek 2004). This period marked a shift from the types of barrages and irrigation canals that had been used downstream in southern Iraq in ancient times, to major hydrological works in the upstream part of the catchment (Partow 2001). Since the 1950s, there have been 32 dams built in the Tigris-Euphrates river basin, with eight more under construction and 13 more planned (Maxwell 2006). In 1951, British engineer Frank Haigh published his plan for the *Control of the Rivers of Iraq,* which outlined a marsh reclamation strategy (Partow 2001). In 1953 construction began on the Third River, a canal that would eventually divert almost all of the flow of the Euphrates away from the Marshlands (Tkachenko 2003), under the supervision of British engineers (Mitchell 2003).[7] However, follow-through on these projects was insignificant until about 1972 and therefore the Marshlands remained relatively stable until the mid-1980s (Partow 2001). It is believed that part of Saddam's obsession with draining the Marshlands can be linked back to this period (Satia 2007). Furthermore, Saddam would later use the plans and projects created during this time as the foundation for his systematic destruction of the Marshlands (Adriansen 2004).

The British would also continue the work begun by the Ottomans by privatizing land based on the Land Law of 1858 between 1920 and 1932 (Polk 2005). Tribal land

[7] Construction of the Third River, however, was sporadic and would not be completed until 1992 (Mitchell 2003).

became solely owned by the tribal sheikhs further strengthening the power of the tribe (Sluglett 2003a).

Another of Britain's goals was to increase control over remote parts of Iraq, like the Marshlands (Sluglett 2003a); the local people generally viewed attempts to extend the government as negative (Sluglett 2003a). From Thesiger's (1964) accounts of his travels in the Marshlands, in the 1950s many facets of the traditional lifestyle of the Marsh Dwellers were still intact like fishing practices, hunting, ceremonies and societal organization. However, his journals also evidence increased contact between the Marsh Dwellers and the outside world, such as the consumption of tea and sugar and the use of rifles (Thesiger 1964). Thesiger (1964) also recounts that the Marsh Dwellers, which were traditionally a bartering society, were starting to be incorporated into the cash economy.

Revolutionary Iraq: 1958-1990

On 14 July 1958, the British installed monarchy of Iraq was overthrown in a bloody coup (Sluglett 2003a) and the fight for control of Iraq continued. In 1968, General Hassan al-Bakr of the Ba'ath Party seized power (Polk 2005) with a young Saddam Hussein as his Vice-President (Stewart 2006). In 1979, Saddam was able to push General al-Bakr aside to officially take the Presidency (Polk 2005; Stewart 2006), which he held until April 2003. The resolve to drain the Marshlands that Saddam would display during his time as President (Satia 2007) can probably be traced back to historical roots and Saddam's efforts to retain political power (Aburish 2000). Tensions between the Sunni and the Shi'i can be dated back to the Abbasid Caliphate (Ágoston and Masters 2009). As previously discussed, Saddam's Sunni government was wary of the Shi'i

majority. Furthermore, there was the predominant view of the Marsh Dwellers as backwards and having low social standing (Thesiger 1964; Jabar 2000; Ochsenschlager 2004). There was also a long-standing fear on the part of the government that if war broke out between Iraq and Iran, that the Marsh Dwellers would side with the Iranians (Tkachenko 2003). However, these fears were unfounded and "in spite of efforts by the Iraqi regime to demonize [the Marsh Dwellers] in this way in the 1980s and 1990s, [the Marsh Dwellers] never identified themselves with 'Iran' or 'Persians', since this was never a part of their own consciousness or oral tradition" (Sluglett 2003a, p.227). When war did break out between Iran and Iraq in 1980, the Marsh Dwellers fought for Iraq. Finally, opponents to Saddam's government sometimes took refuge in the Marshlands (Ochsenschlager 2004) due its isolation and nominal government control. "From the age of the Abbasids (eighth to thirteenth centuries CE) the Marshlands were outside the control of the Baghdad authorities. They were a place of refuge for bandits, rebels and smugglers. The waterways, the wildlife and the conservative and independent nature of the people made the region resistant to any external control" (Clark 2003, p.xii). Ochsenschlager (2004) reports that the Marsh Dwellers had an alarm system consisting of mud drums and whistles that could alert the whole Marshland to the presence of the police within hours giving people time to disappear. Draining the Marshlands allowed Saddam access to these rebels in order to suppress governmental opposition (Mitchell 2003). As a result, the Marsh Dwellers did not prosper in Saddam's regime and were highly persecuted (Richardson and Hussain 2006).

When Ochsenschlager (2004) began his archeological excavations in Iraq in 1968, the majority of the Marsh Dwellers were still living in relative isolation from mainstream

Iraq. So much so that Ochsenschlager (2004) was able to use an ethnographic study of the Marsh Dwellers to interpret findings from his dig site which was dated ca. 2600-2300 B.C. Ochsenschlager (2004), however, does go on to document the rapid changes that occurred in the Marshlands over the next 22 years of his excavation.

By 1968, the Marshlands were already shrinking in some places due to private irrigation projects (Ochsenschlager 2004). "Over the next 10-12 years new canals and dams were built by the government and older ones cleared or reinforced in order, ostensibly, to prevent the consequences of dire seasonal flooding, to recover additional agricultural land, and to increase irrigation" (Ochsenschlager 2004, p.10). In the 1970s, drainage for irrigation purposes increased and the first major impacts on the Marshlands were beginning to be seen (Ochsenschlager 2004). This coincided with the most important period of hydrological development in Iraq which lasted from 1972 to 1990 (Altinbilek 2004). By this time life in the Marshlands was also beginning to change (Ochsenschlager 2004). Ochsenschlager (2004) noted that "[b]y the middle of the 1970s some of the traditional crafts and practices had completely disappeared, and barter was increasingly replaced by cash-driven economy. Goods made elsewhere and purchased in market towns became more common, eroding traditional, almost total, reliance on the material resources of the local area" (p.8).

However, it was not until the outbreak of the Iran-Iraq war that efforts to drain the Marshlands began to speed up. In 1982, Iranian troops advanced into Iraqi territory and the Marshlands become the front lines for the war (Sluglett 2003b). In the mid-1980s Saddam began to drain the Marshlands (Partow 2001) in order to move troops to the front lines and also to use water strategically to block Iranian troops from advancing

(Adriansen 2004; Naff and Hanna 2003). Ochsenschlager (2004) noted that "[i]n the 1980s it dawned on us that a part of this activity might be a deliberate attempt to get rid of the [Marsh Dwellers]" (p.11). The Marshlands also suffered from heavy contamination during the war from spent munitions and poison gas (Sluglett 2003b; Tkachenko 2003; DAI Washington 2006). Some people even believe that Saddam purposefully dumped contaminants into the water in order to make the environment unlivable.

Saddam also conscripted hundreds of men from the Marshlands to fight in the war (Ochsenschlager 2004). Many were killed, leaving their families without their sole provider which put a strain on the traditional rules of community and affected societal organization (Ochsenschlager 2004). The Iran-Iraq war was a time of exponential cultural change in the Marshlands (Ochsenschlager 2004). By 1989, Ochsenschlager (2004) notes that the Marsh Dwellers had disappeared from his study area ostensibly due to the shrinking Marshlands. It is argued that by this time, life in the Marshlands had already been irreversibly damaged (Ochsenschlager 2004).

American Iraq: 1990-present

In August 1990, Iraq invaded and annexed Kuwait (Sluglett 2003b). The United Nations (UN) responded to this aggression with sanctions and resolutions with no success (Francke 1995), and in January 1991, Coalition Forces launched their attack on the Iraqi Army (Polk 2005). To coincide with the ground assault, the U.S.A. unofficially encouraged the Marsh Dwellers, along with the Kurds in the north, to rebel against the government that had oppressed them. While Coalition Forces successfully ousted the

Iraqi Army from Kuwait[8], the rebellion in the Marshlands was brutally crushed by the Iraqi government (Sluglett 2003a). After the 1991 rebellion, efforts to drain the Marshlands intensified in an effort to punish the Marsh Dwellers for the uprising.[9] "After the risings in southern Iraq, some of the rebels took refuge in the Marshes, which caused the Iraqi regime to lay siege to the area, and movement in and out of the Marshlands was forbidden" (Sluglett 2003a, p.235). The central government launched five major drainage projects that would eventually prevent almost all the water from the Euphrates and the Tigris from reaching the Marshlands forcing a mass exodus of Marsh Dwellers with those remaining reduced to extreme poverty (Benvenisti 2003). The Iraqi Army launched a campaign against the Marsh Dwellers using heavy artillery (North *et al*. 1994), artillery, mortar, and ground attacks (Sluglett 2003a). There are also reports of the army burning and bulldozing villages, confiscating land, forcibly removing inhabitants, taking hostages (Sluglett 2003a), and poisoning the water supply (Gleick 1993). By 1993, two-thirds of the Marshlands were no longer receiving water inputs (Tkachenko 2003) and by 2000 less than 10% remained (Richardson and Hussain 2006) (see Figure 6). The Marshlands and their way of life were destroyed (Ochsenschlager 2004). Furthermore, as the Marshlands were drained, agriculture in the area was able to expand to this newly available land. Deprived of their traditional livelihood, some Marsh Dwellers also turned to farming in order to survive (Richardson and Hussain 2006).

[8] On 25 February 1991, the Iraqi Army retreated and were slaughtered as they withdrew from Kuwait (Polk 2005).

[9] It is important to note that while the 1991 rebellion brought to a head the destruction of the Marshlands, drainage and the intent to drain the Marshlands can be dated much earlier (Ochsenschlager 2004).

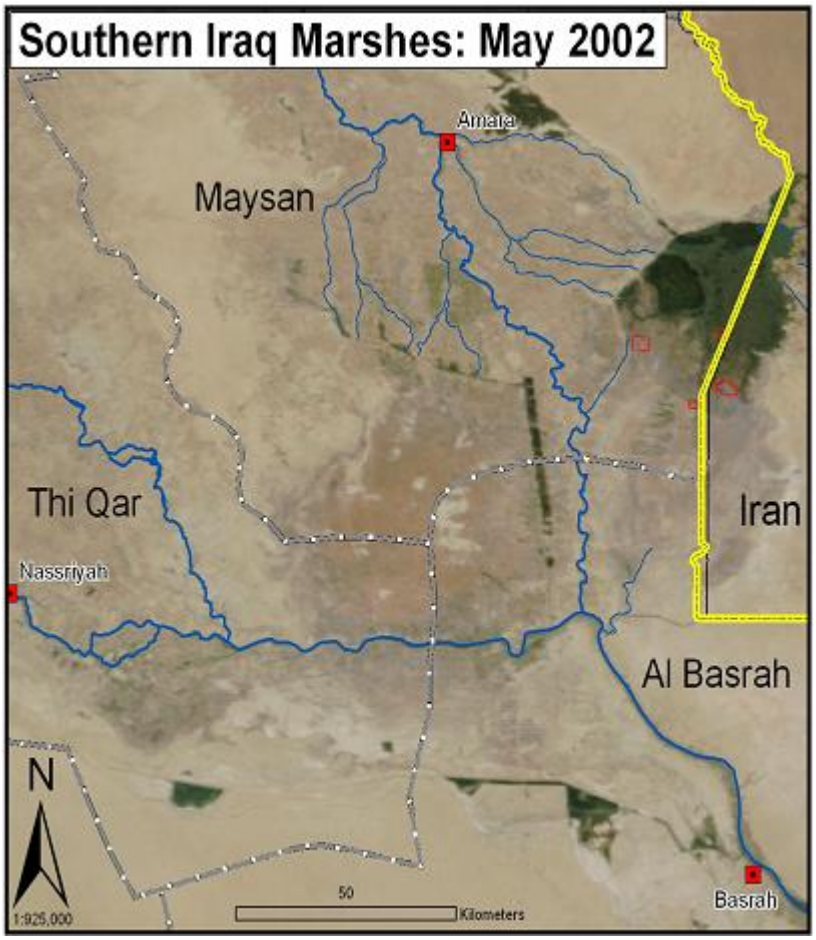

Figure 6: Southern Iraq Marhes, 2002. View of the Marshlands in May 2002 (CIMI-II 2009, p.5). Green represents marsh areas.

By the end of the Iran-Iraq war, about 500 000 Marsh Dwellers remained in the Marshlands (Coast 2003); however, it has always been difficult to record their numbers. The United Nations Office of the Humanitarian Coordinator for Iraq (UNOHCI) estimates that 100 000 to 200 000 Marsh Dwellers were displaced within Iraq and up to 100 000 left the country (UNOHCI 2003). Coast (2003) estimates that up to 120 000 Marsh Dwellers left Iraq (mostly for Iran). Migration to Iran started in 1990, peaked in 1993 and there has been a sharp decline in new refugees coming to Iran since 1996 (Coast 2003). In 1997 about 192 000 Marsh Dwellers were still living in southern Iraq and about 200 000 remained in all of Iraq (Coast 2003).

In 2003, after Saddam's regime was deposed, people living near the Marshlands began to break down the water diversion structures that were keeping water from entering the Marshlands (Richardson and Hussain 2006) (see Figure 7). Since then both Iraq and the international community have emphasized the rehabilitation the Iraqi Marshlands.

Figure 7: Southern Iraq Marshes, May 2004. View of the Marshlands in May 2004 (CIMI-II 2009, p.6). Green represents marsh areas.

Current State of the Marshlands:

Having briefly described the history of the Marshlands and placed them in the greater context of Iraq, this section will discuss the current state of the system.

According to the United Nations Environment Programme Iraqi Marshlands Observation System (UNEP IMOS), wetland vegetation and water surface area has increased by about 58% since 2003 (UNEP 2005). However, the current drought

conditions are heavily impacting the Marshlands ecosystem. In July 2008, Marshland extent was 4950km^2. By April 2009, it was reduced to 3420km^2 and by July 2009 it had reached 2313km^2 (CIMI-II 2009). In one year the Marshlands have shrunk by almost half. The Hawizeh Marshes are in by far the best shape, followed by the Hammar Marshes and lastly the Central Marshes (Richardson and Hussain 2006). The future of the Marshlands will greatly depend on the future availability of good quality water in the region (Richardson and Hussain 2006), which will be discussed in the section *The Future of Water in Iraq*.

Overall the water quality of the Euphrates and Tigris Rivers is declining mainly due to returns of saline irrigation water (Partow 2001). The water quality of the Euphrates tends to be better in the uppers reaches and declines as it moves downstream, but is generally good (Naff and Hanna 2003). However, saline irrigation returns, like Turkey's South-Eastern Anatolia Project (GAP), threaten to impact water quality (Naff and Hanna 2003). Hydrological development also reduces water turbidity, which is important for replenishing the Marshlands (Naff and Hanna 2003); the water turbidity of the Tigris River has been decreasing for decades (Naff and Hanna 2003). Similar to the Euphrates River, the water quality of the Tigris is better in the upper reaches and declines around Baghdad as irrigation returns and industrial wastes are added to the river (Naff and Hanna 2003). The quality of water entering Iraq from upstream is expected to deteriorate in the future especially in the Euphrates (DAI Washington 2006).

Where the Euphrates and Tigris Rivers meet, just past Basrah, they form the Shatt al-Arab which discharges into the Persian Gulf. Salinity rates in the Shatt al-Arab, are quite high and overall quality is low due to the addition of irrigation returns and industrial

waste (Naff and Hanna 2003). Furthermore, owing to reduced flow volumes in the Shatt al-Arab, saline Gulf water is intruding up the river due to tidal movements (Naff and Hanna 2003). As a result of these anthropogenic processes combined with naturally high evaporation rates, a high water table and insufficient water for drainage, the Iraqi Marshlands are becoming salinated (Naff and Hanna 2003). This reduced water quality impacts not only the natural environment but also the economy of the region, especially agriculture. Before the Marshlands were drained, agriculture was very limited (DAI Washington 2006). However, after drainage agriculture became "a more important source of income and livelihood for the marsh residents despite the strict control and frequent disruption of agricultural activities" (DAI Washington 2006, p.231).

Reflooding of the Marshlands is also creating water quality issues due to the release of toxins (from soils that are contaminated with chemicals, mines, and military ordnance) as water is returned to the system (DAI Washington 2006), reaching toxic levels in some parts of the Marshlands (Richardson and Hussain 2006).[10] Nevertheless, regeneration of the natural environment is occurring. UNEP IMOS estimates that between 2003 and 2006, vegetation increased by 800km^2 per year (UNEP 2005). Bird counts have shown that the number of species in the Marshlands is increasing, including some that have not been seen in the Marshlands for years (DAI Washington 2006). However, the Marshlands are not contiguous as they were before (Richardson and Hussain 2006). This reduced system connectivity will have negative impacts for fish, amphibians, microinvertebrates and plants (Richardson and Hussain 2006).

[10] A detailed analysis of the quality of the physical environment (water, soil, etc.) can be found in Richardson and Hussain (2006).

It is difficult to count how many people are currently living in the Marshlands (Nicholson and Clark 2003). UNOHCI estimates that there no more than 10 000 Marsh Dwellers actually living within the Marshlands of which only 10% are able to continue the traditional lifestyle (UNOHCI 2003). It is also uncertain how many of the Marsh Dwellers who were displaced actually want to return (DAI Washington 2006), although reports have shown that internally displaced people are returning to certain areas (UNHCR 2007a; UNHCR 2007b; UNHCR 2007c). Some of the reasons people may choose not to return include security concerns, poor fishing, have taken up agriculture (Richardson and Hussain 2006), age, and lack of services (DAI Washington 2006). Young people have grown up away from the Marshlands and do not wish to live there (DAI Washington 2006). They also lack various skills, such as reed weaving, that are the foundation of the traditional lifestyle. Furthermore, services in the Marshlands are limited. Currently, access to clean drinking water is limited (UNHCR 2007a; UNHCR 2007b; UNHCR 2007c) and the Marshlands lag behind the national average with respect to access to clean drinking water (UNEP 2007). While carrying out a population survey, AMAR International Charitable Foundation (AMAR ICF) workers noted the total absence of systems for disposing of human waste in all of the 83 villages that they visited (Nasir *et al*. 2003). Lack of sanitation in the Marshlands is also problematic (UNEP 2007) and will have negative effects on both the natural environment and human health. Furthermore, access to educational and health facilities is low (DAI Washington 2006) and poverty is high in the Marshlands. Of the 83 villages surveyed by AMAR ICF in 2003, 93% of them had neither government-funded nor private health care (Nasir *et al*.

2003). There is also a severe housing shortage (UNOHCI 2003) and unemployment is high.

The Future of Water in Iraq:

The Iraqi Marshlands are located near the outflow of the Euphrates-Tigris River basin. Therefore, activities in the upstream part of the basin will impact the amount of water that reaches the Marshlands. This section will very briefly discuss the main issues impacting future water availability in the Euphrates-Tigris River basin including population growth, hydrological development and climate change.

The future of water in Iraq holds much uncertainty. Population growth in not only Iraq, but also the upstream countries of Turkey, Syria and Iran, will increase water demand for personal use, industry and irrigation (Richardson and Hussain 2006). Since the 1950s the population of Iraq has increased from 5 million inhabitants to about 24 million (Polk 2005). Moreover, about half the population is under the age of 15 (Polk 2005) which means that the population will continue to increase in the future. Increased demand for water will drive further hydrological development of the Euphrates, Tigris and associated tributaries. Turkey, Syria, Iran and Iraq all have plans to construct more retention structures to provide water for cities, industry, and irrigation (Gruen 2000; Partow 2001; Maxwell 2006). As more water is removed in the upstream portions of the catchment, less water will be reaching the outflow of the system (Gruen 2000). According to Gruen (2000) "[w]hile the total average annual flow of the Euphrates is 35.58 billion cubic meters,…the combined future consumption of Turkey (18.42 billion cubic meters), Syria (11.30 billion cubic meters) and Iraq (23 billion cubic meters) totals 52.92 billion cubic meters" (p.566). A report by DAI Washington (2006) notes that by

the year 2030 water demand in Iraq will have reached 95 billion cubic meters while the total available water will only be 48 billion cubic meters. Furthermore, increased irrigation and industry along the Euphrates and the Tigris will have negative impacts on water quality in the rivers. Finally, it is uncertain how climate change will affect water in the region and there is the possibility that it will reduce the overall water availability of the system.

It is important to note that water availability in the Marshlands is a complicated, transboundary issue when discussing water management in the Iraqi Marshlands. However, it is clear that, given current conditions and predictions of future use, there will not be enough water to return the Marshlands to their previous extent (DAI Washington 2006; Richardson and Hussain 2006).

Conclusion:

This Chapter reviewed the case study of the Iraqi Marshlands. It gave a brief overview of the historical development of the Iraqi Marshlands while placing them in the context of Iraq as a whole. Understanding the context of a system is the first step in the management of a system (Walker *et al*. 2002). Therefore, the purpose of the historical review presented here is to help tease out the components and relationships present in the current configuration of the system while elucidating some of the most pressing issues facing the system. Characterizing the intricacies of the Iraqi Marshlands, and of Iraq, is not an easy task and not every issue could be fully discussed here. However, this Chapter aimed to show the complexities that exist within the system and underscore the fact that they must be taken into consideration during the design and implementation of any water management scheme if it is to be successful.

Chapter 5: Analysis

Introduction:

As stated in Chapter 1, *this thesis will test the bounds of resilience analysis and management using the Framework put forth by Walker et al. (2002) through the case study of water management (quantity and quality) in the Iraqi Marshlands.*

This Chapter will present the analysis of the case study of the Iraqi Marshlands using the methods outlined in Chapter 3. First, it will demonstrate that the Marshlands are a social-ecological system (SESs). Next, it will apply the Framework from Walker *et al*. (2002) to the case study of the Iraqi Marshlands. Finally, this Chapter will discuss the lessons learned from the case study analysis.

The Iraqi Marshlands, SESs, and Resilience:

The resilience approach is used to explore the dynamics of SESs. Therefore, to apply resilience, and subsequently the Framework, to water management in the Iraqi Marshlands, it must first be demonstrated that they are a SES, as outlined in Chapter 4.

According to Anderies *et al*. (2006),

> "…SESs are composed of (1) agents ranging from microbes to plants to humans, each with a different degree of information-processing capacity; (2) a set of allowable actions related to their physical or behavioral characteristics; and (3) a physical substrate that includes chemicals, light and water. The interactions among these agents and their interactions with the substrate generate dynamic social-ecological systems" (Theory and Social-Ecological Systems section, para.1).

The Marshlands support a wide variety of life forms including microorganisms, fish, plants, mammals, birds, reptiles, amphibians, and humans. These agents co-exist on

the physical substrate of the Marshlands where they have access to water, light, nutrients, and survival essentials. The physical substrate is governed by certain rules, like hydrological flow, evapotranspiration rates, and soil properties. Furthermore, the agents in the system are subject to certain behavioural patterns, like fish migration and snake habitat choice, that are often dependent on the state of the physical substrate. Humans are also subject to certain behavioural, religious and social norms. Clearly different agents have different levels of information-processing capacity and some are more constrained in their behaviour than others. Plants and animals are able to adapt to certain changes to their environment. Humans, however, have the capacity to learn and adapt in ways that other agents in the system cannot.

The social and ecological components of the Iraqi Marshlands are inexorably linked. Berkes *et al*. (2003a) agrees with Anderies *et al*. (2006) that this is an essential characteristic of a SES. As discussed in Chapter 4, before the Marshlands were drained, humans depended completely on the Marshlands for their survival. The culture of the Marsh Dwellers has been heavily influenced by the environment and over time the Marsh Dwellers have adapted to create a unique way of life in the Marshlands. There are about 10 000 Marsh Dwellers who continue to live within the Marshlands (UNOHCI 2003) and others who live in the nearby environs. People still depend on the Marshlands for goods and services and the poor health of the Marshlands is impacting their current quality of life. Furthermore, the fate of the Marshlands is dependent on the social component of the system. Given the current state of the Marshlands, it is the actions of the people that will determine if the Marshlands are able to recover or if they will continue to deteriorate. As

such both components need to be considered in order to achieve sustainability (Berkes *et al*. 2003a).

Berkes *et al*. (2003a) also states that SESs are complex. Recognition of this complexity will have implications for the management of SESs such as the inadequacy of models based on linear thinking (Berkes *et al*. 2003a). Complex systems cannot be described using simplistic linear models and both the social and ecological components of the system possess attributes like nonlinearity, uncertainty, emergence, scale, and self-organization that are not found in simple systems (Berkes *et al*. 2003a). Nonlinearity and uncertainty go hand-in-hand (Berkes *et al*. 2003a) "...aris[ing] from both complex internal feedbacks and from interactions with structures and processes operating at other scales" (Lebel *et al*. 2006, Introduction section, para.2). As discussed in Chapter 4, there are a variety of variables and processes, both human and ecological, whose interaction determines the future state of the Iraqi Marshlands. Just as a mathematical solution to a nonlinear equation results in multiple equilibria (Berkes *et al*. 2003a), the interaction of these variables and processes will result in one of several possible future scenarios depending on how they are combined. This nonlinear behaviour, in addition to the inherent uncertainties of the system, makes forecasting difficult and the future of the Iraqi Marshlands indeterminate.

Complex systems also exhibit the property of emergence which states that systems "cannot be predicted or understood simply by examining the system's parts" (Berkes *et al*. 2003a, p.5-6). As discussed in Chapter 4, the Iraqi Marshlands cannot be fully understood by simply examining the individual components of the system; rather, it is essential to investigate how the various components interact and the relationships

between different parts of the system. Any management plan which ignores these linkages will be unsuccessful. Complex systems are also influenced by scalar interactions (Berkes *et al*. 2003a). The Iraqi Marshlands are a nested system: the Marshlands exist within the greater context of Iraq and the international community, and they can also be subdivided into smaller marshes. The interactions and connections between these levels adds complexity and necessitates managing the system at several scales simultaneously (Berkes *et al*. 2003a).

Finally, "[s]elf-organization is one of the defining properties of complex systems" (Berkes *et al*. 2003a, p.6). If a system becomes too unstable it is able to reorganize into a more stable configuration (Berkes *et al*. 2003a). While archeological evidence from Oschenschlager (2004) shows that the pre-drainage lifestyle of the Marsh Dwellers was comparable to that of ancient times, it has not been static. Sanlaville (2003) shows that the shoreline of the Persian Gulf, the path of the Euphrates and the Tigris Rivers, and the extent of the Marshlands have continued to evolve since the last glacial period, with only minor change in the past 3500 years. For instance in the seventh century CE, the Tigris River shifted course creating a vast marsh area in the west (Sanlaville 2003). The course of the Tigris has since shifted eastwards changing the layout of the Marshlands yet again (Sanlaville 2003). The marsh flora and fauna would be forced to reorganize in response to the changing substrate, just as the Marsh Dwellers adapted to these changing conditions in order to survive. In recent times, Marshlands residents have shown evidence of self-organization by tearing down the drainage structures after Saddam was deposed, allowing some of the flora and fauna as well as people to return to the Marshlands.

In light of the above discussion, it is possible to conclude that the Iraqi Marshlands are a complex SES. Therefore, it is feasible to use the concept of resilience and the Framework from Walker *et al*. (2002) to analyze the case study of the Iraqi Marshlands.

The Framework:

As discussed in Chapter 2, the Framework by Walker *et al*. (2002) outlines four steps for analyzing the current resilience of a social-ecological system (SES) in order to manage the future resilience of the system.

Step 1:

Step 1 of the Framework involves an in-depth analysis of the historical and current state of the system (Walker *et al*. 2002). Chapter 4 presented an overview of historical and current perspectives of the Iraqi Marshlands. This overview reviewed the various components of the systems, and explored how they relate to each other. It helped to illustrate the events and factors that have led to the current state of the system. Chapter 4 also highlighted some of the social and ecological issues in the Marshlands at the local, national, and international scales. This overview, combined with the discussion from the section *The Iraqi Marshlands, SESs, and Resilience*, emphasizes the complex nature of the Marshlands. This review of historical and current perspectives of the Marshlands from Chapter 4 constitutes the foundation for Step 1 of the Framework. The context of the Iraqi Marshlands will now be further analyzed by situating it within the adaptive cycle. The adaptive cycle is a metaphor for interpreting the dynamics of SESs through a cyclical pattern of exploitation, conservation, release, and reorganization (see Chapter 2).

In the introduction to Chapter 1, it was hypothesized that human habitation of the Marshlands may have developed after a climatic shift led to a social-ecological collapse and a subsequent reorganization of society (Oschsenschlager 2004). This shift represents a release from the previous adaptive cycle and a transition into a new system configuration. While details from this time period are scarce, evidence does show that nomadic people foraged along the banks of the Euphrates in the winter and spent summers in the plains (Weiss *et al*. 1993). Therefore, it is reasonable to speculate that as the aridity of the region increased, people might choose to live near a permanent water source on a full time basis.

After this period of collapse and the establishment of a new way of life in the Marshlands, archaeological evidence shows that the lifestyle of the Marsh Dwellers was relatively consistent until the second half of the twentieth century (Oschsenschlager 2004). Inasmuch, it appears that after the Marsh Dwellers settled in the Marshlands they transitioned through the exploitation phase of the adaptive cycle into the conservation phase where the system remained until the twentieth century. The resilience of the SES during this time was high. The Marshlands have always been faced with surprise and uncertainty from flooding, drought, sandstorms, etc. (Young 1977). The Marsh Dwellers were able to adapt to changes in the Marshlands boundaries as well as other surprises.

As stated in Chapter 2, the release phase of the adaptive cycle is usually preempted by a loss of resilience, which often goes unnoticed. While the system remained in the conservation phase of the adaptive cycle until 1991, beginning in the 1960s events (such as small private drainage schemes, dams in Turkey, Syria, Iran and Iraq, increased contact between the Marsh Dwellers and mainstream Iraq) began to

reduce the overall resilience of the system. Furthermore, in 1980, war broke out between Iraq and Iran and in 1982 the Marshlands became the frontline for the war. The Iran-Iraq war marked a period of rapid loss of resilience and, consequently, adaptive capacity. The war encouraged extensive draining of the Marshlands and also resulted in heavy pollution, leading to a loss of system resilience as the physical substrate of the system deteriorated. Furthermore, many male Marsh Dwellers conscripted into the army were killed and numerous communities were displaced. This disrupted social networks leading to a further loss of resilience. The result of this rapid loss of resilience, and adaptive capacity, was a SES that was unstable; the various components of the system had been disrupted and functioned poorly. As such, the system had limited capacity to adapt to change making it vulnerable to shocks and increasing the likelihood that a shock would push the system into the release phase of the adaptive cycle.

The resilience of this SES continued to deteriorate after the end of the Iran-Iraq war. If the Marshlands had been left to themselves in the wake of the Iran-Iraq war, it is possible that the cessation of the war would allow the Marshlands to regroup and build back up the resilience and adaptive capacity of the system. Flora and fauna may have been able to return and the Marsh Dwellers could have reformed their communities. However, restoration efforts were constrained by events at the national scale. Saddam Hussein's dictatorial regime did not value the Marshlands and continued with plans to drain them. Iraq was ensnared in a rigidity trap where the tight control of the central government discouraged creativity and innovation, and anyone who opposed the status quo. This significantly reduced the adaptive capacity of the Marshland residents and the ability of the environment to regenerate. This is an example of the 'Remember'

connection that links panarchies where events at the larger scale constrain events of the smaller scale (see Figure 2). Therefore, from 1988 to 1991, the resilience of the Marshlands continued to decrease while its vulnerability continued to increase.

According to Olsson *et al*. (2004) one of the requirements for transitioning from an undesirable state to a desirable state is a window of opportunity. This arrived in the form of the Iraqi invasion of Kuwait in 1991. The Marshland residents attempted to use this crisis as an opportunity to rebel against the central government in order to break the rigidity trap at the national level that was keeping them from reorganizing. "On various occasions Iraqi Shi'i refugees cited the expulsion of thousands of Shi'is to Iran during the Iran-Iraq War of 1980-1988, and the desire to get rid of Saddam and his government, as major factors in their motivations to rebel" (Nakash 2003, p.276). This is an example of the 'Revolt' connection that links panarchies where events at the small scale accumulate to overwhelm events at the larger scale (see Figure 2). However, the government crushed the rebellion thereby maintaining the status quo. After the failed rebellion, efforts to drain and destroy the Marshlands intensified leading to the social-ecological collapse. These reprisals acted as the trigger that pushed the Marshlands into the release phase of the adaptive cycle after the system had already been made vulnerable due to a previous loss of resilience. When resilience, and therefore adaptive capacity, is low during the back-loop of the adaptive cycle (release to reorganization), as in the case of the Marshlands, the system is more likely to move into an undesirable state (Resilience Alliance 2009a). Consequently, in the aftermath of this social-ecological collapse, neither the ecological nor the social components of the system were able to regroup and move forward into the reorganization phase of the adaptive cycle, therefore becoming

mired in a poverty trap. Essentially, the system became stuck in the back-loop of the adaptive cycle, unable to reorganize due to low potential and low resilience (see Chapter 2 for more detail about poverty traps).

By 1993, the Iraqi Marshlands were no longer operating as a functional wetland complex (Mitchell 2003). Due to the tight controls of the national government, the Marshlands remained trapped in this degraded state for the next ten years. During this time, the resilience and adaptive capacity of the system continued to degrade. As long as Saddam's regime remained in control, there would be no chance for the Marshlands to emerge from the poverty trap (Sluglett 2003b).

In 2003, a second window of opportunity arose. Saddam's regime was removed from power and the rigidity trap at the national level was released. This created an opportunity for the Marsh Dwellers to break out of their own poverty trap. After Saddam was deposed, residents began breaking down water diversion structures so that water could get into the Marshlands and, as discussed in Chapter 4, flora, fauna, and people began to return to the region. Furthermore, people at the national and international level began to take a concerted interest in the recovery of the Marshlands.

The history of the Marshlands as a SES fits into one complete adaptive cycle and one incomplete adaptive cycle. This narrative of the Iraqi Marshlands in the context of the adaptive cycle is summarized in a Table 1.

Table 1: The Marshlands in the adaptive cycle.

Phase of the Adaptive Cycle	Date	Event	Social-Ecological Impacts
Release	ca. 2200BCE	Climate change increases aridity, agricultural production and river flow reduced	Social-ecological collapse
Reorganization	ca. 2200BCE	Cities in the north are abandoned and refugees flee south	Resilience high Adaptive capacity high
Exploitation	ca. 2200BCE	Ochsenschlager (2004) hypothesizes that people begin to eke out a living from the Marshlands on a full-time basis	Resilience high Adaptive capacity high
Conservation	ca.2200BCE to 1960s	Life in the Marshlands continues to persist in the face of change, but is not static	Resilience high
	1960s	Private irrigation diverts water from Marshlands	Loss of resilience
	1970s-1980s	Large scale hydrological schemes divert water from the Marshlands Marshlander culture is changing as contact with rest of Iraq increases	Loss of resilience
	early 1980s to 1988	Drainage of the Marshlands increases in intensity Heavy pollution of the Marshlands	Rapid loss of resilience and adaptive capacity
	1988-1990	After the end of the Iran-Iraq war, rigidity trap at the national level prevents the Marshlands from building up resilience	Resilience low

Phase of the Adaptive Cycle	Date	Event	Social-Ecological Impacts
Window of opportunity Release	1991	Iraq invades Kuwait Marsh Dwellers rebel, but the attempt fails leaving rigidity trap intact	Social-ecological collapse
Poverty Trap	1991-2003	Drainage of the Marshlands continues Marsh Dwellers displaced	Resilience and adaptive capacity continues to degrade
Window of opportunity	2003	Saddam is removed from power Rigidity trap at national level is broken	Resilience and adaptive capacity boosted
Reorganization	2003-2009	Efforts to reorganize are underway Some areas of the Marshlands begin to recover	Resilience and adaptive capacity are slowly increasing...
Poverty Trap? Exploitation?	2009-?	Marshlands impacted by drought The future of the Marshlands is uncertain	Tentative build-up of resilience and adaptive capacity under threat

The future of the Iraqi Marshlands is uncertain. The Marshlands are currently in the back-loop of the adaptive cycle, which is characterized by high uncertainty and low predictability (Holling and Gunderson 2002). Cross-scale dynamics are also especially dominant during the back-loop (Anderies *et al.* 2006). The Marshlands are at a critical stage where appropriate intervention could help transition them into the exploitation phase of the adaptive cycle, or the system could fall back into the poverty trap and eventually disappear.

It should be noted that reorganization following a shock is not necessarily a speedy process. Kristianstads Vattenrike (roughly translated as the Kristianstads Water

Realm), located in southern Sweden, was ratified as a Ramsar Convention site in 1975 (Olsson *et al*. 2004). Over the millennia a special relationship had developed between the local people and the wetland (Olsson *et al*. 2004). The wetlands are a rich ecosystem and provide ecological services, and impact cultural and economic traditions (Olsson *et al*. 2004). In the early 1980s, local stakeholders began to notice that the system was deteriorating (Olsson *et al*. 2004). This crisis triggered a process to transform the management of the system using a resilience approach (Olsson *et al*. 2004). This transformation took ten years and it would be another five to tentatively speculate that the system may have reached a state of social-ecological resilience (Olsson *et al*. 2004).

The Iraqi Marshlands have only been on the mend for about six years and the reorganization of the system will be a long-term project. In addition to the inherent complexities of the system, the Iraqi Marshlands face many difficulties, like security concerns, lack of basic services, high unemployment, and drought, that the Kristianstads Vittenrike did not have to contend with. While there are many factors that threaten the reorganization of the Iraqi Marshlands, there are also positive steps that are being taken to improve the situation, such as stakeholder meetings in Basrah and Baghdad. The Marshlands have been presented with a window of opportunity. But as Gonzalez *et al.* (2008) found in the Galapagos Islands, it is up to decision-makers and stakeholders to take advantage of this window of opportunity to create change.

Step 2:

After reviewing the current and historical context of the Iraqi Marshlands, Step 2 of the Framework entails creating a limited range of scenarios that describe possible future trajectories of the system. The Iraqi Marshlands can never be returned to what

they once were (Naff and Hanna 2003). However, CIMI-II has developed three scenarios: a best case, an intermediate case, and a worst case with respect to future Marshlands extent. In Scenario 1, managers will aim to maintain the 2008-2009 borders of the Marshlands (Figure 8). In Scenario 2, managers will focus on protecting the healthiest areas of the Marshlands (Figure 9). Finally, in Scenario 3, the size of the Marshlands will continue to contract and fall into a permanently degraded state (Figure 10).

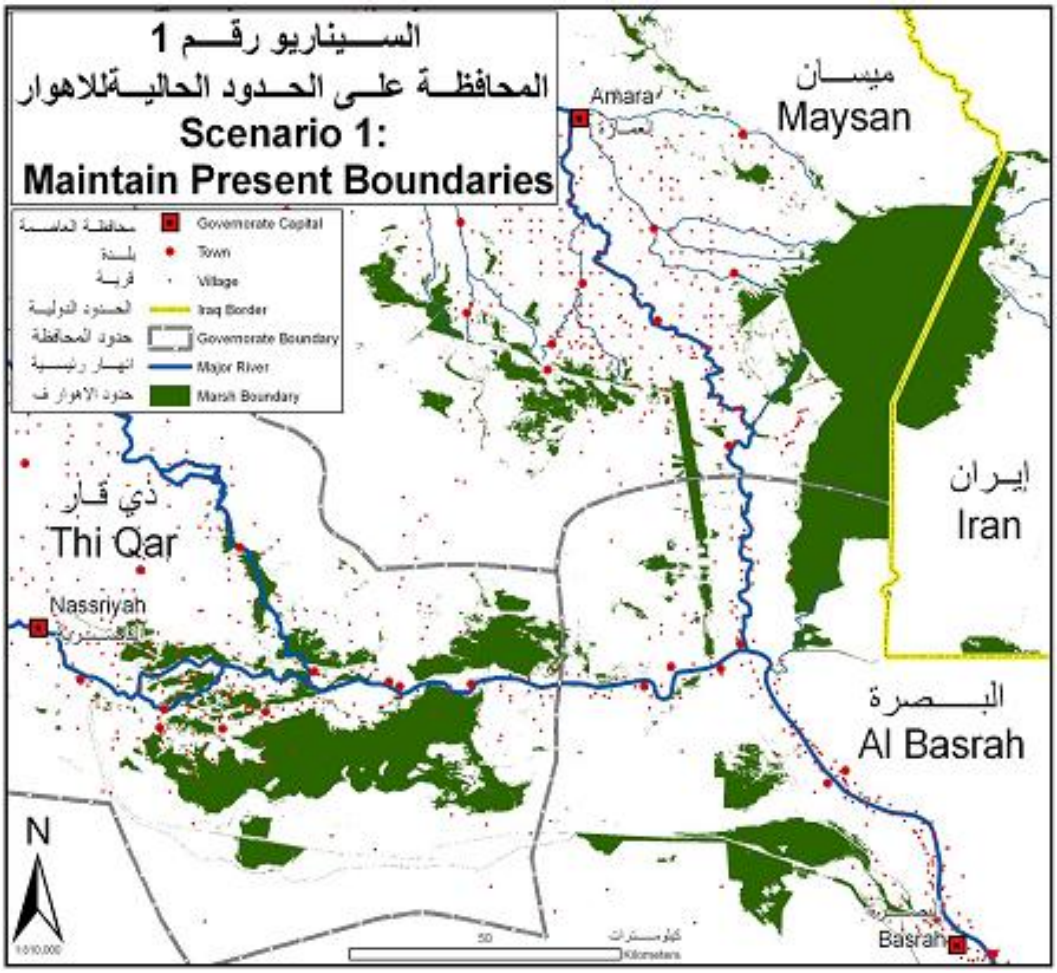

Figure 8: Scenario 1. Map of Marshlands extent in Scenario 1 (CIMI-II 2009, p.22).

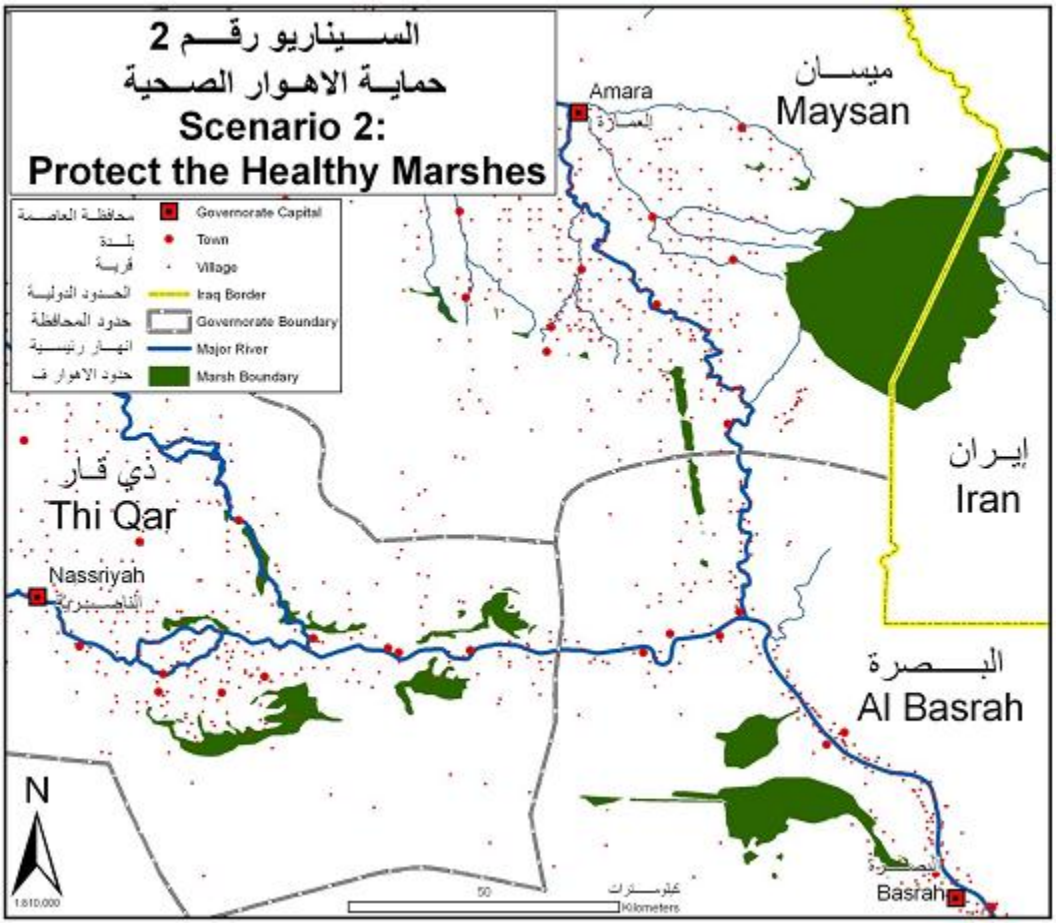

Figure 9: Scenario 2. Map of Marshlands extent in Scenario 2 (CIMI-II 2009, p.24).

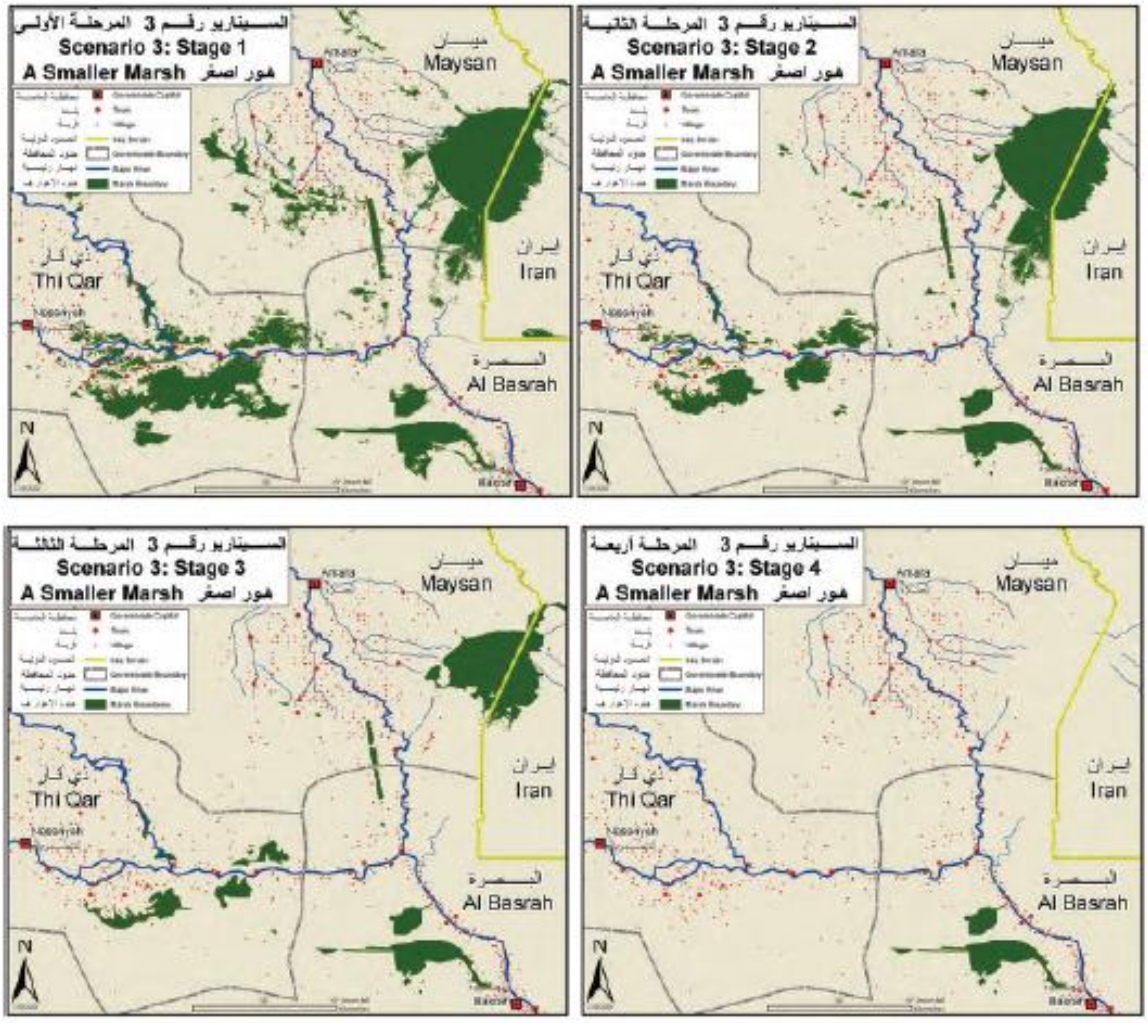

Figure 10: Scenario 3. Maps of the four stage progression to a smaller Marshlands in Scenario 3 (CIMI-II 2009, p.26).

In terms of desirability, there is a broad consensus among stakeholders that they do want the Marshlands to persist, making Scenario 3 an unattractive option. There are many who would like to achieve Scenario 1. However, the current drought conditions are heavily impacting the Marshlands ecosystem. In July 2008, Marshland extent was 4950km^2 (CIMI-II 2009). By April 2009, it was reduced to 3420km^2 and by July 2009 it had reached 2313km^2 (CIMI-II 2009). In a year's time the Marshlands have shrunk by almost half. Furthermore, the Ministry of Water Resources is at present unable to release any more water to the Marshlands. At this point in time, achieving Scenario 1 would be

an ambitious undertaking. Scenario 2 involves protecting the healthiest Marshlands areas. While this scenario is definitely more desirable than Scenario 3, the total Marshlands extent would be less than half that of Scenario 1 with most of the contiguous remaining marsh areas located in Basrah and Maysan governorates (CIMI-II 2009). While not the most desirable scenario, it may be the most realistic. Current drought conditions have actually pushed the Marshlands into a configuration that is quite similar to Scenario 2 (Figure 11). Naff and Hanna (2003) argue that focusing on one marsh area, specifically the Hawizeh marshes, is the only chance to save some remnant of the Marshlands for future generations. Currently, the Hawizeh marshes are the most viable. Future viability will depend heavily on flow of water from Iran which uncertain. However, protecting the healthiest areas may also allow for Marshland expansion in the future if conditions become more amenable.

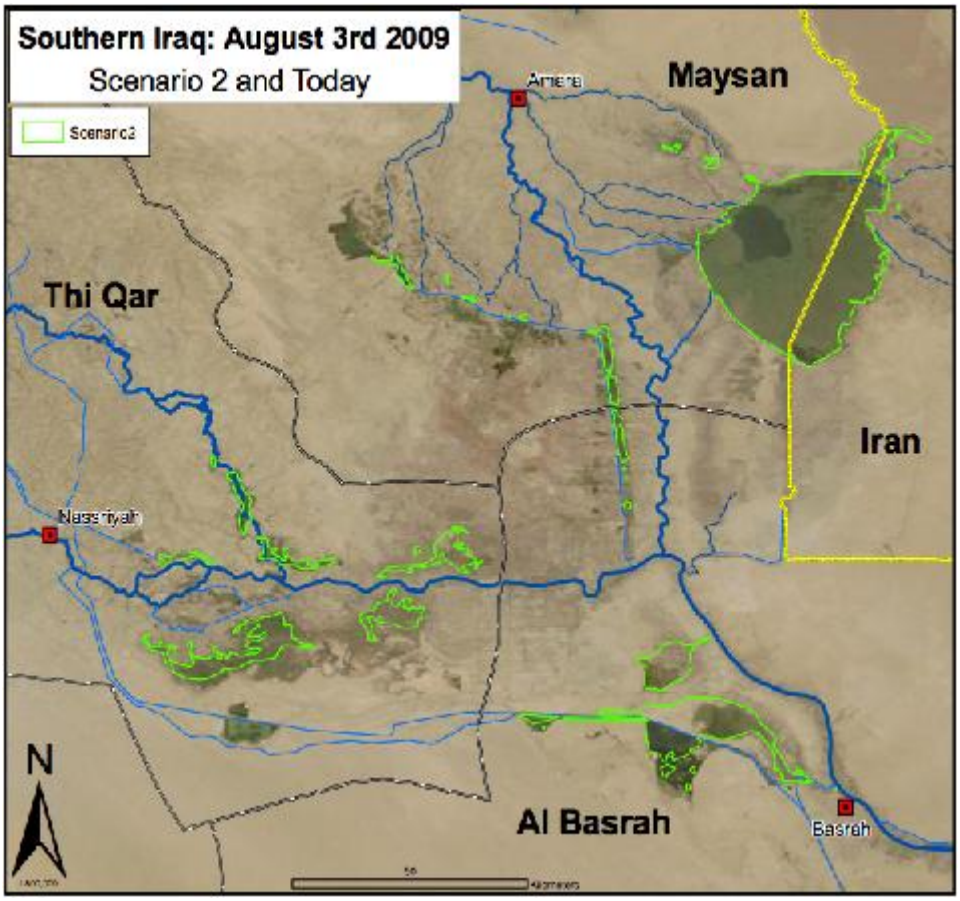

Figure 11: Southern Iraq, August 3rd 2009. Overlay of current Marshland extent (gray) and predicted Marshland extent in Scenario 2 (green outlines) (CIMI-II 2009, p.7).

The scenarios developed by CIMI-II are concerned with the future boundaries of the Marshlands. Future Marshland extent will greatly depend on the availability of sufficient quality water, and securing this supply will be a primary concern for decision-makers and managers. While the scenarios do incorporate social components, like community responsibility and population and economic development, the scenarios grew from a primarily ecological perspective. The resilience approach recognizes that social and ecological systems are inextricably linked and cannot be successfully managed without giving full consideration to both components. Therefore, an expanded discussion

on the social component of the system will help to increase understanding of the Iraqi Marshlands in the context of the resilience approach.

Water management concerns not only the boundaries of the Marshlands, but also the activities and attitudes of the local people. The common thread between the future scenarios is that in all three there will be areas where marsh habitat is present on the landscape and areas where it is not. In each of these zones there will be a different perspective that dominates, which will be referred to as the 'Ecologically-centered' (EC) and 'Socially-centered' (SC) perspectives. The EC perspective will prevail in marsh zones, while the SC perspective will prevail in non-marsh zones. In these two perspectives different attitudes and activities will dominate (see Table 2).

Table 2: Summary of attitudes and activities in Ecologically-centered perspective and socially-centered perspective. The Ecologically-centered perspective assumes that some people will choose to live in the Marshlands, and the Socially-centered perspective assumes that those living outside the Marshlands will remain interested their future existence.

	Ecologically-centered	**Socially-centered**
Attitudes	• Focus on maintaining functional Marshlands in order to derive benefits • Relationship with environment is close and maintained due to frequent/constant interaction between people and the Marshlands	• Focus on minimizing negative environmental impacts on Marshlands while developing non-marsh related activities • Relationship with environment is distant due to less frequent interaction between people and the Marshlands

	Ecologically-centered	Socially-centered

Activities	• Small-scale agriculture
	• Fishing
	• Hunting
	• Animal husbandry
	• Handicrafts
	• Aquaculture and related activities
	• Ecotourism
		• Large-scale agriculture
		• Aquaculture and related activities
		• Non-productive land
		• Oil and related activities
		• Heavy industry and factories, ex:
		  • Plastic
		  • Paper
		  • Sugar
		  • Vegetable oil
		  • Fertilizer
		  • Cement
		  • Detergent
		  • Electrical goods

The EC perspective is primarily concerned with maintaining ecosystem integrity while the SC perspective is primarily concerned with developing manufactured capital. Manufactured capital refers to "factories, buildings, tools, and other physical artifacts usually associated with the term 'capital'" (Costanza and Daly 1992, p.38). Agriculture would also be considered manufactured capital as it requires inputs like water and fertilizer, and is not usually self-renewing. The two perspectives, however, are not mutually exclusive. In both perspectives, services like health, education, sanitation, and electricity, as well as employment are necessary. There are also ecological considerations in the SC perspective and social considerations in the EC perspective. Residents from the SC zones will need to be conscious of environmental concerns in order to minimize the impacts of development on the marsh areas. There must also be economic developing in EC zones so that residents are able to make a living. Additionally, residents of SC zones will benefit from wetland services, like flood control,

water filtration, reduced dust, and temperature control, as well as revenue generated from economic activities in EC zones while residents of EC zones will benefit from the revenue generated from economic activities in SC zones and access to larger urban centres. Furthermore, "[s]everal studies [have shown] that contact with nature is a human need and contributes to an improved quality of life" (Di Giulio *et al*. 2009, p.2963). Therefore, if the Marshlands disappear, everyone's quality of life will be reduced.

Marsh habitat in the region is currently fragmented, which negatively impacts ecosystem health (Richardson and Hussain 2006), and this condition will persist, to varying degrees, in all three of the future scenarios. As a result, in the future scenarios, marsh habitat will exist as fragments within a matrix of non-marsh area (Vandermeer and Perfecto 2007), or EC fragments in a SC matrix. In such fragmented landscapes it is not enough just to preserve the fragments, but it is also important to make the matrix as environmentally-friendly as possible (Vandermeer and Perfecto 2007). This could involve reducing pollution from effluent, zoning industry, creating green spaces, etc. Ecologists are beginning to recognize the value that a high quality matrix can play in maintaining biodiversity in a fragmented landscape (Jules and Shahani 2003). For example, a more permeable matrix can facilitate migration and flow between patches, and, contrary to traditional theories of fragmentation, can support sizable populations of some species (Jules and Shahani 2003). Creating a high quality matrix can help to stem the pattern of local extinction that inevitably accompanies habitat fragmentation (Vandermeer and Perfecto 2007). As such, it will be important to maintain support for marsh conservation and restoration efforts from people living in non-marsh areas, and to ensure that SC activities in the matrix do not overwhelm EC activities in marsh areas (Di

Giulio *et al*. 2009). Because people in the SC zones will have less frequent contact with the Marshlands, it will be important to actively cultivate this relationship in order to maintain their support.[11] "Contact with nature and native wildlife can reduce the gap between humans and the natural world. This gap is h[e]ld responsible for the [lack of] public support for biodiversity conservation" (Di Giulio *et al*. 2009, p.2963). Limited contact between humans, especially children, and the environment leads to a condition where people accept a degraded environment as the baseline against which they measure future degradation (Di Giulio *et al*. 2009). The environment continues to degrade but this degraded state is accepted as normal by each ensuing generation (Di Giulio *et al*. 2009). Enabling people to experience their local environment can help to prevent this (Di Giulio *et al.* 2009). It can also help to foster community stewardship. Community stewardship is essential for implementing good environmental practices. Without it, the health of the marsh habitat will deteriorate and quality of life will be reduced.

The relationship between the two perspectives and the ratio of fragments (EC zones) to matrix (SC zones) is key to the future of the Marshlands. In each of the three scenarios, there will be a different balance of fragments (EC zones) to matrix (SC zones). In Scenario 3, the vast proportion of the landscape will be SC with only a few, small areas that are EC. Reduced access to marsh habitat will increase environmental generation amnesia and limit support for conservation and restoration efforts (Di Giulio *et al.* 2009). Management efforts will reflect these values. The region will be increasingly dominated by manufactured capital and the Marshlands will deteriorate and eventually disappear (see Figure 10).

[11] For example, in Lake Racken, Sweden, two days of intensive crayfishing each year helps to create a sense of community and establish support for the management of this resource (Folke *et al.* 2003).

In Scenario 2, marsh habitat will occupy a higher proportion of the landscape than Scenario 3. However, the region will still be primarily dominated by manufactured capital (see Figure 9). As such, the marsh ecosystem will be secondary to the manufactured landscape. The SC perspective will predominate the region meaning that marsh habitat extent will be limited by manufactured capital and the goodwill of the residents of the SC zones. Positive interaction by people with the landscape creates a positive attachment to place which will help garner support for its continued existence (Di Giulio *et al*. 2009). Therefore, in Scenario 2 it will be important to cultivate support for the marshes in order to keep manufactured capital from overwhelming the marsh habitat.

In Scenario 1, there is the highest proportion of marsh habitat on the landscape of the three scenarios (see Figure 8). As a result, EC views will have more influence as EC zones are much more prominent on the landscape. Ideally, this would help to create balance between the two perspectives and integrate activities in the two zones. However, in order for Scenario 1 to be achieved, current marsh extent will need to be increased. Therefore, in Scenario 1, manufactured capital will be limited by marsh habitat extent, rather than the reverse as in Scenario 2. "Landscapes thus serve as a kind of external memory, reminding people of their experiences, values and social affiliation" (Di Giulio *et al*. 2009, p.2963). As marsh extent increases, there will be increased interaction between people and environment, which can help gain support for conservation and restoration efforts.

When creating a water management plan for the region, decision-makers must consider the two perspectives and their relationship in order to coordinate activities in the

two zones. In a linked SES like the Iraqi Marshlands, decisions made in isolation can negatively impact other parts of the system. It is important that a dichotomy is not exacerbated between marsh regions and non-marsh region, or to create conflict between conservation and development (Vandermeer and Perfecto 2007). Rather it is more useful to think of the perspectives as complementary-allowing for a diverse array of activities to persist in the region. This diversification will help to increase the resilience of the system and its ability to deal with surprise.

Step 3:

In Step 3 of the Framework, the results from Step 1 and Step 2 are combined by creating simple models that help link the current state of the system, possible futures, and management decisions. This section will present two models that were created to help characterize and understand the Marshlands.

From the review in Chapter 4 and the discussion of Steps 1 and 2 in Chapter 5, it is apparent that the Iraqi Marshlands are a complex SES. However, Yorque *et al*. (2002) and Walker *et al.* (2006b) agree that "[c]ritical changes in social-ecological systems are determined by a small set of three to five key variables" (Proposition Four section, para.2). Furthermore, the Framework suggests that by concentrating on the coarse-grained features of a system, it is possible to move beyond uncertainties and complexities to find resilient pathways (Walker *et al*. 2002). These pathways help to suggest actions that will increase the overall resilience of the system (Walker *et al*. 2002).

The analysis of Step 1 and Step 2 of the Framework were used to distinguish these key variables for use in the models. While availability of sufficient quality water is crucial to water management in the Iraqi Marshlands, there are also other factors to

consider. Water management in the Marshlands will depend on scalar cooperation and coordination, institutional support and capacity, development, and local quality of life (Figure 12).

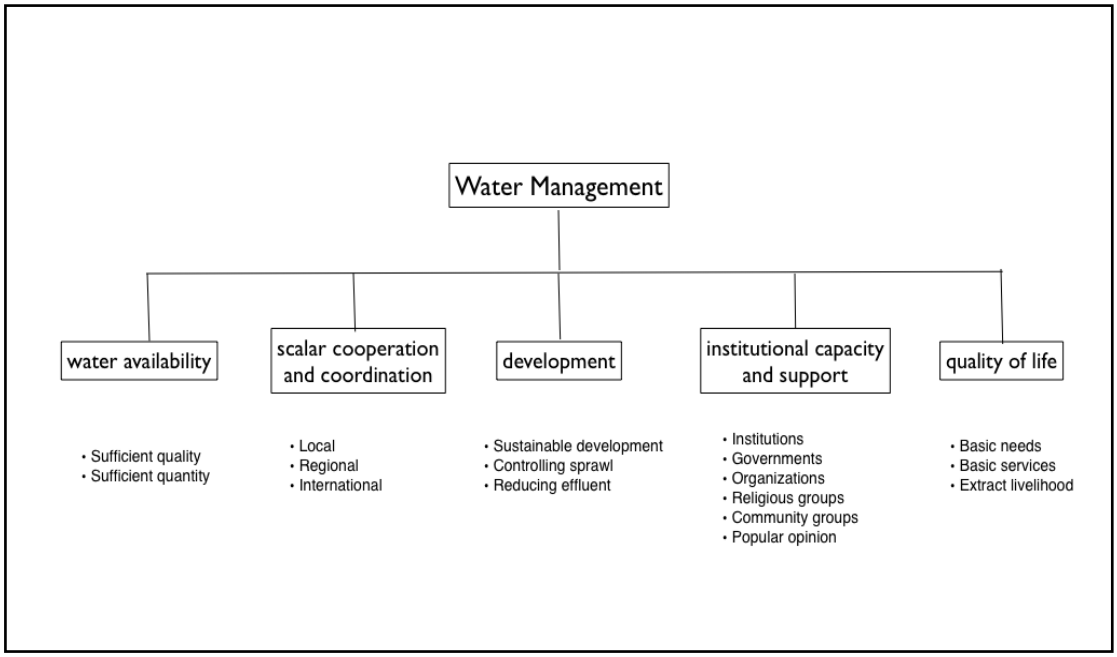

Figure 12: The five key variables for water management.

The Iraqi Marshlands are a nested system: the Marshlands exist within the greater context of Iraq and the international community, and they can also be subdivided into smaller marshes. Therefore, coordination and cooperation between the different levels is essential. Implementation will also depend on institutions having the capacity and support to undertake and complete management activities and to determine which future scenario is the most desirable and feasible. For the purposes of this discussion, institutional support and capacity includes all social networks from more formal entities (ie. political, religious, government, and organizations) to more informal entities (ie. popular opinion, loose affiliations and groups). Regional development, both EC and SC

activities, is required so that local people are able to make a living. However, this development must be controlled and planned in order for water management in the Marshlands to be successful. This includes controlling sprawl, reducing effluent, and extracting marsh benefits at sustainable levels. Finally, water management will depend on local quality of life. People require services (ie. health care, education, electricity) and the ability to extract a livelihood in order to meet their basic needs. This includes utilizing resources from healthy marshes. The current poor health of the Marshlands is negatively impacting the quality of life of the Marsh Dwellers. It is also widely accepted that if people are unable to meet their basic needs emphasis will be on short term survival rather than long term sustainability (Okello *et al*. 2009). In this linked SES, the health of the ecological and social components of the system are intertwined. "It is important to acknowledge these realities, establish the linkages, and address root causes for both poverty and environmental degradation in rural landscapes so as to improve the quality of life of many rural poor in the rural landscapes" (Okello *et al*. 2009, p.132). Therefore, both models use the assumption that poor marsh health will negatively affect human quality of life. These five variables are quite broad, but they can be used to organize and categorize system complexity, and to find resilient pathways.

As such, the goal of the models created for Step 3 is not to show every complexity and detail of the system, but rather to use the five key variables to generalize the system and to show the links between the three future scenarios. By characterizing the coarse grained features of the system it is possible to envisage the system as a whole and to discern resilient pathways. Due to the 'big picture' focus of the models, it is also possible

for stakeholders at different scales to place specific, complex issues within the context of the models and to be able to see the implications of their decisions for the system.

The first model (Figure 13) deals with the amount of water that is available to the Iraqi Marshlands.

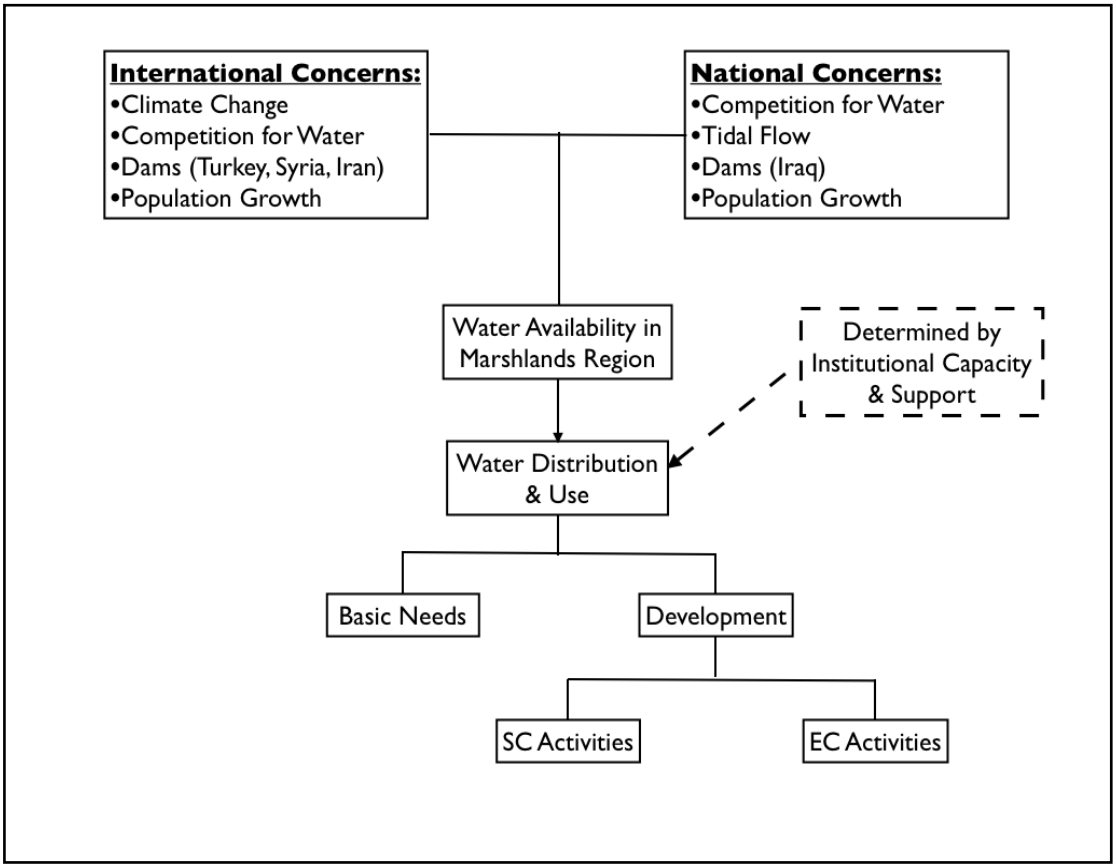

Figure 13: Conceptual Model 1. This conceptual model shows the scalar connections to the Iraqi Marshlands, and focuses on water availability and the importance of institutional capacity and support.

Issues upstream from the Marshlands, at the international and national levels, will determine how much quality water will reach the system. Since this will directly affect which future scenarios are feasible it is important to recognize these key scalar connections. Once the amount of quality water that is available is determined, it must then be distributed at the local level. Water allocation will be driven by institutional capacity and support, one of the key variables that were mentioned earlier. Social

networks will decide which water uses are most valued. Therefore, it is this social component of the system that will determine the water balance in the region and the future state of the Marshlands. Decision-makers can use Figure 13 as a tool to visualize how their decisions and policies will impact the amount of water in the system and the future viability of the Marshlands. This tool can aid in planning processes by helping envisage which pathways will lead to the desired outcome and enabling actions to be determined accordingly. For example, if decision-makers are hoping to move the system towards Scenario 1 the current water supply is insufficient. Therefore, to increase the reality of this Scenario and the resilience of the system more water is required. Decision-makers could use Figure 13 as a tool to determine where, and if, more water can be obtained. These resilient pathways, like negotiating with upstream neighbours to release more water from dams or redistributing water at the local level, can be used to create more specific action plans to achieve the desired outcome.

The second model (Figure 14) characterizes the dynamics of the Iraqi Marshlands at the local level in each of the three future scenarios. While Figure 13 focuses on the key variables of water availability, scalar cooperation and coordination, and institutional capacity and support, the second model focuses on the key variables of development and quality of life. Therefore it draws heavily on the idea of the SC and EC perspectives, and the discussion of the three future scenarios from *Step 2*. Given the current efforts focused on restoring the Marshlands, Marsh Health is presented as the central feature of the model (see Gonzalez *et al*. 2008).

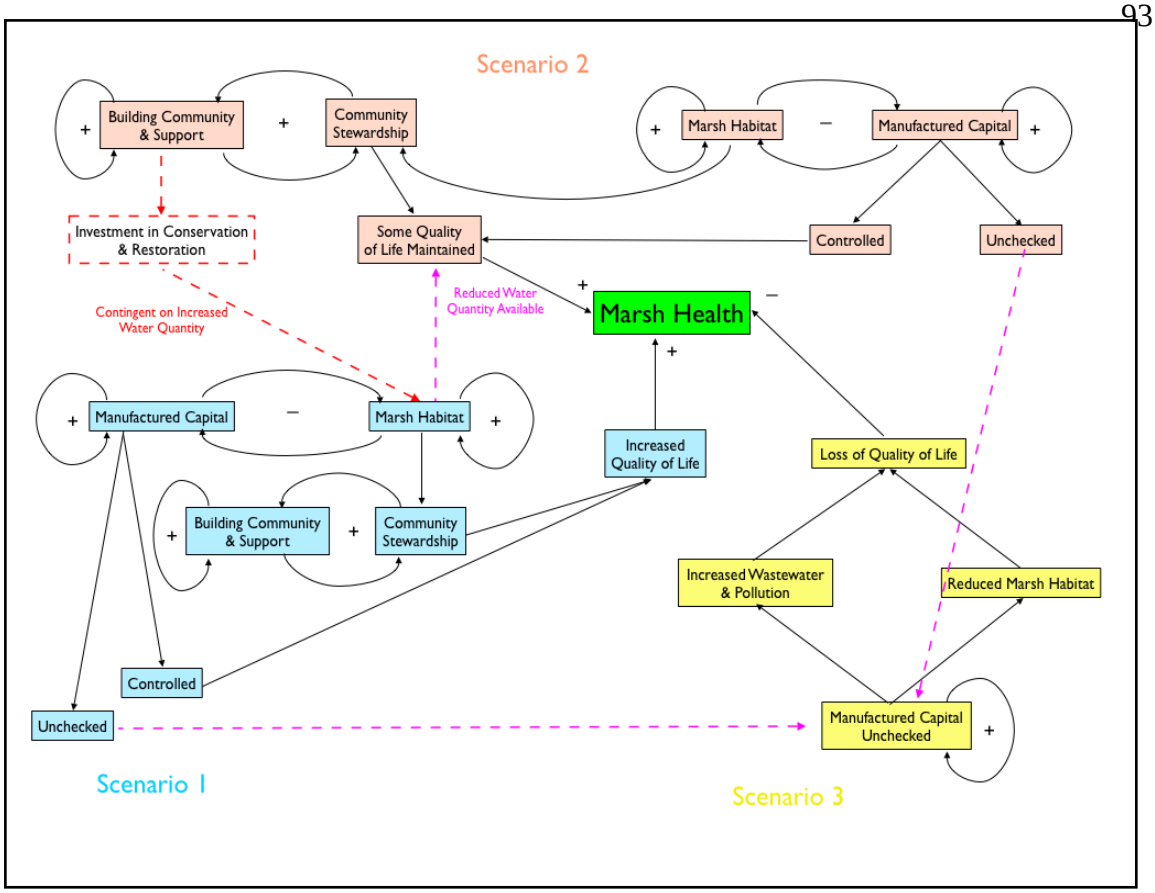

Figure 14: Conceptual Model 2. This conceptual model characterizes the Iraqi Marshlands and focuses on the key variables of development quality of life. A +/- in a loop indicates a positive or negative feedback cycle. Eventually, the interactions of the components in each of the three scenarios will have a positive (+) or negative (-) impact on Marsh Health.

In Figure 14 each of the three future scenarios represents an alternative stable state for the Marshlands (see Briske *et al.* 2008). The interaction of the elements within the three stable states reflects the relationship between SC and EC space in each of the scenarios. The model strongly focuses on the relationship between "Manufactured Capital" (SC perspective) and "Marsh Habitat" (EC perspective). This includes the importance of fostering support for conservation and restoration efforts. The relationship between Manufactured Capital and Marsh Habitat is visually represented in the model by feedback cycles (see Bennett *et al.* 2005). Individually, both Manufactured Capital and Marsh Habitat are self-perpetuating positive feedback cycles. However, they are limited

by each other. In Scenario 2, the feedback cycle between the two elements shows that Marsh Habitat is limited by Manufactured Capital and in Scenario 1 shows that Manufactured Capital is limited by Marsh Habitat. Marsh habitat is absent from Scenario 3 because circumstances will cause it to deteriorate and eventually disappear.

The model also shows the links between the scenarios. These links represent a threshold to a less desirable state or a restoration pathway towards a more desirable state (see Briske *et al*. 2008). For example, if the development of Manufactured Capital is uncontrolled it will overwhelm the Marsh Habitat and cause a regime shift to Scenario 3. Furthermore, if enough water and support is available, the system could transition from Scenario 2 to Scenario 1. However, there is no restoration pathway out of Scenario 3. It is assumed that in Scenario 3 the Marshlands will become sufficiently degraded that the damage is irreversible

The shift between different scenarios, or stable states, will be determined by the resilience of the system (Gonzalez *et al*. 2008). Therefore, Figure 14 can be used to find resilient pathways that will increase the resilience of the system. These resilient pathways lead to positive impacts on Marsh Health. As with the first model (Figure 13), locating these resilient pathways can help to determine an action plan that will reinforce that pathway. For instance, resilient pathways that support Scenario 1 include securing ample water supply, fostering community support, and controlling development. Corresponding actions that would increase the resilience of the system could include repairing leaking dams in Iraq, creating a radio campaign about the benefits of the Marshlands, arranging for children from cities to visit the Marshlands, enforcing environmental standards for industry, installing sewerage systems etc. While it is

impossible to perfectly forecast or steer a system along a desired trajectory, focusing on strengthening resilient pathways will increase the resilience of the system making it more likely to be able to absorb shock and persist in the future. If the resilience of the system is low, it becomes more likely that it will shift to an undesirable state.

Figures 13 and 14 do not lay out what state of the Marshlands is desirable or undesirable. The Figures could be used as a focal point for discussions about the future state of the Marshlands, but these value-laden decisions should be determined through deliberations by the people of Iraq. Fundamentally, Figures 13 and 14 are qualitative evaluative tools to help stakeholders understand the impacts and consequences that their actions will have on the resilience, and the state, of the system. The flows and feedbacks in the two conceptual models can be used to understand how different elements in the system affect resilience. This knowledge can help to locate resilient pathways and be used as a planning tool for water management efforts in the Marshlands.

Step 4:

Finally, Step 4 involves a review of the entire process and a discussion of the "the implications of the emerging understanding for policy and management actions" (Walker *et al*. (2002). However, it is important to note that the resulting implications are suggestions only and not an attempt to perpetuate colonial sentiment or traditions of western dominance.

Process Review:

As previously discussed, it was not possible to visit the Iraqi Marshlands firsthand. This impacted all steps of the Framework. While local voices were heard through interaction with the Advisory Committee, CIMI-II Iraqi team members, and data

collected by CIMI-II assistants through workshops and interviews, the analysis of Step 1 and 2 would have benefited from increased input and participation from local stakeholders to increase insight into the local context. Step 3 and 4 would also have benefited increased stakeholder involvement. This would have enabled a more detailed discussion on policy options and management.

The models created in Step 3 are an important part of the process as they represent the culmination of Steps 1 and 2 and the foundation for Step 4. Models must, out of necessity, simplify the system that they are representing. The models created in Step 3 are no exception. To include all the details of the Iraqi Marshlands in the models would be overwhelming and unhelpful. "Developing parsimonious models of complex systems is not easy. Good systems models will capture essentials while ignoring unnecessary details" (Bennett *et al*. 2005, p.946). It is also important to note that the Framework does not advocate the use of any particular type of model. Therefore, there are other types of models that could be used to characterize the Iraqi Marshlands. The models from Step 3 are meant to help better understand the system and to explore system resilience (Walker *et al*. 2002). Furthermore, "[s]ystems models are particularly useful for organizing the key elements of a case into a structure that can be used to appreciate the connections and interactions among the elements" (Bennett *et al*. 2005, p.946). To this end, the models created in Step 3 do help to characterize and understand the system and to visualize the impacts that decisions may have on the state of the system.

It is common knowledge that Iraq is currently experiencing violent conflict and that the security situation is unstable. However, this is not explicitly stated in the models from Step 3. The future of not only the Marshlands but all of Iraq depends on

stabilizing the security situation. "Depending how long the struggle in Iraq continues and how violent it is, Iraqis could be dragged down into a kind of social incoherence from which they are likely to give up trying to attain a just and peaceful society" (Polk 2005, p.192). While violence is ongoing, efforts to manage the Marshlands are currently underway. Before 2003 this would have been impossible. While conflict is an important part of the equation, it is one of a number of elements that must be considered.

The models from Step 3 also assume that it is realistic to transfer land use from Manufactured Capital to Marsh Habitat and vice versa. This is not always the case. It is important to note that once marsh habitat has been converted it is can be very difficult to restore. In addition to the ecological difficulties associated with restoration, once land has been converted, convincing people to give up the new land use (such as agriculture) will be very difficult (Sluglett 2003b). This clash between environmental and economic interests is not a new challenge in resource management and it is one that is not easily resolved. This is reflected in the discussion of SC and EC perspectives from *Step 2*. Inasmuch "development" was identified as a key variable in the Iraqi Marshlands and is a main driver in the models from Step 3. Future development in the Marshlands must be carefully considered, especially given the presence of oil in the region.

Policy Implications:

The analysis shows that the system cannot be returned to its pre-drainage state due to lack of quality water, land use conversion, and significant social upheaval. It may be possible for some marsh habitat to persist, but every possible future scenario represents a regime shift into a new adaptive cycle. While this is not a new idea, it is one that is not easily accepted and has meaningful implications for policy. In order to be

successful water management plans need to focus on reorganization a new system rather than clinging to the previous regime.

Furthermore, the analysis shows that resilience may be a useful management tool in the Marshlands. Traditional resource management techniques are inadequate for governing complex SESs. Given that the Iraqi Marshlands are experiencing intense upheaval, management tools must be flexible and able to cope with uncertainty and change. Resilience analysis and management can offer alternative approaches and ideas (discussed below) in order to work towards solving the current water management challenges in the Marshlands.

- **Build a shared vision of the future:**

Given that it is impossible to restore the pre-drainage state of the Marshlands, people must decide on what the Marshlands should look like in the future. There are many stakeholders in the Marshlands with different ideas about the Marshlands. "Only through a shared understanding among the different stakeholder groups of the processes and of their implications for the system, will changes in policy and management actually arise" (Walker *et al*. 2002). It is important to build a shared vision of the future so that all stakeholders are working towards a common goal.

- **Focus on increased stakeholder participation:**

Iraq was governed by a dictatorship that restricted ordinary citizens from participating in decisions that affected their everyday lives. After the removal of this regime in 2003, Iraqis were eager for political participation (Klein 2007). Spontaneous elections occurred all over the country at all levels and in certain cities " ...religious leaders, secular professionals and tribes-people worked together to set local priorities for

reconstruction, defying the worst predictions about sectarianism and fundamentalism" (Klein 2007, p.436). The US administration ultimately suppressed these activities which strained relations between the CPA and the Iraqis (Klein 2007). This example highlights the need for an inclusive process that encourages stakeholder participation. Local people need to be involved as decisions made with respect to water management will affect their everyday lives. Furthermore, lack of support from local people could result in low implementation of water management activities and undermine the shared vision of the future. Getting people involved will help them take ownership of the Marshlands and will help to foster community stewardship and support for conservation and restoration efforts. It can also help to bridge the gap environmental and ecological interests. "If clear mechanisms, mainly grassroots, are created to support and mitigate negative outcomes, it can be possible to meet local community livelihood needs and conserve environment and resources" (Okello *et al*. 2009, p.132). Finally, increased stakeholder involvement will help to increase the resilience and the adaptive capacity of the system.

- **Focus on managing the resilience of key system variables:**

The preceeding analysis has shown that the future of the Marshlands can be determined by five key variables: water availability, scalar cooperation and coordination, institutional capacity and support, development, and local quality of life. There needs to be a focus on strengthening these resilient pathways in order to increase the resilience of the system and increase the likelihood of achieving a desired future scenario. Managing each of these variables is a challenge that will require flexibility and innovation.

- **Create an integrated approach:**

Creating an integrated management plan is an important component of the resilience approach. In complex SESs, trying to manage individual elements without considering their interactions will give poor results. In the Marshlands, a water management plan must consider how the key variables interact and impact each other. Newman (2007) notes that without an integrated approach that considers all the elements of the system, it will not be possible to restore the Iraqi Marshlands in any way.

- **Embrace flexible mechanisms:**

The resilience approach promotes flexibility. It allows for a "muddling through" approach that focuses on the best use of available resources and reevaluating activities as the situation changes (Wollenberg *et al.* 2007). Creating mechanisms, organizations, institutions, programs, etc. that can respond to changing local conditions will be valuable in the Iraqi Marshlands, where the situation is uncertain and volatile. Flexibility will increase the resilience and adaptive capacity of the system which will augment its ability to respond and adapt to changing circumstances. This is especially important as the Marshlands navigate the back-loop of the adaptive cycle.

- **Support and foster innovation:**

Innovation in the Marshlands has been suppressed (see *Step 1*). Water management in the Marshlands is a complex challenge that will require innovative solutions. Focusing on resilient pathways and stakeholder participation will help to create a space for innovation. Supporting and fostering innovation will help to increase the adaptive capacity of the system. Innovation is an important element that will help the Marshlands to navigate the back-loop of the adaptive cycle and help the system to reorganize.

- **Emphasize monitoring:**

Finally, good data on the system is required in order to make informed decisions. This includes qualitative and quantitative data, as well as scientific and indigenous knowledge. There is currently a paucity of data, both ecological and social, relating to the Iraqi Marshlands. Monitoring is required to learn about the new state of the system and understanding how the system has and will change. Conceptual models, like those created in Step 3, can help to guide data collection by identifying important variables and related data requirements (Elf *et al*. 2007). Furthermore, as new data and information is acquired the conceptual models should be updated to reflect the changing system (Soullière *et al*. 2001). It is also important to monitor the impacts of different management activities and uncontrollable events on the Marshlands (ex. Farajalla and El-Khoury 2007).

The policy implications of the case study discussed above are interrelated and build on each other. They will all help to promote resilience and adaptive capacity in the Marshlands. This, in turn, will help the system during the reorganization phase of the adaptive cycle and, potentially, avoid falling back into a poverty trap. While not novel, these suggestions may help to make the system less vulnerable to future shocks. As such they represent resilient pathways that can help direct the future of the Marshlands along the desired trajectory.

Lessons Learned:

After completing the case study analysis of the Iraqi Marshlands using the Framework, the final step is to extract the lessons learned about the Framework and the concept of resilience and discuss how the analysis may be useful for other SESs.

The analysis of the case study offered insight into the Framework presented by Walker *et al*. (2002). It reinforced the importance of local context and stakeholder involvement as well as building support for implementation. The analysis also showed that the Framework can be applied to a system that is experiencing violent conflict, which will be discussed in more detail below. It was initially thought that the violent conflict in Iraq would be the overriding driver of the system. However, completing Steps 1 and 2 of the Framework revealed that this was not the case. While violent conflict was an important factor, the analysis revealed that it only represented one aspect of a complex system.

The analysis also revealed certain limitations of the Framework. The Framework was useful to help identify critical variables, identify resilient pathways, and relate these to policy. However, it should be noted that completing the steps of the Framework does not necessarily result in a transition to more sustainable management. It is possible that the results of the Framework could show that the problems facing a SES are actually intractable or that there are too many obstacles to implementing the recommended changes. Furthermore, completing the Framework does not necessarily generate the will and support to implement the results. The analysis also demonstrated the subjectiveness of the Framework depending on the stakeholders who are involved and how the steps are completed. The analysis revealed the ambiguity of the process of completing the

Framework. The case study of the Iraqi Marshlands helped to clarify the procedure for applying the four steps of the Framework to SESs, especially Step 3. Walker *et al.* (2002) does not specify any procedures for creating the models for Step 3. Creating models to represent complex SESs is always challenging. Due to the paucity of data and the high levels of uncertainty in the Iraqi Marshlands, it was determined that a qualitative model would be most useful to characterize the system, specifically a conceptual model. Conceptual models are useful tools for representing complexity and visualizing the relationships and interaction between the components of a system (Dresner 2008). Due to the importance of scale in the Marshlands, it was determined that two models would be created: the first would focus more on the connections between different scales (see Figure 13) while the second would focus more on characterizing the Marshlands (see Figure 14). Given that the second model was going to be built around the three future scenarios, state-and-transition models were found to be a useful framework for organizing the three scenarios within the conceptual model and showing the links between them (see Briske *et al*. 2008). Archetypal systems models were also found to be useful for organizing the components of the system within each scenario and showing the relationships between the different components of the system (see Bennett *et al*. 2005). While organizing the components in the conceptual models it was found that reducing the system to its most critical components (see Yorque *et al*. 2002 and Walker *et al*. 2006b) allows for a model that characterizes the 'big picture' but also allows users to place more specific issues within the larger context of the system. "Resilience is often complex, context specific, and highly dynamic, qualities that make it hard to develop general tools and methods of application" (Marshall and Marshall 2007, Introduction section, para.4).

By continuing to apply the Framework to various SESs, it will help to determine the most useful guidelines for completing the Steps. This in turn, will make using the Framework, as well as resilience analysis and management, a more practical tool and increase the use of the concept of resilience by resource managers.

The analysis of the case study showed that resilience analysis and management may be a useful tool in the Marshlands. It can be used to visualize and gain perspective on the system. It can be used as a lens to frame the issues and to think about management strategies. The case study analysis of the Iraqi Marshlands can also offer insight into the concept of resilience, specifically the impact of war on resilience and reorganization following release. The Iraqi Marshlands can offer a valuable perspective as they have experienced a catastrophic release and are attempting to reorganize. This information could eventually be compared with other case studies to determine patterns and commonalities in order to increase knowledge of the concept of resilience.

There is a little research looking specifically at the resilience of systems that are in a state of war. The eight year long Iran-Iraq war led to a regime shift in the Marshlands. However, after the war between Lebanon and Israel that lasted from 12 July 2006 and 14 August 2006, testing in the Tyre Coast Nature Reserve in Lebanon revealed that the violence had not permanently damaged the wetlands (Farajalla and El-Khoury 2007). Based on the case study of the Iraqi Marshlands, it would appear that as the intensity and duration of the war increases, the more likely it will be that the system will move into the release phase of the adaptive cycle and the more difficult it will be for it to transition into the reorganization phase.

It would appear that the most damaging consequence of war is not the potential for release but rather its impacts on the resilience of the system. The case study of the Iraqi Marshlands has shown, not unexpectedly, that extended periods of war will have a devastating impact on resilience and adaptive capacity. It is these attributes that help a system to persist in the face of surprise and reorganize after release. This could suggest that resilience analysis and management may not be useful in SESs experiencing high levels of violent conflict as conditions are too disruptive. However, the case study analysis also suggests that resilience analysis and management is useful in SESs, like the Iraqi Marshlands, that are attempting to reorganize after a war where there is still some violent conflict that is occurring. Under these circumstances, resilience analysis and management is able to help manage uncertainty and quickly changing conditions.

Given the difficulty of managing for resilience during a war, an important focus for research may be how to increase resilience following the cessation of violence. In the case of the Iraqi Marshlands, one of the reasons the system could not reorganize after the Iran-Iraq war was low resilience. This low resilience makes a system vulnerable to surprises as it attempts to reorganize. These surprises can counteract efforts to reorganize, reduce resilience, and potentially push a system into a poverty trap. Right now for example, the Iraqi Marshlands have been given a window of opportunity to reorganize. However, events like drought and sandstorms are jeopardizing these efforts.

While there is little research being done specifically on war and resilience, there are numerous case studies being conducted in regions that have experienced war or extended violence in the recent past (ex. Sanginga *et al.* 2007; Bohensky 2008; Resilience Alliance 2009b). As was the case in the analysis of the Iraqi Marshlands,

these case studies did not focus on violence as the main system driver but rather view it as one component of the system.

The lessons learned from the case study analysis of the Iraqi Marshlands about the Framework and the concept of resilience can be applied to other SESs experiencing similar issues. Furthermore, the policy implications from Step 4 of the analysis can also be used as general guidelines for managing the resilience of a SES. While not groundbreaking, these policy implications are aligned with the available literature on resilience and could be used as archetypes of resilient pathways that could be applied to a variety of SESs.

Conclusion:

This Chapter presented the results of the analysis of the case study of the Iraqi Marshlands. It proved that the Iraqi Marshlands are a SES. Next, it presented the results of the case study analysis of the Iraqi Marshlands using the Framework. Finally, it discussed the lessons learned from the case study analysis. Due to the paucity of studies examining the back-loop of the adaptive cycle, the case study of the Iraqi Marshlands can offer valuable information regarding regime shifts and reorganization following release.

Chapter 6: Conclusion

Introduction:

The goal of this study was to explore the concept of resilience in social-ecological systems (SESs) using the case study of the Iraqi Marshlands. As stated in Chapter 1, *this thesis will test the bounds of resilience analysis and resilience as a management tool using the Framework put forth by Walker et al. (2002) through the case study of water management (quantity and quality) in the Iraqi Marshlands.* Specifically,

1. Can the Framework by Walker *et al*. (2002) be applied to the management of water quantity and quality in the Iraqi Marshlands?
2. Is the concept of resilience analysis and management a useful management tool in the context of the Iraqi Marshlands?
3. What lessons can be learned from the case study of the Iraqi Marshlands about resilience analysis and management?

This Chapter will summarize the key findings of the case study analysis and relate these findings to the original research questions presented in Chapter 1. Next, it will explore possible venues for future research and finally, it will give a brief discussion on the future prospects of the Iraqi Marshlands.

Key Findings:

The results of the case study analysis found that the Resiliency Framework developed by Walker *et al*. (2002) can be applied to the Iraqi Marshlands. The Framework was useful to help identify critical variables, determine resilient pathways, and relate these to policy. The case study analysis also reinforced the importance of

stakeholder involvement and understanding local context as well as the importance of building support in order to make the transition to resilience management. However, completing the steps of the Framework does not necessarily result in a transition to more sustainable management. It is possible that the results of the Framework could show that the problems facing a SES are actually intractable or that there are too many obstacles to implementing the recommended changes. Furthermore, completing the Framework does not necessarily create the will and support to implement the results.

The case study analysis also revealed the subjectiveness of the Framework depending on the stakeholders who are involved and how the steps are completed. Therefore, in the future, users of the Framework should be certain to carefully identify relevant stakeholders and to be as transparent as possible throughout all of the steps of the Framework. The analysis also revealed the ambiguity of the process of actually completing the Framework. The case study of the Iraqi Marshlands helped to clarify the procedure for applying the four steps of the Framework to SESs, especially Step 3 which involves creating simple models that link the current state of system, possible futures, and management decisions. The case study analysis found that qualitative conceptual models are useful for representing SESs as well as state-and-transition models and archetypal systems models. It also found that when creating the models for Step 3 it is necessary to identify the critical variables of the system (usually three to five) in order to create a model that is simple enough to be useful but focused enough to handle the complexity of the system. These recommendations will help to make applying the Framework easier in the future and help to increase the use of resilience analysis and management by water managers. "Resilience is often complex, context specific, and highly dynamic, qualities

that make it hard to develop general tools and methods of application" (Marshall and Marshall 2007, Introduction section, para.4). By continuing to apply the Framework to various SESs, it will help to determine the most useful guidelines for completing the Steps. This in turn, will make using the Framework, as well as resilience analysis and management, a more practical tool and increase the use of the concept of resilience by resource managers.

The case study analysis showed that resilience analysis and management may be a useful tool for future water management in the Iraqi Marshlands. It can be used to visualize and gain perspective on the system. It can also be used as a lens to frame the issues and to think about management strategies. Notwithstanding, the analysis also showed that resilience analysis and management is not useful during wars of high intensity and duration. Therefore, it would appear that resilience analysis and management can be a useful tool in places still experiencing residual violence following a war but not during the war itself. Resilience analysis and management is a flexible approach that can handle uncertainty and quickly changing conditions. However, it would appear that a certain threshold of security is required in order for it to be implemented. While the security situation in the Iraqi Marshlands is still unstable, the case study analysis revealed that the violent conflict, while important, was only one component in a complex system, rather than the overriding driver of the system.

All of the lessons learned from the case study analysis about the Framework and resilience analysis and management discussed above can be used as considerations for the management of other SESs. Furthermore, the policy implications emerging from Step 4

of the Framework, which involves a review of the process and a discussion of the implications of the case study analysis, may also be useful:

- Build a shared vision of the future,
- Focus on increased stakeholder participation,
- Focus on managing the resilience of key system variables,
- Create an integrated approach,
- Embrace flexible mechanisms,
- Support and foster innovation, and
- Emphasize monitoring.

Given that the discussion of policy implications was out of necessity more general, the recommendations above can be used as an archetypal list of guidelines for policy makers hoping to transition to resilience management. While this list is not exhaustive, it can be used as a starting point for managers to build on and adapt to their local context.

Future Research:

The case study analysis of the Iraqi Marshlands illustrates several worthwhile venues for future research in the Iraqi Marshlands and for resilience analysis and management in general.

To build on this case study analysis of the Iraqi Marshlands, it would be useful to create sub-models to further investigate the key system variables. This would help to increase understanding of the system, identify more specific resilient pathways, and reveal more ideas about implementation. It would also be a valuable exercise to repeat the case study analysis with increased stakeholder participation. It could help to create a

shared understanding of the system, and empower local people. It would also be interesting to compare the two case study analyses to see if they had similar results.

Researchers and practitioners need to continue applying the Framework to different SESs to help create guidelines and protocols for completing the steps of the Framework. The more we familiarize ourselves with this, the easier it will be to operationalize resilience analysis and management. It would also be interesting to complete further case studies of SESs in areas that are currently experiencing violent conflict. Comparing these case studies would help to validate the findings from the case study of the Iraqi Marshlands and identify patterns. This exercise would increase understanding of the concept of resilience and help to add to the archetypal list of policy implications that came out of the case study of the Iraqi Marshlands. It could also help to gain more perspective on maladaptive cycles (poverty and rigidity traps) and how systems reorganize following a shock like violent conflict. Further case study analyses may also offer insight into methods for increasing resilience and adaptive capacity following a war.

Future of the Iraqi Marshlands:

Since the removal of the previous regime in 2003, the Iraqi Marshlands have been given a window of opportunity to reorganize. However, the future of the Iraqi Marshlands is grim. The drought of the past two years has taken a heavy toll on the marsh habitat and quality of life in the Marshlands is poor. While efforts are underway to affect change, the question remains if it will be enough. Only time will tell if the system will be able to reorganize or if it will slide back into a poverty trap and eventually disappear.

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