CLIMATE CHANGE IN ECUADOR'S COASTAL COMMUNITIES AND MANGROVE ECOSYSTEMS: LOCAL KNOWLEDGE, PERCEPTIONS, AND PRIORITIES

by

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This thesis is dedicated to the people of Portovelo, Bellavista, Bunche and Santa Rosa in Ecuador who welcomed me into their lives and shared their precious knowledge and experiences.

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ABSTRACT

Coastal communities in Ecuador – and worldwide – are vulnerable to climate change due to both marine and inland pressures that may exacerbate current issues. Studies predict that changes to sea-level rise, precipitation patterns, and hydrometeorological events will impact strongly on coastal zones, with particularly negative effects on communities who rely on natural ecosystems such as mangroves for their livelihoods. Unfortunately, such studies are rarely integrated with knowledge of how rural, coastal populations, such as those in Ecuador, perceive climate change, and more broadly how they understand the environmental changes witnessed during their lifetime. This research compiled information from two Ecuadorian coastal communities, as well as regional and national non-governmental organizations, global scientists, and national institutes, in an effort to learn about the different perceptions and knowledge bases relating to mangrove ecosystems, climate change vulnerabilities, and historical environmental change. The information was compared in an effort to discover where information gaps or points of collaboration exist. Results show a separation between priorities at the local level, on the one hand, and analyses of climate change, and use of its associated vocabulary, at other levels. Historical change was often attributed to the drastic effects of the shrimp farm industry, deforestation of mangrove and tropical forests, and El Niño (ENSO) events. Participants mentioned God, a displeased nature, and the climate being *loco* (crazy) as partial reasons for change. However, participants also recognized differences in the seasons, temperature, rainfall variability, and flooding. The richness of the local knowledge base in the communities studied indicates that top-down models are insufficient when dealing with complex issues such as climate change, thus necessitating use of more bottom-up information through monitoring and collaborative dialogue. Addressing climate change vulnerabilities requires a focus on local ecological knowledge and priority issues of food security, freshwater, pollution, and diminishing fish species. Collaboration around mangrove restoration may indeed be a critical and relevant adaptation strategy.

LIST OF ABBREVIATIONS USED

C-CONDEM	*Corporación Coordinadora para la Defensa del Ecosistema Manglar*
FAO	Food and Agriculture Organization of the United Nations
FUNDECOL	*Fundación Ecológica*
INOCAR	*Instituto Oceanográfico de la Armada*
INAMHI	*Instituto Nacional de Meteorología e Hidrología*
IPCC	International Panel on Climate Change
LEK	Local Ecological Knowledge
MAE	*Ministerio del Ambiente*
SCC	*Subsecretaría de cambio climático*
UN	United Nations

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DECIMA DE REFLEXIÓN
PAREN LA MANO

Linver Nazareno

Señores paren la mano
Ya no tumben el manglar
No contaminen los ríos
La concha se va acabar

Dicen que fue por trabajo
Que el hombre empezó a talar
Hicieron grandes piscinas
Pa camarones sembrar
Sin pensar en los usuarios
Tumbaron nuestro manglar
Era fuente de trabajo
Para la concha agarrar
Por los errores cortados
Señores paren la mano

Todo lo que está pasando
Ahora en la actualidad
Al mundo lo están dejando
En la pura soledad
Y la gente está abusando
De la bondad del Señor
Las especies se terminan
Por la tala irracional
Para hacer camaroneras
Ya no tumben el manglar

De los manglares que aún quedan
Han hecho sus basureros
Nadie limpia los estuarios
Que algunas especies se fueron
Para la siembra del camarón
Químicos echan a diario
Con tanto plástico al agua
Nos están dejando fríos
Pensemos en el mañana
No contaminen los ríos

Los viejos siempre decían
Que mi Dios bajito estaba
Y que del cielo bajaba
A dormir en el manglar
Que conchas comíamos todos
Nadie la pasaba mal
Que las especies que habían
Sí las supieron cuidar
Señores paren la mano
La concha se va a acabar

CHAPTER 1 INTRODUCTION

1.1 Project Statement

Coastal communities worldwide are predicted to face various impacts from climate change. However, often little is known about how rural, coastal populations understand and perceive climate variability or biophysical change and how these factors interact with their main priorities and concerns.

Low-lying coasts in Latin America are among the most vulnerable to climate variability, extreme hydrometeorological events (rain and windstorms), hurricanes and associated storm surges (Magrin, 2007) as well as small increases in sea-level (Gilman et al., 2007b). The various predicted biophysical changes are expected to cause a loss of coastal resources, infrastructure and land (Klein et al., 1999). This will affect fifty-five per cent of the world population who draw on coastal and marine ecosystems for recreation, transportation, food, and industrialization and the 1.2 billion people who live within 1.2 kilometres of the shoreline (Food and Agriculture Association of the United Nations [FAO], 1994; Small & Nicholls, 2003). Additionally, coastal inundation and corresponding saltwater intrusion into surface waters and groundwater aquifers are also very real threats affecting coastal processes and human health (Nicholls et al., 2007; 2009). However, variability in exposure and vulnerability result in scale-dependent impacts which will be unevenly distributed among and within nations, regions, communities and individuals (Clark et al., 1998). Depending on the region, this will have important implications to their potential to adapt, especially if these stresses have a compounding effect on the pressures already present.

Human induced pressures exacerbate many of these coastal climate change impacts thus increasing the risk to coastal communities and their natural ecosystems (Convention on Biological Diversity, 2003; Nicholls et al., 2007). Coastal communities which depend on their natural resources are particularly vulnerable[1] in that their livelihoods will be impacted by marine and inland pressures and stresses (Nicholls et al., 2007; Pomeroy, et al., 2006). Especially in developing countries, sea-level rise, rising air and sea surface temperatures, erosion, storm surges, and ocean temperatures and acidification will pressure ecological processes and cause a

[1] This socially constructed phenomenon is a function of exposure, sensitivity, adaptive capacity or capacity to adapt and links in resilience, leading to a wide application in global change science widely influenced by

series of changes; this will in turn affect their ability to engage in adaptation activities (Kundzewicz et al., 2007; Nicholls et al., 2007, 2009). In fact, risks are already apparent in the fisheries which support livelihoods in rural, developing country populations (Adger et al., 2003).

The top-down scenario-driven approaches such as those described by IPCC (classical or first generation impact and adaptation studies), has led to "growing dissatisfaction" and a need to find ways to work from the bottom-up, at a locally relevant scale (Riedlinger & Berkes, 2001; van Aalst et al., 2008). Various studies support the notion that when faced with complex issues and unstructured problems, participation of non-scientists in research is required (van Asselt & Rijkens-Klomp, 2002). Local and non scientific knowledge and values have been shown to offer a more complete knowledge base than scientific study alone (Berkes et al., 2000), improve the quality of research (van Asselt et al., 2002), and increase confidence in shared results (Johannes et al., 2000). Indeed, one should inform and base their analysis of present day vulnerabilities to climate change on historical perspectives (Adger, 1996 in Adger, 1999) because factors that have constrained and contributed to people's past and present exposure and adaptive capacity are likely to similarly affect future climate change responses (Ford et al., 2006). As such, the involvement of local stakeholders in vulnerability assessments and monitoring is encouraged in order to support proactive adjustment to changes (Tschakert, 2007). The first step, according to Tschakert (2007) is to incorporate views from the vulnerable if meaningful and feasible adaptation and livelihood resilience improvement is to be achieved. Indeed, "people with such deep experience recognize anomalies readily" and can contribute with insights about weather, species, habits, etc. (Turner & Clifton, 2009). Local knowledge can make valuable contributions to and promote the understanding of climate change (Byg & Salick, 2009) and elucidates the breadth and depth of local realities. For this reason, incorporating local perceptions of climate change is a critical component of adaptation. People's local values and beliefs play a key role in climate change response due to their effect on behaviour (Turner & Clifton, 2009); their local knowledge influences actions, decisions, and adaptive measures (Berkes & Jolly, 2001). Discovering where overlaps occur between different knowledge bases (local, scientific, national) may indeed offer appropriate entry points and opportunities for collaboration in the face of complex changes.

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institutional and economic dynamics (Adger et al., 2003; Adger, 2006; Preston et al., 2008; Smit & Wandel, 2006).

1.2 Project Overview

In coastal Ecuador, the communities of Portovelo, Manabí and Muisne, Esmeraldas are subject to various coastal and inland stresses which are impacting their livelihoods and surrounding natural environment. With so many scientific studies predicting impacts to their coastal zone, it bears the question "what do they think about it?" and "what factors contribute to these impacts"? What initially stemmed from the idea of incorporating the local voice to compare top-down and bottom-up knowledge then evolved into a mixed methodology research project which utilized interviewing, focus group, community mapping and observational data collection techniques.

1.2.1 Research Questions

The following research questions guide this thesis.

1. What are the biophysical vulnerabilities of Ecuador's mangrove ecosystems and coastal zones to climate change according to various sources such as global scientists, national institutes, government, national and regional organizations, and local people?

2. What are the local perceptions of climate change in Ecuador's coastal communities?

3. How does the information from top-down sources and global predictions compare to local ecological knowledge and 'bottom-up' perspectives on change?

4. What role can the various sources (government, community) have in addressing vulnerability and contributing to climate change dialogue?

There is much uncertainty surrounding climate change and its impacts on coastal ecosystems and communities and understanding how vulnerabilities come into play is critical. The research questions were designed in such a way as to elucidate information about the local perceptions of climate change as compared to various other sources in order to produce recommendations at the community, organizational and government level. Over the course of the analysis, it became clear that the results from certain interview questions merited closer inspection. Though the research questions dealt with in this study in chapter three and four overlap, the implications and lens upon which they are each answered is quite unique. For example, research question two which is related to local perceptions of climate change directly,

is dealt with separately from the contributing reasons behind these local perceptions. In a similar fashion, research focusing on describing which entities need to play a role when addressing vulnerability is taken up separately from the discussion surrounding the role of government specifically.

1.2.2 Thesis Outline

This thesis is organized into five chapters and eight appendices. Chapter one outlines the research scope and the following section provides background information about the area, context, and broader themes investigated throughout the thesis. Specifically, it offers a brief literature review on Climate Change, Ecuador and Mangrove Ecosystems, Local Ecological Knowledge, Adaptation and Adaptive Capacity, and Participatory Methods. Chapter two outlines the methodology used during this research. Chapter three and four are stand alone papers intended for submission to scholarly journals. Their foci are: a) the local perceptions of climate change as compared to predicted vulnerabilities and the knowledge these various sources provide; b) community priorities and the discovery of entry points on which to base collaborative climate change dialogue. The final chapter synthesizes and discusses the results of both papers as they relate to the thesis questions, provides a personal reflection on the limitations to this study, identifies future research directions and describes conclusions. The appendices include a summary of the distribution of results and materials, a photo of the four community maps, as well as methodological materials such as the interview schedule, consent forms and other documents required by the Dalhousie University Research Ethics Board.

1.3 Background Literature

1.3.1 Climate Change

Mounting scientific evidence and increasing awareness levels have resulted in the emergence of climate change as a defining political, economic and environmental issue (Burch et al., 2009). Results from a collaborative study of South America show that significant trends were observed based on daily minimum temperature which include more tropical nights, warmer 'coldest night of the year' as well as an increasing percentage of warm nights (Vincent et al., 2005). Ecuador is located on the pacific coast of South America and has a population of 13.8 million (Population Reference Bureau, 2008), 61% of which live within 100km of the coastline (Earthtrends, 2003). Climate change stands to affect this country in a multi-faceted

way due to the varied Amazon, Andean Mountain, and coastal zones which make up this small country. Ecuador has been characterized as 'highly vulnerability', which will be intensified by the direct and indirect impacts of climate change (UNFCCC, 2000); research has confirmed the existence of a trend of rising temperatures, and uneven rainfall which has an inclination toward decline on the coast (Magrin et al., 2007; UNFCCC, 2000). The coast of Ecuador has been shown to be more vulnerable than others in Latin America due to exposure to sea-level rise, coastal flooding, weather and climatic variability and extremes which will not only impact mangrove ecosystems but will add to the present and adverse pressures on freshwater supplies (Magrin et al., 2007; Vergara et al., 2007).

In Alcamo and Henrichs' (2002) analysis of world water resources sensitive to global changes, much of the southern and central Ecuadorian coast was under severe stress. This is important because, "water and its availability and quality will be the main pressures on, and issues for, societies and the environment under climate change" (Bates et al., 2007, p. 7). Freshwater systems will be affected by climate change impacts due to observed and projected temperature and sea level increases, as well as precipitation variability (Kundzewicz, et al., 2007). Water stresses as they relate to coastal communities are still far from understood, especially with regards to the relationships between freshwater and saltwater and how these will be affected by global warming (Nicholls et al., 2007). In coastal areas, there may be negative effects on storm-water drainage and sewage disposal, an increased potential for saline water intrusion into fresh groundwater or coastal ecosystems due to rising sea levels (Bates et al., 2008). Indeed, climate impact scenarios have predicted all seacoast areas to be subject to flooding and an increase in average sea level would lead to floods virtually along the entire Ecuadorian coastline (UNFCCC, 2000). The various impacts on coastal ecosystems such as mangroves are important to consider in light of the important ecosystem services they provide. Further information about the causes and effects of climate change are available in the literature (Adger et al., 2003; Nicholls et al., 2007; Magrin et al., 2007).

1.3.2 Ecuador and Mangrove Ecosystems

In Ecuador there are 7 species of mangrove, the four most dominant ones being red, black, white and *botón* or *jelí* mangrove (FUNDECOL, 2000; Navarrete, 2002). According to CLIRSEN (1991) mangroves historically extended across 203,695 hectares of Ecuador, with 32,039 hectares in the province of Esmeraldas and 12, 419 hectares in the province of Manabí

(Torres & Yepez, 1999 in Papuccio de Vidal, 2004). In the province of Esmeraldas (Muisne) there is high tidal amplitude and large river discharge whereas in Manabí (where Portovelo is situated), an arid environment, there is little freshwater input and minor tides (Bodero & Robadue, 1995). Almost 14% of mangrove forests in Ecuador are legally protected (Earth Trends, 2003). As a natural and renewable resource, mangroves are among the most productive terrestrial ecosystems (FAO, 1994) and have tremendous social and ecological value (McLeod & Salm, 2006). In Ecuador, mangrove ecosystems are used for agriculture, aquaculture, wood products, salt production (FAO, 2007), habitat and fisheries support, and offer multiple ecosystem services that benefit coastal communities (Walters et al., 2008). Traditionally, they were also used for the production of charcoal, the extraction of tannin from mangrove bark, and agricultural land use (FAO, 2007; Ocampo-Thomason, 2006). Mangrove ecosystems serve as habitat and nursery habitat for countless migratory birds, crustaceans, reptiles, small mammals, insects, molluscs, microorganisms and marine creatures (Gilman et al., 2008; McLeod & Salm, 2006).

Artisanal, small-scale fisheries

Artisanal fisheries include the collection of crustaceans, molluscs, and fish as a source of protein on which coastal populations base their alimentation. Both Muisne and Portovelo harbour individuals and groups who fit the characteristics of small-scale fisheries described in Salas et al. (2007). The three types of artisanal fishing in Muisne and Portovelo are (adapted from Papuccio, 2004):

(a) Artisanal coastal fishing without motor. This occurs 1-2 km off the coast in a 4-5m long canoe and usually at a distance of 2 hours (maximum) from home. The maximum catch is usually 100 pounds based on the limited size of the boat.

(b) Artisanal fishing with a motor. This occurs 1-5 miles from the coast and focuses on shrimp, prawn, sea bass, dolphin, long nose gar (*picudo*), etc.

(c) Artisanal fishing '*de altura*'. Using fibreglass boats they head out to open sea at a distance of 3-8 hours from shore and focus on shark, dolphin, and *picudo*.

In Ecuador, the blue crab (*cardisoma crasum*) and red crab (*guariche or veidas occidentalis californiensis*) are important economic resources for the local populations, usually caught by males and young men using pineapple, coconut and mature mangrove leaves (Papuccio, 2004). In addition to the crab, various fish species, shrimp and cockles are also caught

in the estuaries. The collection of these animals provides income for the surrounding communities, and the services provided by the mangroves have an estimated annual economic value of $200,000-$900,000 per hectare (Wells, 2006). Globally, mangroves represent a critical part of the overall livelihood security of the coastal community (Walters, 2008). Lesser know uses of mangroves include their medicinal capabilities to alleviate pain, antiseptic, etc. Mangroves are also source of myths, legends and stories as well as inspiration for songs, dances and poems in Ecuador (FUNDECOL, 2009).

Threats to mangrove ecosystems

Many countries have lost 50-80% or more of the mangrove forests present 50 years ago due to conversion to agriculture, aquaculture, industrial and urban development (Macintosh & Ashton, 2003). Mangrove forests and the estuaries in which they are found are often destroyed or degraded by urbanization in the coastal zones and are the most threatened coastal habitat in the world based on recent loss rates (Valiela et al., 2009). According to the *Ecuadorian Environmental Plan and the Environmental Strategy for Sustainable Development*, their noteworthy specific concerns include natural disasters and fragile ecosystems such as mangroves. Ecuador stands to lose ~300km^2 to 500km^2 respectively of their mangroves with up to 1300km^2 in danger due to climate change (UNFCCC, 2000). In Ecuador, the loss of 57% in 30 years (1969-1999) and 70% in the last four decades is attributed mainly to uncontrolled shrimp aquaculture and inadequate governance by the Ecuadorian state (Bodero & Robadue, 1998; C-CONDEM, 2007; Ocampo-Thomason, 2006). An absence of property rights, ineffective management regimes and incentives given by the Ecuadorian government to shrimp farmers are among the reasons behind shrimp farm expansion (Ocampo-Thomason, 2006). This has resulted in the destruction of 254 503 hectares of the 362 803 hectares which were declared protected in 1986 (C-CONDEM, 2007).

These various causes have historically impacted coastal mangroves, yet sea-level rise is expected to contribute disproportionately to future mangrove losses and negative impacts especially if they are constrained from migrating inland, or lack necessary sediment (Gilman et al., 2007b; 2008; Nicholls et al., 2007). If sea level rise happens slowly, at a rate of 10-15 mm/year mangroves may be able to adapt and colonise new areas (Blasco et al., 1996). If not, further stresses such as erosion will lead to weakened root structures, falling of trees, increased salinity, and inundations that are excessively high, deep and long (Gilman et al., 2008).

Variability due to tectonic processes, sediment, and oceanographic factors will also affect vulnerability (Gilman et al., 2008) hence coastal subsidence or uplift the effects the mangroves must be carefully assessed (Hoffman, 1984 in Blasco et al., 1996). Additionally, the many climatic variables predicted to be altered may influence mangrove responses to sea-level rise and exacerbate the problem (Gilman et al., 2008; McLeod & Salm, 2006). However, mangroves will respond both positively and negatively to climate change (Gilman, et al., 2008; Saenger, 2002) and may serve as important indicators of the effects of climate change (Field, 1995).

Mangroves have a unique role in controlling water quality and water levels through trapping, stabilization of coastal land, assimilation of sediment and nutrients, protection against storm surges and a buffering role (Walters, 2008). This protective role is a natural first line of protection from storm surges and flooding (Nicholls et al., 1997). This integral ecosystem is not only important for livelihoods, it also serves a barrier to contaminants by intercepting pollutants, nutrients, suspended sediments and preventing their arrival to deeper water (Valiela et al., 2001). Historically, Ecuador has experienced estuarine water quality problems since 1986, including a lack of enforcement of water quality regulations, an increase in pollutants from shrimp farms and agricultural pesticides, improper and insufficient collection of water quality information, and a lack of sanitation facilities among other things (Montaño & Robadue, 1995). Mangroves can play a key role in improving water quality and removing pollutants from the shrimp pond effluent which is rich in suspended solids, nutrients and organic compounds. Between 1.8 and 5.4 hectares of mangroves are required to remove nitrate wastes from 1 hectare of shrimp pond (Primavera, et al., 2007). Other management options have been suggested by Gauthier et al., (2001) among others.

Mangroves have demonstrated their role as protective coastal buffers providing plentiful ecosystem services, and hot spots for biodiversity possessing a large 'blue carbon' sink capacity (Duarte & BBVA Foundation, 2009; Nelleman et al., 2009). Mangroves are indeed vital in storing carbon in the form of sediments; a climate change mitigation measure that must not be ignored (Nelleman et al., 2009). Additionally, mangrove loss releases stores of carbon, thus exacerbating global warming (Gilman et al., 2008).

In summary, these aquatic ecosystems not only provide physical protection against pollution and extreme weather, they also contribute to social well-being and food security; they also play an important role in binding carbon as they are natural CO_2 sinks (Nelleman et al.,

2009). The elimination of non-climatic stresses on mangroves augments overall ecosystem health, reduces vulnerability and increases resilience to stresses regardless of climate change (Gilman et al., 2008) and several high and low tech options exist to improve mangrove resilience (McLeod & Salm, 2006). The protection and restoration of natural ecosystems can thus serve to mitigate climate change (Trumper et al., 2009) but their role must be evaluated in a localized context by taking into consideration the cultural, socioeconomic and temporal contexts in the region.

1.3.3 Local Ecological Knowledge

As stated by (Tiessen et al., 2007), issues are so complex, multidisciplinary, transnational and adversarial that it is no single scientist or loose association of scientists can deal with them effectively. In fact, some argue that, "the complex relations among environmental, economic, and social processes that drive change at the global scale can only be unravelled by careful locality-specific research" (Wilbanks & Kates, 1999, p. 606). Incorporating local and traditional knowledge into climate change research and design is key (Dolan & Walker, 2004). Dessai et al. (2004, p.20) found that: "representing normally excluded voices, vulnerable groups, or even values attached to the non-human world is a transformative process that can construct institutional motivation and promote in-depth understanding of the issue at hand".

There is a general lack of place-specific study and content around appropriate adaptation and abatement responses to global warming; "a grave mismatch between the knowledge that is needed to act locally and what is currently being done globally to generate knowledge about climate change" (Wilbanks & Kates, 1999, p. 616). To gain a complete picture, one must acknowledge the locally embedded realities and constraints that affect community responses to climate change (Moser, 2000, 2005 in Nicholls, 2007). Brklacich et al. (2007) found that the same processes which put one in harm´s way may also limit one´s options for avoiding these adverse outcomes. Social, economic, and political conditions in addition to associated social inequalities can produce an increase in vulnerability (Tiessen et al., 2007). For this reason and in the face of climate change, the interactions of natural and human sub-systems are critical to understanding human vulnerability in coastal and low-lying areas and should thus include public participation in their assessment (Nicholls et al., 2007). Local dynamics and localities make a difference in that individual phenomena underlying resources use, economic activities

and population dynamics often occur at a local scale; “an important variable in understanding the reality of global change” (Wilbanks & Kates, 1999, p.606).

Three broad issues affect Ecuador’s coastal communities and need to be considered. Ecological changes have occurred due to the shrimp aquaculture industry and El Niño phenomenons thus contributing to future vulnerabilities in the region. Likewise poverty plays a part influencing the vulnerability of the region as well.

Shrimp Aquaculture Industry (‘Las camaroneras’)

In 1969 the first commercial shrimp pond was constructed and by 1999 approximately 208,714 hectares had been converted to shrimp ponds (Ocampo-Thomason, 2006). In 1985 these mangrove areas were declared protected by Ecuador’s national government through the *Ley Forestal y de Conservación de Áreas Naturales y Vida Silvestre* (Forestry and Natural Areas and Wildlife Conservation Law). In 1999, the president created the executive decree $N^0$1102 which prohibits the cutting of mangroves, yet the shrimp industry was able to continue and expand ‘illegally’ due to government land concessions, a lack of harmonization between regional and national laws and insufficient enforcement. In 2001 the *Camara Nacional de Acuacultura* concluded that only 25% of shrimp farms were legal and the other 75% lacked government agreement (C-CONDEM, 2007). Theoretically, there are strict penalties and fines of USD 7000 per hectare and an obligation to replant the deforested area, but enforcement is lacking (Macintosh & Ashton, 2003). As these intensive or semi-intensive shrimp farms usually last only 5-10 years (Gujja and Finger-Stich, 1996 in Rönnbäck, 1999), the gains for the business are short term, but result in long-term negative consequences for the communities. In fact, in many regions this unsustainable practice has resulted in 70% of ponds abandoned after a period of production (Stevenson, 1997 in McLeod & Salm, 2006). In comparison to the shrimp farms (3000 ha) which employ a mere 0.6% of locals, 85% of households in Northern Ecuador depend on fishing and cockle gathering as their most important economic activity (Ocampo-Thomason, 2006). Obviously, fisheries activities and their provision of food and income have an importance that cannot be overstated (Rönnbäck, 1999).

El Niño Phenomenon

Due to the poor natural drainage systems in the soils along the coast, excessive precipitations during the 1997-1998 El Niño phenomenon caused an overflow of rivers in the coastal zone (Ministerio de Salud Pública, n.d.). The coinciding rise in sea-level and the presence

of shrimp farms exacerbated the poor drainage thus leading to flooding and the destruction of many houses, stores, and agricultural productivity (Ministerio de Salud Pública, n.d.). Damage to houses in the province of Manabí due to the El Niño phenomenon was significant, with 3,139 affected and 1,822 destroyed coinciding with a loss of approximately 12% of gross national product per capita (Ministerio de Salud Pública; UNDP/UNPF, 2003). In total, the 1997-1998 El Niño phenomenon caused a total of 2869.3 million USD in damages with much of the harm to productive sectors such as the agriculture and livestock, fishing, commerce and tourism (Ministerio de Salud Pública, n.d.).

Poverty

Latin America in general, is a region with an economy that depends heavily on natural resources, where poverty and inequality persist, and where half of the region's impoverished populations live in rural areas (ECLAC, 2008; Hoffman & Centeno, 2003 in Eakin & Lemos, 2010). A lack of integration between policy sectors, scales of decision-making and institutional influence represents a significant obstacle to adaptation which is important to the resilience of social and ecological systems (Eakin & Lemos, 2010). Whereas primary manifestations of climate change are physical, secondary manifestations vary in terms of social, ecological, and economic impacts (Byg & Salick, 2009). One of the contributing factors to vulnerability in Ecuador's coastal communities is poverty. Poverty affects over half of Ecuador's population (52%) and 20% live in extreme poverty (UNDP/UNPF, 2003). The socioeconomic situation of those living in mangrove regions is dire. Approximately 81.68% of the inhabitants lack basic needs, 89.07% lack basic services, 11.29% are illiterate and only 2% have access to medical care (C-CONDEM, 2007). The lack of employment opportunities exacerbated by the destruction of the natural environment has resulted in outmigration to larger cities and dependence on informal and/or multiple jobs (C-CONDEM, 2007). Indeed, poverty and inequality, or the disruptions of livelihoods and security which underlie social and economic situations have both direct and indirect links to vulnerability (Adger, 1999).

1.3.4 Adaptation and Adaptive Capacity

Adaptation can be described as a modification of behaviour or adjustment to natural or human systems which can either alleviate adverse impacts or take advantage of new opportunities based on actual or expected changes in climate (Adger et al., 2004, 2005; IPCC, 2001). It can be anticipatory or reactive, autonomous or spontaneous, planned, public and/or

private (IPCC, 2001). Individuals, communities and organizations alter their behaviour in anticipation or reaction to climatic changes in many different ways and at different scales. Adaptation, in fact, is primarily a local process (Klein et al., 2007). In fact, traditionally people have innovatively adjusted to change and surprise by seeking alternative resources, new technologies, etc (Turner & Clifton, 2008). The adaptive coping abilities of coastal, often rural and often non-literate people have enabled their survival under stress" (Raynor & Malone, 1998, p.18). Some adaptations are motivated by safety whereas others are focused on the protection of economic well-being (Adger et al., 2005).

Adaptive capacity refers to the ability of a system to change in a way that makes it better equipped to manage its exposure and/or sensitivity to climatic influences (Preston et al., 2008). A more recent definition by the IPCC is: the ability of a system to adjust to climate change (including climate variability and extremes) to moderate potential damages, to take advantage of opportunities, or to cope with the consequences (2001). The idea is to increase security and resilience to existing shocks in order to develop flexibility and a buffer against future climate change consequences (Schipper & Pelling, 2006). The adaptive capacity has multiple dimensions described by Armitage (2005) who noted its function in resources management due to its ability to reflect learning, experimentation, and foster innovative solutions. Indeed, a combination of long-term ecological understanding and learning from crises and mistakes increases the resilience of integrated social-ecological systems to deal with change, in a sustainable way for both people and their environment (Berkes & Turner, 2006). Therefore, the context within which local communities face vulnerabilities and climate change is an important part of adaptation and may be recognized through participatory methods.

1.3.5 Participatory Methods

In spite of the many threats predicted for these coastal regions, climate change remains a "creeping environmental problem" (Moser & Dilling (2004, p. 34)) not yet being addressed collaboratively at local and global scales. Several factors such as human perception limits, scientist's failure to communicate, temporal lags in climate and social systems, and the complexity and uncertainty surrounding climate change have been a cause of inaction and inattention (Moser & Dilling, 2004). Additional factors such as the significant time lags in our climate and social systems, the disproportionately small effects felt by power elites, and the overshadowing of global warming by other problems have contributed to the delay in action

(Moser & Dilling, 2004). Individuals, communities and organizations alter their behaviour in anticipation or reaction to climatic changes in many different ways and at different scales. Researchers and decision makers must therefore seek a combination of local and scientific knowledge that will engage local stakeholders to partake in vulnerability assessments and monitoring while also encouraging them to use climatic information in order to proactively adapt to expected conditions (Tschakert, 2007). Applying the vast experiences of people and communities who have experienced climate variability and incorporating the information into adaptation decisions will lead to more successful responses to climate change.

When faced with multifaceted issues such as climate change, collaboration is important for knowledge-sharing and creation. It is worth noting that the participatory process is complex and requires an acknowledgement of, and reflection on, power differences, knowledge control and the effect of outsiders conducting research in communities. The fundamental works of Paolo Freire (1968) and Robert Chambers (1994) offer in depth analyses of these themes. Research with Canadian fishing communities by Wiber et al. (2009) focused on being co-learners in a "learning community" which allowed for a broader understanding of the world and elucidated some of the issues faced by fishermen and academics working in collaboration. This type of interdisciplinarity encompasses the desire for alliance and is a concept which promotes the recognition and development of complimentary referents, while teaching about one's subject and better understanding the meaning behind it (Garbay, 2003). What must be avoided is using rapid research focused solely on the informational needs of institutions, instead of challenging assumptions (Russel & Harshbarger, 2003). Outsiders or people marginally situated in the community social system are often able to step back and evaluate from a distance, which allows them to come up with new ideas (Chuenpagdee & Jentoft, 2007). However, one of the main problems with insider/outsider research occur when the knowledge and values of indigenous people (or community members) tend to receive less value than science-based perspectives brought forth by the researcher (Davidson-Hunt & O'Flaherty, 2007). Through active participation in the process, the local's experience and knowledge is further validated and emphasized. Importantly, empowerment comes from participatory method when the process is generated by the local people (Chambers, 1994). Though it is beyond the scope of this review to fully summarize the various possible participatory tools, methods, and terms (legitimacy, empowerment, true or false generosity) as they pertain to international development and

participatory research, they are worth mentioning as they provided a broad context upon which this research was based.

CHAPTER 2 RESEARCH METHODOLOGY

This chapter describes the research design and participatory methodology used to investigate vulnerability to climate change in two of Ecuador's coastal communities: Portovelo, Manabí and Muisne, Esmeraldas. Mixed methods were used during this fully developed research project including:

- Extensive literature review;
- Interviews
    - Community-based non-governmental organizations: *Corporación Coordinadora Nacional para la Defensa Del Ecosistema Manglar* (C-CONDEM); *Fundación de Defensa Ecológica* (FUNDECOL);
    - Key informant and community member interviews;
- Community 'Green Map®' mapping activities;
- Multi-objective focus group sessions;
- Observations and field notes;
- Data analysis
- Discussion and presentation of findings, summary paper and final map materials with C-CONDEM, FUNDECOL, communities and Ecuador's Ministry of the Environment

Based on participatory research methods, participants shared their local ecological knowledge (LEK) and informed the research about historical changes to the coastal zone and mangrove ecosystems, as well as vulnerabilities and adaptations in the surrounding estuaries (*Estuario del Rio Chone* in Portovelo and *Estuario del Rio Muisne* in Muisne). Furthermore, community perceptions and awareness of climate change, freshwater quality and quantity, and priorities regarding the changing mangrove ecosystem were investigated. To compare and contrast this information, data from national and international institutes, government, and regional organizations was compiled. This convergence of data from different sources (Yin, 2003) was also achieved through the triangulation of data and methods during focus groups, mapping and field observations in each coastal community. The use of multiple sources allowed the author to summarize the stresses (inland, coastal, regional, local), impacts, changes and conditions in which Portovelo and Muisne residents live while also helping to recognize how these changes are perceived and understood.

2.1 Study Design

2.1.1 Background

The republic of Ecuador is located in South America; bordered by Colombia on the north, Peru on the east and south, and the Pacific Ocean on the west. Ecuador has an area of

256,370 square kilometres and diverse environments which include the coastal zone '*la costa*', the Amazon '*la Amazonia*', the highlands dominated by the Andes Mountain range '*la sierra*' and the Galapagos Islands.

The two coastal communities selected were Muisne in the province of Esmeraldas and Portovelo in the province of Manabí (Figure 1). Ecuador was specifically chosen as the country of interest for this research based on the author's previous International Youth Internship (IYIP) experience there in 2007-2008 working with an NGO named *Fundación Rescate de los Bosques Tropicales* (FURARE). From a personal perspective, a combination of international experiences in a variety of Latin American countries (including Costa Rica and Nicaragua) fuelled an interest in cross-cultural collaboration and encouraged the author to utilize her linguistic abilities in Spanish. Through contacts in Ecuador, dialogue was instigated with many local organizations such as FURARE, FUNDECOL, *Fundación Natura*, and C-CONDEM to discuss options that would fulfill organizational, personal and academic objectives and interests. The C-CONDEM and (to a lesser degree) FUNDECOL became the main organizational contacts and supportive partners during this research endeavour.

The LEK in the two coastal communities provided a rich dataset that enabled an in-depth and diverse exploration of the research questions. Case study design acknowledges that participant observation and unstructured interviewing are particularly helpful in generating detailed and intensive examination of a case (Bryman & Teevan, 2005). Furthermore, what is useful in this particular instance is that case studies allow for the analysis of multiple sources of evidence, which is a strength of this type of data collection (Yin, 2003). Moreover, case studies allow for the identification of local circumstances and important institutional factors in terms of vulnerability (O'Brien et al., 2004).

Subsequent to a mee ting with C-CONDEM in December 2008, two communities were chosen out of five possible options. These communities were purposively selected to represent a sample of coastal communities in terms of geography (surrounded by mangrove ecosystems), high livelihood dependence on natural resources (especially mangroves and surrounding tropical forests), size of population (small communities), culture (mixed), proximity to other resources (regional partnering NGOs such as FUNDECOL) and a relationship with C-CONDEM. The selected communities have years of history with C-CONDEM, united in the protection of mangroves from outside pressures such as the shrimp farm industry and government legislation. Though

Portovelo and Muisne are in different provinces, they possess similar lifestyle and resource use practices which facilitated the recognition of common themes and a comparison between both sites.

Figure 1 Ecuador's provinces and two study sites (n.d.). Source: *Red de Centros Educativos*, redced-ec.relpe.org

The outlined research was of interest to C-CONDEM and FUNDECOL who were keen to shift their focus to include climate change. Dialogue between C-CONDEM and the communities was continuous since October 2008 to ensure that community feedback was incorporated into the methodology and to determine availability and interest. Initially, the communication was strictly linear with C-CONDEM acting as the conduit. C-CONDEM facilitated the research process including initial introductions to each community (and key informants or community champions) and played a supportive role throughout the field season while also providing links and contacts from previous research in the region. Importantly, communication soon became fluid and constant between the author, C-CONDEM and the communities during the implementation of the research and continued throughout the year after the initial field season. Communication and travel between communities and Quito (where C-CONDEM is located) occurred throughout the field season in order to reach the field sites which are described in the following section.

2.1.2 Location

Within Ecuador, Muisne, Esmeraldas and Portovelo, Manabí were the two main research sites. Upon arrival, the author also visited San Felipe, San Jacinto and Salinas with members of C-CONDEM and helped conduct research gathering biometric data on mangrove species, measuring salinity levels in the estuary, verifying cockle populations grown in captivity, etc. This was also an opportunity for discussion about current issues in the various coastal communities and vulnerabilities they face.

Portovelo

Portovelo (80°22'6") was the initial community in which research was conducted from May 26th-June 4th, 2009. Portovelo is made up of approximately 150 families, including those who live in Puerto Portovelo, located one kilometre west. Portovelo is situated approximately 15 kilometres east of San Vicente, and across the Estuary from Bahia de Caraquez (Figure 2). Accommodation was found with a family within the community, which allowed the author to integrate more readily and participate in community activities.

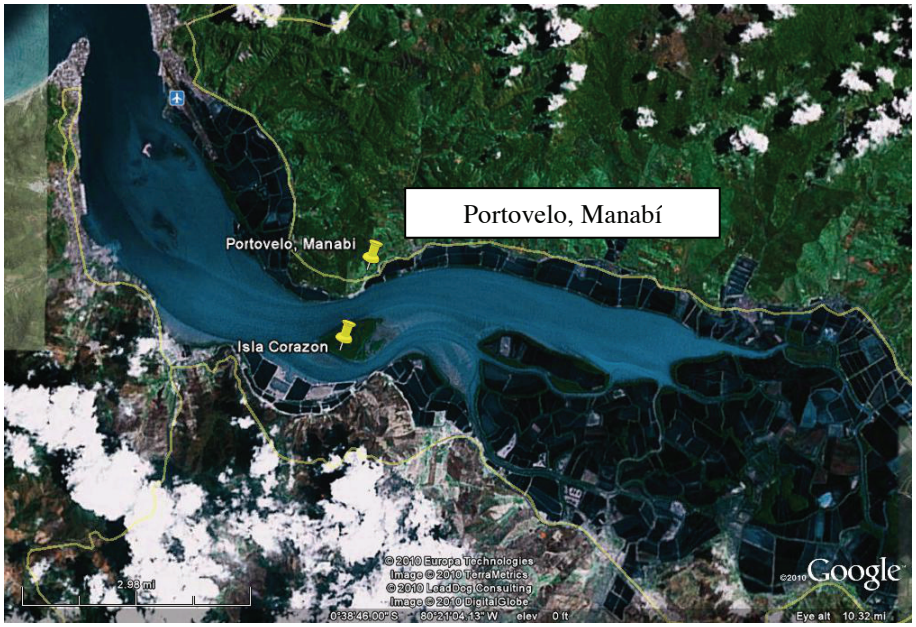

Figure 2 Portovelo, Manabí, Ecuador and surrounding area (2009). Source: GoogleEarth

Muisne

Muisne is an 8 kilometre long island measuring 300 meters in width outlined by mangrove ecosystems on the south-western half and sandy beaches and palm trees on the

Northern tip and Western side (Figure 3). Upon arrival in Muisne, Esmeraldas in June 2009, the author realized that the study site was too large to adequately compare to Portovelo, and thus focused on a smaller community within the island named Bellavista.

Accommodation consisted of a small 'eco-tourist cabin' that had recently been jointly constructed on a family property with the help of FUNDECOL. During the course of the field season relationships were made with members of Santa Rosa (south of Bellavista) and Bunche (on the mainland North-West of Muisne) who subsequently became research participants.

In the end, approximately five to six weeks were spent in each respective community, which was an essential part of ethnographic research as suggested by Babbie (2002). Data were collected during five distinct phases using mixed methods to answer the research questions.

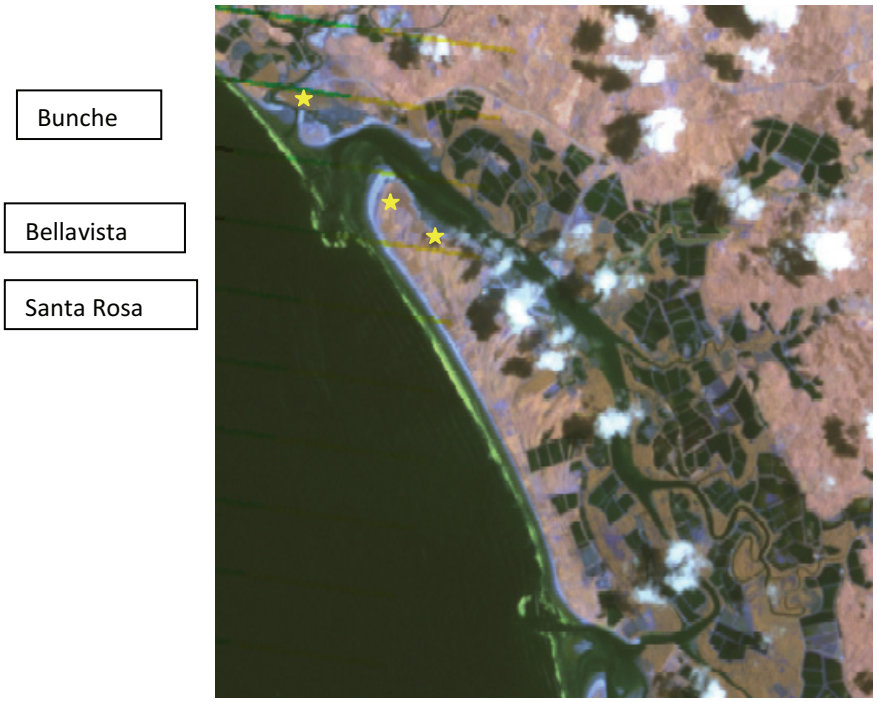

Figure 3 Island of Muisne, Esmeraldas, Ecuador and surrounding area (2008). Source: Landsat ETM USGS

2.2 Data Collection and Rationale

2.2.1 Literature Review

Documents and scholarly literature were reviewed in order to better understand past research conducted on vulnerability, resilience and adaptive capacity, climate change, mangrove

ecosystems, international development in Latin America, and to give context surrounding the reality of Ecuador's social, economic and environmental issues. Web-based searches were conducted to find and review local media coverage (newspaper articles, promotional videos, and publications), grey literature, and to gauge the information available to the public. Key word searches around vulnerability, Ecuador and climate change, mangrove resilience, were undertaken. The combination of sources during this ongoing literature review aided the author in familiarizing herself with theories and developing a conceptual framework for the research. Specific sources of data included:

- Global scientific predictions by the Intergovernmental Panel on Climate Change (IPCC)
- Institutional research by *Instituto Oceanográfico de la Armada (Naval Oceanographic Institute or INOCAR) and Instituto Nacional de Meteorología e Hidrología (National Institute of Meteorology and Hydrology or INAMHI)*
- Non-governmental organizations at the regional and national level (FUNDECOL, C-CONDEM)
- Government- Ministry of the Environment (MAE) and National Climate Committee (CNC) which is now the *SubsecretarÍa de Cambio Climático* (SCC or Undersecretary on Climate Change)
- Coastal community members

Literature was also consulted regarding the appropriateness of using various methods to empower and involve the local population (Participatory Rural Appraisal as described by Robert Chambers and Paulo Freire for example) and the role of outsiders in communities. This was personally useful as the author strived to understand the impact of her research and the multiple ethical considerations it involved. The literature aided the author in familiarizing herself to the local context and highlighted gaps to be addressed during the five research phases. The combination of sources during this ongoing literature review aided the author in developing a conceptual framework for the research.

2.2.2 Research Participant Selection

Key informants were selected from observation and by recommendation from C-CONDEM, FUNDECOL, partnering community-based organizations such as *Asociación de Pescadores* and key informants. They were sought in order to provide insight based on their specific experience and knowledge as it relates to this research, as suggested by Hay (2000). A random sample of the residents of Muisne (Bellavista and Santa Rosa) and Portovelo was not

possible as no official list was available and it was not feasible to contact people at random. Thus participants were chosen using a mixture of convenience and purposive sampling. According to Sullivan (2001) convenience sampling and purposive sampling involve using elements which are readily available and elements that judgment and prior knowledge suggest would best serve the study. A balance was sought between men and women, though this was challenging due to the gender roles and tendencies for males to more frequently be involved in fishing and resource use activities. The invitation to partake in the research process was carried out by the author. Contacting individuals took place in person by the author and often involved walking through the community, striking up conversation at random and frequent self-introductions to as many people as possible. According to Patton (1990), the interesting component of exploratory research lies within strategic sampling of informants as opposed to a large, representative random sample. The in-depth information from a select number of people proved to be very valuable, as concluded by Patton (1990).

Various community members were informed about the author's arrival by staff members of C-CONDEM and expressed interest in the plan to undertake research related to environmental changes to mangrove ecosystems. It is important to note that the term 'environmental changes' was used initially instead of 'climate change' in order to be able to gauge the true relative knowledge and perceptions of this phenomenon without a pre-conceived notion imparted upon them. Participants in each of the following phases were chosen based on specific criteria (Table 1).

Table 1 Summary of data sources, scope and purpose for the analysis of climate change and vulnerability in Ecuador

Data Source	Participants	Scope of research focus	Purpose
Qualitative semi-structured	Portovelo and Muisne Residents 11 interviews	o Selected through strategic purposive and convenience sampling. o Questions on historical changes and biophysical impacts to mangrove ecosystems and coastal zone, climate change, water, and management of resources. o Included Muisne (Bellavista, Santa Rosa) and Portovelo	o Gain an understanding of the local ecological knowledge, perceptions, realities, and priorities surrounding climate change
	Local NGO FUNDECOL staff 3 interviews	o Focus on county of Muisne where FUNDECOL is based. o Discover historical changes, work done within communities, issues faced, and key vulnerabilities. o Influence of FUNDECOL in research community	o Comprehend the contributing factors to change and local vulnerabilities o Understand collaborative relationship
	National NGO C-CONDEM staff 4 interviews	o Focus mainly on Portovelo and Muisne but also other coastal communities in Ecuador. o Data on historical changes, work done within communities, organization goals and practices.	o Gain understanding of role within communities and broader scope of work at national and wider political level
Community Mapping Activity	7 groups 117 participants	o Creation of 14 visual maps in Santa Rosa, Bunche, Bellavista and Portovelo to represent social, environmental, economic, historical changes that have occurred. Compiled into 4 final maps.	o Share knowledge, gain understanding about context and issues, local priorities and values o Trust-building
Qualitative focus groups	4 sessions	o Qualitative questions on historical impacts, El Niño phenomenon, adaptations, mangrove ecosystem and estuaries. o Contributing factors to change and community perceptions and priorities o In Muisne (Bellavista (N=1), Bunche (N=1), Santa Rosa (N=1) and Portovelo (N=2)	o Expand upon information gained during interviews and mapping activities o Understand community dynamics within groups

2.2.3 Research Phases

A description of the five research phases is as follows:

PHASE I: Involved seven in-depth, in-person, one-on-one, semi-structured interviews with staff from community-based organizations C-CONDEM and FUNDECOL

PHASE II: Involved eleven in-depth, in-person, one-on-one semi-structured interviews with key informant resource users from Muísne, Esmeraldas (including Bellavista and Santa Rosa) and Portovelo, Manabí

PHASE III: Seven group sessions were held with the goal of creating participatory Green Maps®.

PHASE IV: Four follow-up focus groups were organized to expand upon themes discovered in PHASE II and III.

PHASE V: Included a return visit in June 2010 to present initial findings, the finished map product and to verify the information used. This provided an opportunity to further discuss the gathered information, to present an executive summary, findings, and recommendations.

PHASE I: Semi-Structured Interviews (C-CONDEM and FUNDECOL Staff)

Four semi-structured one on one interviews were conducted with C-CONDEM in May 2009 and three with FUNDECOL during the month of July 2009 (Table 2). The interviews lasted between 50 and 53 minutes and were conducted in each respective office in Quito and Muisne. The interviews were tape recorded and notes were taken throughout. This allowed the author to familiarize herself with past and present research conducted locally or nationally and offered a broader understanding of the guiding principles behind the organizations' work and influence on each community. Introductory questions were followed by three sections on mangrove ecosystems and coastal zones, water, and management of natural resources as well as questions specific to my research. This allotted time period at the beginning of the field season and before community interviews allowed the author to discuss the methodology with the NGOs in greater detail in order to incorporate their feedback and experience. Gaining a greater understanding of

the current context and practicing interviews to increase confidence were beneficial outcomes of Phase I.

Questions posed in the semi-structured interviews loosely followed an interview guide (Appendix C), but were altered slightly where appropriate in order to probe further discussion or to clarify the meaning of the questions. As described by Warren (2002), three kinds of questions should be generated to begin and guide the conversation; probe, clarify and request further examples; and finally, to pursue the implications of answers to the main questions. Furthermore, flexibility and attentiveness to changing contexts and meanings were an important component for successful interviews (Bryman & Teevan, 2005; Warren, 2002). These techniques were used during all semi-structured interviews in Phase I, and II.

PHASE II: Semi-Structured Interviews (Community Members)

A total of 11 semi-structured interviews were conducted during the period of June-August 2009 in Portovelo and Muisne, including Bellavista and Santa Rosa (Table 2). On average, the interviews lasted 40 minutes, but ranged anywhere from 25 minutes to 67 minutes. The interviews were tape recorded and notes were taken throughout. Most interviews were one-on-one however at times family members (brothers, wives or kids) were present and occasionally helped trigger memories. The research questions were answered in part through a semi-structured interview process using a list of fairly specific topics and questions as an interview guide (Appendix D). The interview process was flexible and cognizant of how interviewees framed and understood issues and events (as suggested by Bryman & Teevan, 2005). This method has been shown to be a good choice when undertaking multiple-case study research (Bryman & Teevan, 2005) and efforts were made to ensure consistency between research methods in each of the case study communities.

These interviews took place at an agreed upon time and place; usually in the comfort of the participant's own home. However, certain interviews (and many unofficial discussions) also took place in the field, which allowed the author to observe firsthand and associate the information with exact areas of interest. Individuals already involved in environmental conservation, those with a longer history in the area, those who had expressed an interest in the research, and resources users such as fishermen were the main participants. The interview explored what individuals know and understand about environmental change and climate

change, how their natural ecosystems have responded and adapted to historical events (including flooding, storm surges, and sea level rise), the role of government, and what priorities and values guide their management and conservation decisions about the natural environment. The question of climate change awareness was broached by asking participants to describe and name changes initially, without introducing the term ´climate change´ or ´global warming´ thus allowing the author to assess perceptions of climate change indirectly. Tucker et al. (2010) utilized a similar method when assessing farmer´s perception of risk and requesting they name the "problem" and changes in their livelihood activities. In their methods, Byg and Salick (2009) concerned themselves with the way climate change manifests itself in the knowledge, perceptions and experience of Tibetans. The author had a similar goal based on the perceptions of climate change in Ecuadorian coastal communities. However, these methods are different than those employed by Bostrom et al. (1994) who chose to introduce the high-level issue of climate change during the interviews.

Another goal was to gather baseline information about the status of the natural environment, to summarize and document exposures, and assess vulnerabilities and potential adaptation that could be carried out at the local level. Further aims were to explore the needs and challenges faced by the communities in responding to climate change and to identify vulnerable areas or those which are important for adaptation and increased resilience. Key Informants from Phase II were also asked to participate in Phase III and vice versa.

Table 2 Interviews and focus groups conducted in Ecuador

Community	Portovelo	Muisne	C-CONDEM	FUNDECOL	Total
Interviews	7	4	4	3	18
Focus Groups	2	2*	-	-	4

* Includes Bellavista, Santa Rosa

PHASE III Green Mapping Activity

The aim of Phase III was an iterative process that involved dialogue between community members as they worked together to create a community map. Various participants who were present during these activities were asked to participate in Phase II depending on the timing of both Phases. The community Green Map activity was conducted with seven organizations between June and August 2009 and included 72 men and 45 women for a total of 117 (Table 3).

A Green Map®[2] activity uses map-making as a medium to promote inclusive participation in sustainable community development. Discussion was encouraged and the author intentionally took a more background role throughout the process in order for the community to take control of the activity and knowledge being shared. Materials provided for the green map included:

- Pens, pencils, markers
- Large base maps of the area
- Various smaller maps of different styles and colours
- Examples of Green Map products from Japan, USA, Chile, etc.
- Green map icon stickers
- Post its

The first step was to explain the process and purpose of the mapping project for the community (Wates, 2000). The aim was for the community to be engaged from the very beginning and have a sense of ownership and decision-making power in the whole process, which has been shown to be important in participatory research (See Chambers, 1997). There was flexibility in determining the end result and format of the maps in order to allow the community to input ideas and desired outcomes for the project.

The assessment of one's perspective on vulnerability and change is a complex undertaking but there are various ways that information can be shared. Vulnerability mapping (O'Brien et al., 2004), documenting the views of the vulnerable (Tschakert, 2007), and aiming to understand the nature and components of vulnerability as opposed to establishing a score (Smit & Wandel, 2006) were utilized as guides for this research, though a vulnerability assessment in itself was not conducted. Notably, "If one can document the effects of the present day climate and respond to current vulnerability, one will be in a better position to deal with future changes" (Perez, n.d., p. 226). In other words, one should inform and base their analysis of present day vulnerabilities to climate change on historical perspectives (Adger, 1996 in Adger, 1999). As seen by Shah (2000), through making their own maps, different sectors of the population revealed very different perceptions of a problem or situation. In this case, groups chose to represent their information about change and vulnerability in substantially different ways. For example, one group chose to write a story on a blank piece of paper, another group retraced the available maps and inserted their information above it, while others chose to use

2 Green Map®. http://www.greenmap.org/. Accessed March 8th, 2009.

the available tools. This flexibility and creativity allowed for the consideration of different perspectives and the comparison within and across communities. The discussion was centered around resource mapping, thematic mapping, or monitoring and impact mapping with a special focus on mangrove ecosystems, water resources and the theme of environmental change. However, there was ample flexibility to include cultural, social, historical and economic information on each map.

Importantly, the maps were made available in the community centres throughout the research process to allow for continuous discussion and for those absent during the activity to nonetheless contribute to the community-owned map product. Often, this led to impromptu discussions and trust-building in a central location such as their community centre.

Table 3 Data sources for Green Mapping activity in Portovelo and Muisne (2009)

Location	**Organisation**	**Date**	**Participants** M= Men, W= women	**Maps created**
Portovelo, Manabí	Mujeres la casita Portovelo	June 12th 2009	9 W	2
	AsoManglar	June 13th, 2009	10 M	2
	Asoc. Pescadores Portovelo	June 17th, 2009	25 M, 3 W	3
Muisne, Esmeraldas	Mujeres de Bellavista	July 20th, 2009	17 W	2
	Asoc. Concheras de Bunche	July 22nd, 2009	11 W	1
	Asoc. Carboneros Bellavista	July 24th, 2009	20 M, 2 W	2
	Asoc. Pescadores Santa Rosa	August 2nd, 2009	17 M, 3 W	2
Total			117 (45W, 72M)	14

At the end of the mapping activity, participants were asked to reflect on the process of creating the map and to evaluate the activity and materials produced in order to make recommendations to improve the process. By gathering information on the approach used and comparing the consultation processes and final maps for each community, the research contributes to improving the understanding of how best to share and combine the scientific, LEK and cultural knowledge that communities possess.

PHASE IV: Focus Groups

Four focus group sessions were conducted in Portovelo and Muisne and included, on average, 6-10 participants (as informed by Morgan, 1998; Marshall & Rossman, 2006, Table 2). The goal was to create a supportive environment in which participants' views and realities could be shared in a way that also created high 'face validity' (Marshall & Rossman, 2006). Using some

of the same semi-structured interview guide questions as in Phase II, the goal of each session was to share data about the natural environment; significant historical changes and present vulnerabilities; general perspectives on mangrove ecosystems and water resources in the area, etc. Often, several stories, anecdotes, songs and poems were shared, as groups reminisced about their past.

The objective of the fourth research phase was two-fold. First, it was an opportunity to probe further into some of the discussion created during Phase II and Phase III. It offered an opportunity to contact certain individuals who did not participate in the interviews, or members who preferred to meet as a group instead of individually in order to explore new or important themes. Furthermore, this research phase allowed the author to verify and triangulate the data from interviews and community mapping activities.

PHASE V: Return Visit

The fifth research phase occurred nine months after the end of Phase IV and included a four-week return visit to Ecuador in June-July 2010 to present initial findings and recommendations, the finished map product and to verify that participants were aware of and comfortable with the information used. It was also an opportunity to maintain personal relationships with the communities and to continue sharing information.

The presentation of initial findings and recommendations occurred at the community centre or a central and agreed upon location and was open to all members of the community. During the week spent in each of the communities, there were opportunities for questions, sharing interpretations, further discussion of progress, and a chance to solicit general feedback. This phase was also an occasion to demonstrate the author's commitment to the research and the community.

A summary and presentation were also given to FUNDECOL and C-CONDEM, leading to discussion and a verification of the quotes used and conclusions. Furthermore, the author delivered a presentation of her project and findings to Ecuador's Ministry of the Environment Undersecretary of Climate Change and contributed to the 4-year communication plan for Education and Awareness around Climate Change on a national level. The National Climate Committee, which was the coordinating body during the initial research phase, is now the Sub-secretariat (Undersecretary) on Climate Change and includes both mitigation and adaptation

divisions. The author was able to present to 10 of its members and follow-up with individual meetings to discuss results, present the maps, and, importantly, to include recommendations into their current design of the national communication plan on education and awareness of climate change in Ecuador. A summary of all information sharing mechanisms including presentations, reports, and map distribution can be found in Appendix A.

2.2.4 Observation

It is important to note that the Phases I-V were meant to serve as a guideline and plan for the field season. However, conversation and observation were ongoing throughout the field season (May-August 2009, June-July 2010). An adaptive, flexible process was used whereby informal conversations and trust-building were seen as positive opportunities within the research project. These informal conversations often yielded important information and lead to interview opportunities. As described by Pretty (1995, p. 1256), "observation increases the depth of understanding and breadth of realities encountered". For example, observation allowed the author to experience some of the daily realities in these communities, offered a more thorough understanding of the local context and Ecuadorian life, and put into context some of the information gathered during the five research phases.

Furthermore, photographs taken during the field season served as 'aides mémoires' (Bryman & Teevan, 2005) in conjunction with field notes and put certain aspects of the research into perspective (for example, pictures of changed mangrove ecosystems). Field notes provided a unique layer of information to intertwine within the rich interview and focus group data. This method aided in documenting information not available through other sources, such as personal reactions, settings and social and temporal contexts upon which the information was framed. It also served as a reminder of certain events, and a place to write key observations or emerging themes and ideas. For example, on June 27th, 2009 the author organized a community 'road race' event with 6 different categories which involved the majority of the community. Through this, many new contacts and friendships were made, and opportunities to converse came up. Field notes were important in recording names, thoughts, conversation pieces, and describing the setting and events of the day for future review. Time in the field on walks (or in canoes) with participants were opportunities to record significant social and physical features of the area and to gain the confidence of local people

In Quito, the author was able to participate in C-CONDEM's opening of the restaurant '*Martin Pescador'* which featured dishes from the coastal provinces which are provided by the community fishermen themselves. In Muisne, the author helped with a large conference on '*La Soberanía Alimentaria'* which brought together fishermen, farmers, academics and organizations to discuss issues in food sovereignty. Organizing games with the children, and playing soccer were other examples of activities that allowed the author to integrate more readily into the community and observe the social systems and dynamics at play. Indeed, using a mixture of rational, explorative, and intuitive methods were used whereby the author's skills and experience were important in the analysis of data.

2.2.5 Document Recording and Analysis

Transcription

Data was provided in the form of descriptions and opinions in the participant`s native Spanish language. All interviews and most participant focus groups were audio recorded using a digital recorder. The benefit of recording interviews and focus groups was the ability to focus on interactions with participants instead of concentrating on taking notes. Interviews and focus groups were fully transcribed into a word document from audio recording which was undertaken both personally by the author (N=10) and by a paid professional Ecuadorian (N= 11). A confidentiality agreement was signed and all files were encrypted and subsequently destroyed by the transcriber once the author received the completed transcription. Every single transcription was then thoroughly proofread and carefully reviewed by the author as suggested by McLellan et al. (2003), and any discrepancies were interpreted by the author and changed to allow for consistency across all transcriptions. The analysis took place entirely in Spanish.

Transcription and review of the interviews and focus group sessions allowed the author to familiarize and immerse herself in the data. In doing so, an initial coding system was constructed which aided in conceptualizing and categorizing the data. The method of code application using the qualitative coding software facilitated a systematic approach of extracting meaning and drawing out common themes and comparisons among participant accounts (as suggested by Bryman & Teevan 2005). The NVivo data analysis software was a useful tool for comparing, conceptualizing and categorizing data (Bryman & Teevan, 2005) and the data were organized by individual respondents and coded specifically so as to ensure anonymity.

The transcription of the interviews followed some of the seven principles outlined by Mergenthaler and Stinson (1992) such as to preserve the morphological naturalness and that transcripts should be exact reproductions. McLellan et al. (2003) spoke of "end of interview" lines, identical format and other conceptual suggestions which were also followed during the transcription process. Identifying emerging concepts, both initially in Phase II and III and subsequently in Phase IV, allowed the author to tease out patterns and themes while identifying salient ideas and quotations from participants. Quotations were chosen in this thesis to demonstrate key perceptions and knowledge which emerged through the analysis.

A constant review of the literature allowed the author to add depth and context to the study. As data was integrated and grouped into more specific categories, codes became more focused and fostered a deeper understanding of how coded themes were related. The use of multiple methods in this study (interview questions, focus group information, field observation, and Green Mapping activities) were used for triangulations of information, which is suggested by Bryman and Teevan (2005) and Yin (2003) as a way to check observations with interview questions and look for misunderstandings. These mixed methods allowed for a more complete analysis in identifying and interpreting themes and meeting research objectives.

Translation

The research took place in a social, linguistic and cultural environment different than the author's own. For this reason, and to ensure validity of the document recording and analysis, quality control methods were used. Once transcription was ready and reviewed, portions of the text were verified by a professional native Spanish speaker with experience as a translator. This review and verification of the transcription ensured accuracy and that the overall meaning and language were adequately interpreted and transcribed. The quality control methods also verified gaps, consistency and grammatical correctness.

After extensive proofreading and review of the transcribed interviews, only the pertinent quotations were translated into English in order to share with my thesis committee and include in the thesis. Once specific transcribed portions were selected for use in the thesis, their translations were also reviewed by native Spanish speakers for accuracy and to preserve the integrity of the quotation. In this thesis, the original quotation is shown in its entirety in Spanish as a footnote to the translated English version in order for others to review the interpretation.

Since the research required travelling, both within Ecuador and through the United States and Canada, data was saved on a portable disk drive and then encryption software was used to protect participant anonymity.

2.3 Ethical Considerations

An ethics application was submitted in March 2009 and approved by the Dalhousie University Social Sciences and Humanities Human Research Ethics Board in April 2009. All information gathered has remained confidential and only the author had access to the raw data. The data will be stored for five years post publication of the thesis and will then be destroyed as required Dalhousie University's Policy on Research Integrity. Participation in this study was strictly voluntary and research participant confidentiality was maintained unless they explicitly chose not to be anonymous.

Before participation in interviews and focus groups, participants were asked for consent. Members of C-CONDEM were asked to provide written consent to participate in the study (Appendix E) whereas all other participants provided oral consent in an effort to be cognisant of literacy differences or illiteracy in an unobtrusive way (Appendix F). All expressions of consent were obtained and kept in confidence and all consent forms or other documents describing the study were provided in Spanish.

Furthermore, participants were asked to specify whether they wished to remain anonymous in the event that their quotes were used in the thesis. By specifying whether they preferred their name, their association or affiliation, or complete anonymity, the participants were able to choose the level of confidentiality that they desired. During the return visit in June 2010, participants were shown a written copy of the quote to be used, and retained final rights as to whether or not the quote was indeed included.

2.4 Limitations

The main limitation was the short time frame in which to conduct this research. The three month summer period limited the field season and allowed for only five weeks to be spent in each community. As is often the case in qualitative research, and since the research was conducted in a social, cultural and linguistic context outside of the author's many aspects of this research project took considerable time and could not be rushed into following a research

schedule. For example, community trust and buy-in are processes that do not follow a timeline and must take their own course. Substantial time and effort was required to collect the data and analyze it in the author's third language, which was only a barrier insofar as certain colloquial words and expressions were not initially known. Interpretations of the data may have differed from the actual meaning due to different cultural perspectives or perhaps unknown subtleties in meaning were not picked up, but every possible effort was made to prevent this. For quality control purposes, portions of the completed transcriptions, field notes and audio sections were verified for accuracy by Ecuadorians from the area and other native Spanish speaking individuals which helped mitigate these limitations.

2.5 Community Gift

In Portovelo, the author met with 12 institutions: INFAA, el Comité de damas, la Casita, la Procapilla (Iglesia), la Asociación de pescadores, la Asociación 12 de octubre, AsoManglar, la Brigada barrial, la Escuela, el Grupo de la cancha, el Grupo de jóvenes, la Comuna (el comedor). This was done to both introduce the author to the community, and also to discuss the 'community gift'. Part of the funding received through the Robin Rigby Trust was set aside as a 'community gift' in appreciation of the time and participation offered during the research project. This was done so as not to discriminate in such a way that certain segments of the population or specific individuals benefited more than others. For example in Portovelo, due to the nature of the study the eco-tourism guides from AsoManglar or members from the *Asociación de Pescadores* were able and interested in contributing to interviews more often than the rest of the community. In Muisne, the *Asociación de Carboneros and Asociación de Concheras* also contributed disproportionately. For this reason, the community gift was meant to serve as a means of collaboration and a way to meet the needs of the population as a whole. In order to do this, the author met with several individuals, organizations, institutions and families to discuss their suggestions about how the money should be spent. Portovelo received $500, Bellavista $440, Santa Rosa $140, Bunche $50 based on the nature of the chosen project and time spent participating in the research.

The groups in Portovelo reached a consensus on the creation of a community park in the centre. Several 'minga' days were held where lunch was provided and community members came to volunteer their time in putting up a fence and preparing the vegetation for planting. In Bunche, the *Asociación de Concheras* decided that they would focus on rebuilding the columns

in their clubhouse. The *Asociación de Pescadores de Santa Rosa* chose to use the contribution in a variety of ways, as decided and agreed upon as a group; their current focus is a *Centro de acopio*. The people of Bellavista focused on building a community centre, which everyone would build together, with the supplies purchased using funds from the Robin Rigby Trust.

CHAPTER 3 LOCAL PERCEPTIONS OF CLIMATE CHANGE AND THE ROLE OF VARIOUS SOURCES IN CONTRIBUTING TO COLLABORATIVE CLIMATE CHANGE DIALOGUE AND ADAPTATION

Tiffanie Rainville was responsible for the research and writing of this manuscript. Anthony Charles was the thesis supervisor and Michelle Adams, Cathy Conrad, and John Kearney were thesis committee members. All provided guidance, revision, and feedback. This paper will be submitted for publication in an academic journal.

3.1 Abstract

Coastal communities worldwide are vulnerable to climate change due to sea-level rise, changes in precipitation patterns, and hydrometeorological events; often exacerbated by both inland and marine stresses. Many studies have focused on top-down models to guide their predictions of climate change impacts, frequently failing to take into account local voices and perspectives. Indeed, little is known about how Ecuador's rural, coastal populations understand climate variability or biophysical change in the coastal zone and mangrove ecosystem. This research compared and collated local perceptions of environmental and climate change from two of Ecuador's coastal communities with information from various sources including community-level, regional and national organizations, national institutes, government, academic literature, and climate change scientists in an attempt to discover where overlaps occur and to find relevant knowledge gaps. Including the local voice and divergent sources is important in guiding future adaptation policies and actions. It became apparent that climate change and its associated vocabulary are not yet fully understood (or used) at the local level. Results show that when discussing environmental change, both shrimp farms and the El Niño phenomenon remain clear culprits due to the vast deforestation and significant impacts inflicted on the estuaries. However, change was also attributed to God, displeased nature and the climate being *loco* (crazy) and participants gave examples of changes in the seasons, temperature and rainfall variability; all the while expressing concern over what they had witnessed. When this range of responses discovered through interviews, focus groups and community mapping activities is overlaid with information from different sources it allows us to discover points of contention and draw out common themes to stimulate dialogue around climate change vulnerabilities. Each source has valuable information to contribute in an effort to localize climate change impacts and

find relevance from the bottom up at a community scale. There may also be a role for community-based environmental monitoring as a means to apply the heightened awareness and wealth of local ecological knowledge that local people have stemming from their inextricable link to the natural environment. Results can serve as a basis to focus future climate change education, iterative collaboration and knowledge-sharing around adaptation.

3.2 Introduction

Climate change is a complex challenge that will impact individuals, groups, regions and countries in a variety of ways. Due to mounting scientific evidence and increasing awareness levels, climate change is finally emerging as a defining political, economic and environmental issue (Burch et al., 2009). Globally, 1.2 billion people live within 1.2 km of the shoreline (Small & Nicholls, 2003) exposing them to both marine and inland pressures. Additionally, rising air and sea surface temperatures, increasing CO_2 temperatures, ocean acidification and variations in precipitation will cause a series of changes and have important implications (Nicholls et al., 2009). Due to significant regional differences in geological, social, oceanographic and biological processes, the effects of global environmental change[3] will be unevenly distributed. Many of the biophysical changes are predicted to cause loss of land, infrastructure and coastal resources (Klein & Nicholls, 1999) thus affecting 55% of the world population who draw on coastal and marine ecosystems for recreation, transportation, food, and industrialization (FAO, 1994).

Results from a collaborative study of South America show that significant trends have been observed based on daily minimum temperature, including more tropical nights, warmer 'coldest night of the year' as well as an increasing percentage of warm nights (Vincent et al., 2005). The National Meteorological and Hydrological Institute (INAMHI[4]) in Ecuador has seen a sustained increase in the average temperature and, in various areas, extreme temperature increases of around 1°C (Cáceres, 2001); a similar pattern as that seen globally (Magrin et al., 2007; UNFCCC, 2000). Ecuador is not only highly vulnerable to natural disasters (UNDP/UNPF, 2003) but research has also shown uneven rainfall in Ecuador with an inclination toward decline on the coast (UNFCCC, 2000). One of the main pressures for societies and the environment from climate change will be water and its availability (Bates et al., 2007) due to observed and

[3] Global Environmental Change is a set of biophysical transformations of land, oceans, and atmosphere driven by an interwoven system of human and natural processes (Göbel, B. 2007).
[4] *Instituto Nacional de Meteorología e Hidrología*

projected temperatures, sea level increases and precipitation variability (Kundzewicz et al., 2007). In fact, much of southern and central Ecuador's coast has also been shown to be under severe water stress (Alcamo & Henrichs, 2002). In fact, an increase in average sea level would flood nearly the entire Ecuadorian coastline (UNFCCC, 2000) leading to saltwater intrusion into surface and groundwater in many areas (Nicholls et al., 2009) while also negatively affecting storm-water drainage and sewage disposal (Bates et al., 2008). The coast of Ecuador is more vulnerable to the impacts of sea-level rise than other Latin American countries, including coastal flooding and salinization of coastal aquifers (Vergara et al., 2007). This diverse, sometimes contradicting and scattered data reveals part of the issues due to climate change, but also illuminates the existing gap about the on-the-ground changes witnessed at a smaller scale. Furthermore, in data-poor regions, local ecological knowledge (LEK) is often the only source of information about changing ecosystems. These changes and predictions are varied but stand to affect the biophysical processes and systems (such as mangroves) along the coast, thus affecting coastal communities who depend on them.

According to climate models, low-lying coasts in Latin America are among the most vulnerable to climate variability, extreme hydrometeorological events, hurricanes and associated storm surges, (Magrin, 2007) as well as small increases in sea-level (Gilman et al., 2007). Although hypothesized biophysical changes, precipitation variability and water insecurity have been widely discussed at the global level, there have not yet been thorough qualitative studies addressing the many processes at work at the local level in the study region of Ecuador. This is worrisome as Ecuador (among many other countries) has been characterized as 'high vulnerability' which will be intensified by the direct and indirect impacts of climate change (UNFCCC, 2000).

Climate Change and Mangroves

The coast of Ecuador has been shown to be more vulnerable than others in Latin America due to exposure to sea-level rise, coastal flooding, weather, climatic variability and climatic extremes which will negatively impact mangrove ecosystems and add to the present and adverse pressures on freshwater supplies (Magrin et al., 2007; Vergara et al., 2007). Nationally, according to the Ecuadorian Environmental Plan and the Environmental Strategy for Sustainable Development, some of the noteworthy specific concerns around climate change are natural disasters and impacts to fragile ecosystems such as mangroves. Indeed, at a national

scale, Ecuador's priority adaptation measures in response to predicted climatic changes include mangrove preservation and reforestation, biophysical surveillance program, and the reorganization of shrimp farming activities (UNFCCC, 2000). Mangroves have a unique role in controlling water quality and water levels by trapping and stabilization coastal land, assimilating sediment and nutrients, protecting against storm surges and play a buffering role that has been well studied (Nicholls et al., 1997; Walters, 2008). These important services are not always considered when it comes to inland practices or policies and, consequently, mangroves face a variety of threats from both inland and marine sources which include pollution, deforestation, improper land use, and now climate change. Based on scientific climate impact scenarios, Ecuador stands to lose ~300 km^2 to 530km^2 respectively of their mangroves with up to ~1,300km^2 in danger (UNFCCC, 2000). Mangrove communities have various functions that will show a blend of positive impacts (increased growth due to higher temperatures and levels of CO_2) and negative impacts (saline intrusion and erosion) in response to climate change (Saenger, 2002). Some may face threats from increased intensity and frequency of storms (resulting in defoliation and tree mortality) while others' growth and distribution will suffer from variance in precipitation patterns, CO_2 levels, or temperature rise (Gilman et al., 2008). Additionally, sea level rise and decreased precipitation could increase salinity in mangroves due to less freshwater surface and groundwater water input (McLeod & Salm, 2006). Mangroves are also vital in storing carbon (carbon sinks) in the form of sediments; a climate change mitigation measure that must not be ignored (Nelleman et al., 2009) since mangrove felling also releases carbon, thus exacerbating global warming (Gilman et al., 2008). The synergy of anthropogenic threats, combined with changes in precipitation, hurricanes, storms, and sea levels will threaten the resilience[5] of mangroves, and some studies have declared sea-level rise as the greatest threat to this ecosystem (Field, 1995; McLeod & Salm, 2006).

In the quest to understand its complex impacts, studies have focused on biophysical aspects of climate change (Nicholls et al, 2007), species-specific responses (McLeod & Salm, 2006), or vulnerability and adaptation concepts (Adger, 2003, 2006; Smit & Wandel, 2006). The top-down scenario-driven approaches such as those described by IPCC (classical or first generation impact and adaptation studies), have led to increasing dissatisfaction and a need to

[5] Though the concept of resilience as a whole incorporates social resilience and elements of group dynamics, economics, etc., this paper mainly focuses on the ecological resilience associated with mangrove ecosystems.

find ways to work from the bottom-up, at a locally relevant scale (van Aalst et al., 2008). Issues are so complex, multidisciplinary, transnational and adversarial that no single scientist or loose association of scientists can deal with them effectively (Tiessen et al., 2007). Often, an underemphasized focus on community-based research has led to climate models and scenarios which are too broad to adopt at a local scale (Riedlinger & Burke, 2001). There is thus "a grave mismatch between the knowledge that is needed to act locally and what is currently being done globally to generate knowledge about climate change" (Wilbanks & Kates, 1999, p. 616). There is a need for 'integrative science' (Miller et al., 2010) which brings together forms of knowledge and a combination of sciences to engage on research challenges or knowledge needs.

What is even more challenging, is how little is known about a local population's view and understanding of environmental change and climate change. Various studies support the notion that when faced with complex issues and unstructured problems, participation of non-scientists in research is required (van Asselt & Rijkens-Klomp, 2002). In fact, some report that incorporating local and traditional knowledge into climate change research and design is key (Dolan & Walker, 2004) as it can make valuable contributions to research and promote the understanding of climate change (Byg & Salick, 2009). For this reason, balancing insider and outsider knowledge is critical since local knowledge of species, habitats, and social systems add to the wider political, demographic, biological trends that could threaten livelihoods and the surrounding environment (Russel & Harshbarger, 2003).

This paper draws on information from various sources including global science, national institutes, non-governmental organizations (NGO), and local residents in the two case study communities with the purpose of combining the information in light of future adaptation opportunities. The aim is to answer the following questions:

1) What are the biophysical vulnerabilities of mangrove ecosystems and coastal communities in Ecuador due to climate change according to various sources?

2) How does the information from top-down sources and global predictions compare to local ecological knowledge and perspectives on change?

3) What are the local perceptions of climate change?

4) What role can the various sources have in addressing vulnerability and contributing to climate change dialogue?

The aim of this research was not to establish a score of a community's current or future vulnerability but instead to understand the nature and components of its vulnerability (as defined in Smit and Wandel, 2006). The research was based on the principle of "if one can document the effects of the present day climate and respond to current vulnerability, one will be in a better position to deal with future changes" (Perez, n.d., p. 226). In other words, one should inform and base their analysis of present day vulnerabilities to climate change on historical perspectives (Adger, 1996 in Adger, 1999). In their work on scale and global change, Wilbanks and Kates (1999) found that local dynamics and localities are "worth worrying about" and "the complex relations among environmental, economic, and social processes that drive change at the global scale can only be unravelled by careful locality-specific research" (Wilbanks & Kates, 1999, p. 602, 606). Understanding the interactions of natural and human sub-systems is critical to understanding human vulnerability in coastal and low-lying areas and should include public participation in their assessment (Nicholls et al., 2007). This research thus considered how coastal communities view environmental change and how they perceive climate change in an effort to tease out key factors viewed as priorities in light of future adaptation strategies.

3.3 Methodology

Study Sites Selection

Ecuador has a territory of 256,370 km^2 straddling both sides of the equatorial line and containing three unique environments; *'la costa'* (the coast), *'la sierra'* (Andean mountains), and *'el oriente'* (the Amazon) (Figure 1). The country has two highly differentiated rainfall seasons which contribute to its diverse physical, geographical and socioeconomic conditions. It is located on the pacific coast of South America and has a population of 13.8 million (Population Reference Bureau, 2008), 61% of which live within 100km of the coastline (Earthtrends, 2003). Subsequent to a meeting with the *Corporación Coordinadora para la Defensa del Ecosistema Manglar* (Coordinating Corporation for the Defence of Mangrove Ecosystems C-CONDEM) in December 2008, two communities were chosen in Ecuador. Portovelo and Muisne were purposively selected to represent a sample of coastal communities in terms of geography (surrounded by mangrove ecosystems), high livelihood dependence on natural resources (especially mangroves and surrounding tropical forests), size of population (small communities), culture (mixed), proximity to other resources (regional partnering NGOs such as *Fundación Ecológica* (FUNDECOL)) and a relationship with C-CONDEM. Both communities were chosen based on the

interest of their Fishermen Associations, Eco-tourism guides (*AsoManglar*), and suitability based on the experience of C-CONDEM. Though Portovelo and Muisne are in different provinces, they possess similar lifestyle and resource use practices which elucidated common themes and facilitated comparison between both sites.

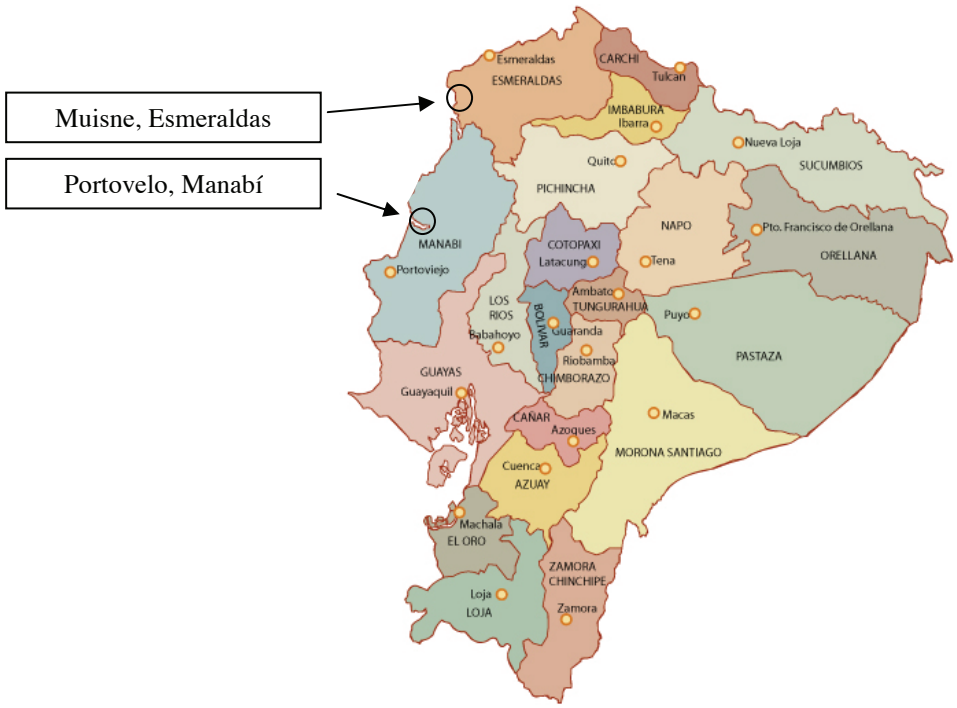

Figure 1 Ecuador's provinces and two study sites (n.d.). Source: *Red de Centros Educativos*, redced-ec.relpe.org.

Portovelo

Portovelo is made up of approximately 150 families, including those who live in Puerto Portovelo, located one kilometre west. The town is situated approximately 15 kilometres east of San Vicente, and across the Estuary from Bahia de Caraquez (Figure 2). It is nestled between the *Río Chone* estuary (Chone River) and the *bosque seco tropical* (Tropical dry forest) in a bay located in the province of Manabí. There is great pressure on the coastal zone leading to erosion and sedimentation from mangrove deforestation and tropical dry forest soil degradation. In fact, the estuary is so deteriorated that it is susceptible to a grave ecological collapse of ecosystem quality and functions (Ministerio del Ambiente, 2007). The social repercussions in Portovelo are incredibly important as 90% of the working population is dedicated to fishing in the *Río Chone* as

their main economic income with 30% also engaging in agricultural activities in the *bosque seco* during the winter months (U.E./PUCE-MANABÍ, 1999).

Figure 2 Portovelo, Manabí, Ecuador and surrounding area (2009). Source: GoogleEarth

Muisne

In contrast, the island of Muisne is situated beside the inland *bosque tropical* (Tropical forest) in the province of Esmeraldas and measures 8 kilometres in length and 300 meters in width, or 153km^2. It is outlined by mangrove ecosystems on the south-western half and sandy beaches and palm trees on the northern tip and western side separated by about 300m from the mainland by the *Río Muisne* estuary (Figure 3). The population is estimated at 8000 (INFOPLAN, 2001). Fishing activities are the primary generators of income in Muisne, followed by agriculture, both of which are important to the local population. Studies show that within the parish of Muisne, 50-60% of the economy is linked to mangrove ecosystems (CEGEL, 2008).

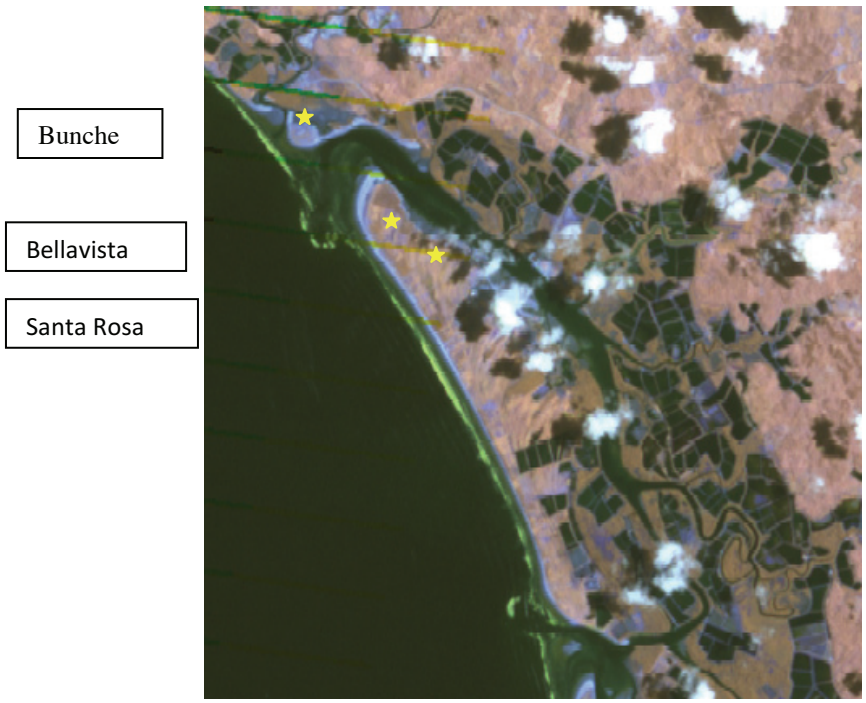

Figure 3 Island of Muisne, Esmeraldas, Ecuador and study sites (2008). Source: Landsat ETM USGS

Data Collection

Research was undertaken from May to August 2009 and June-July 2010 using mixed methods including:

- Extensive literature review;
- Interviews
  - Community-based organizations C-CONDEM and FUNDECOL (N=7);
  - Key informant and community member interviews (N=11);
- Community 'Green Map®' mapping activities (N=117);
- Multi-objective focus group sessions (N=4);
- Observations and field notes;
- Data analysis
- Discussion and presentation of findings, summary paper and final map materials with C-CONDEM, FUNDECOL, communities and Ecuador's Ministry of the Environment (MAE)

Literature Review

An on-going scholarly literature review included key word searches, cultural and historical data from the area, web-based searches for grey literature, information from government agencies and NGOs which allowed for a more thorough understanding of the issues at hand in Ecuador and Latin America, and a wider knowledge base. Local and regional media

coverage such as newspaper articles, promotional videos, and publications were reviewed in order to gauge the information available and presented to the public. Literature was also consulted regarding the appropriate use of various empowering participatory methods which involve the local population (Participatory Rural Appraisal as described by Robert Chambers and Paulo Freire's work, for example) and the role of outsiders (author) in communities. The participatory research guidelines outlined by these authors (as well as Crocker, 1991; Russel & Harshbarger, 2003) formed the basis of this inclusive research process. To answer the research questions, several sources of information were consulted:

- Global scientific predictions (IPCC, other)
- Research by institutes such as *Instituto Oceanográfico de la Armada* (Naval Oceanographic Institute or INOCAR) and *Instituto Nacional de Meteorología e Hidrología* (National Institute of Meteorology and Hydrology or INAMHI)
- Non-governmental organizations at the regional and national level (FUNDECOL, C-CONDEM)
- Government- Ministry of the Environment (MAE) and National Climate Committee (CNC) which is now the *Subsecretarĺa de Cambio Climático* (SCC or Undersecretary on Climate Change)
- Coastal community members

This convergence of data from different sources (Yin, 2003) was also achieved through the triangulation of data and methods during interviews, focus groups, community mapping and field observations in each coastal community. The use of multiple sources allowed the author to summarize various stresses (inland, coastal, regional, local), impacts, changes, and conditions which Portovelo and Muisne residents face. It also helped in demonstrating local perceptions of change and adaptations that have occurred in the surrounding estuaries.

Interviews

Eighteen semi-structured, face-to-face interviews were conducted in Ecuador in 2009. Seven were conducted in Portovelo, four in Muisne, four with the C-CONDEM, and three with FUNDECOL (Table 2). Interviews lasted on average 47 minutes and took place in participants' homes or offices. A random sample of the residents of Muisne and Portovelo was not possible as no official list was available and it was not feasible to contact people at random. Instead, the organizations provided insight on potential key informants based on their specific experience and knowledge as it related to this research, as suggested by Hay (2000). Thus participants were chosen using a mixture of convenience and purposive sampling (described by Sullivan, 2001)

which involved using elements which were readily available and elements that judgement and prior knowledge suggested would best serve the study.

The initial portion of the semi-structured interviews focused on the LEK of the key informants regarding environmental change, including sections on the mangrove ecosystem, coastal zone, water and culture. Once the changes had been discussed and the line of questioning exhausted, climate change was introduced as a term and participants were asked about their knowledge and awareness of climate change and global warming. This included discussion about what it meant to them, as well as specific questions about sea level rise, temperature, rainfall, etc. By objectively initiating the interview with the words 'environmental change' instead of 'climate change', the author was able to gauge the general awareness levels surrounding climate change based on participant descriptions of changes witnessed and their personal vocabulary to describe what they had seen. The final section of the interview centered on management of resources and included the role of government and community in diminishing vulnerability.

Community Green Map

Key informants' intricate connection to and dependence on natural resources enabled them to provide valuable, detailed information about the social ecological systems they interact with daily. The 'Green map[6]' activities employed universal icons and tools to create maps based on the knowledge and contributions of seven participant groups in Portovelo and Muisne. The benefit of these mapping activities was that they offered a more in-depth understanding of the issues at hand and promoted the importance of LEK with the participants as 'experts' in their own natural environment. The green mapping activities created a space which cultivated collective knowledge, the creation of new knowledge and the sharing of stories, poems or anecdotes, while also promoting rich dialogue and discussion around points of contention. To this end, a more complete picture of the ecological and socioeconomic systems at play was developed by the author as a platform upon which to conduct the analysis.

Focus Group

Four focus group sessions were conducted in Portovelo and Muisne and included an average of 6-10 participants as informed by Marshall & Rossman (2006) and Morgan (1998)

[6] Green Map: www.greenmap.org. Accessed April 10th, 2009.

(Table 2). The focus groups were comprised of both individuals who participated in the green mapping activities and other members of the community. The goal was to create a supportive environment in which participants' views and realities could be shared in a way that also created high 'face validity' (Marshall & Rossman, 2006). Using a portion of the semi-structured interview guide, the objective of each session was to share data about the natural environment, significant historical changes and present vulnerabilities, general perspectives on mangrove ecosystems and water resources in the area, etc.

Observation

As described by Pretty (1995, p. 1256), "observation increases the depth of understanding and breadth of realities encountered". During the field research, the author spent five weeks in Portovelo followed by 5 weeks in Muisne (based primarily in Bellavista but including Bunche and Santa Rosa). For the sake of simplicity, the author will refer to Muisne though research was conducted in only a segment of the island. Observations allowed the author to experience some of the daily realities in these communities, offered a more thorough understanding of the local context and Ecuadorian life, and put into perspective some of the information gathered. Invitations to gatherings, birthday parties and to accompany daily work such as fishing events or the 'be-heading' of shrimp aided greatly in building rapport. Listening to experienced local resource users, establishing useful dialogue with those familiar with the culture and resource use patterns, and fishing with them was not only a recommendation by Johannes et al. (2000), but also an incredible delight. Observation allowed for additional gauging of the presence of dialogue around climate change and environmental change at the community level.

Table 2 Summary of total interviews and focus groups conducted in Ecuador (2009)

Community	Portovelo	Muisne	C-CONDEM	FUNDECOL	Total
Interviews	7	4	4	3	18
Focus Groups	2	2*	-	-	4

* Includes Bellavista, Santa Rosa

Data Analysis

Interviews were audio recorded and transcribed in their entirety in the participant's native language: Spanish. Based upon this data, the literature review and the author's

experience of 3.5 months in Ecuador, a coding system using NVivo software was created which helped conceptualize and categorize the data into themes. The qualitative data was cross-validated using information from observation, interviews, literature review as well as focus groups and mapping activities; a method of triangulation supported by Bryman and Teevan (2005).

Information-sharing

A return visit from May-June 2010 allowed the author to discuss and present findings, a summary report, and final map materials with C-CONDEM, FUNDECOL, communities and Ecuador's Ministry of the Environment (MAE) (Appendix A, B).

3.4 Results

3.4.1 Local

This research methodology acknowledged the legitimacy of community perspectives which are often expert based on their lived experience, and sometimes the only source of information for rural or remote areas. Their awareness and stewardship stems from being active observers capable of and familiar with monitoring the ecological condition of the mangrove ecosystem. Participants were cognisant of change and demonstrated a strong link to the natural environment; especially mangrove and inland tropical forest ecosystems. They were knowledgeable about the various ecosystem services provided by mangroves such as an ability to filter sediment, a natural barrier, a habitat to the crabs, fish, shrimp and cockles important to their livelihoods and diet, the provision of resources, and oxygen. In short, mangroves were often described as a source of work, food and life: "Life here, ours, is the mangrove[7]".

In both Portovelo and Muisne when participants spoke of environmental change in their coastal zone and mangrove ecosystems, they often centered discussion on shrimp farms; the main cause of vast deforestation in the area. The shrimp aquaculture industry was at the forefront of their mind due to the significant "indiscriminate felling" of 80-90% of the surrounding mangrove forests which have been converted to shrimp ponds over the last 30-40 years. For example, "the shrimp farms have been the destruction of the environment… the

[7] *"La vida de aquí, de nosotros es el Manglar"(IM-3, 2009).*

mangroves came to be destroyed when the shrimp farms arrived"[8]. Participants recognized that this deforestation has greatly influenced species availability and water quality in the estuary. Effluent from the shrimp ponds is released without treatment back into both *Río Chone* and *Río Muisne* estuaries leading to the death of many fish species in the area and resulting in adverse health effects on the local population such as skin rashes. In short, "as we lost the mangroves, we lost life, culture, education and health"[9]. Participants also indicated a strong connection between deforestation impacts and changing precipitation patterns claiming that rainfall has decreased due to the cutting of trees.

> "The water goes looking for trees"
> "The trees call the water...[10]"
> "Winter [rainy season] always goes looking for air [from the trees]"
> "More trees attract more cold, attract more rain"
> "The forests can retain clouds"
> "Mangroves and forests attract the rain and now lots have been cut down"[11].

The ability of trees to attract or "call" rain and cold was said to affect not only the rain, but also sun and temperatures since the trees can no longer offer protection. Participants' knowledge and awareness of deforestation was evident during the creation of the maps using Green Map icons (Appendix G), colour coded post it notes, drawings, discussions and descriptions, resulting in complex and information-filled products (Figures 4 and 5). In total, 14 maps were created by 117 participants in 7 groups; providing a story that not only served to share information, but also crossed literacy boundaries through the use of visual media. The 14 maps were combined into 4 unique maps (Figure 4, Appendix B). Though there was flexibility in the end product of the map- it could focus on nearly any aspect of culture and society, nature, sustainable living, or a certain species- there was a predominant draw to forests, coastal zones and the natural environment. Of the green map icons used, the majority and most frequently used icons were Public Forest/Natural Area, Aquatic Habitat, Special tree, and Deforestation, which demonstrates a clear link between the participants and their surrounding mangrove and tropical forests (Figure 6).

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[8] *"Las camaroneras han sido la destrucción del medio ambiente… los manglares se vinieron a destruir cuando vinieron los camaroneros" (IP-4, 2009).*
[9] *"Porque a medido que se nos iba perdiendo el Manglar, se no iba perdiendo la vida, la cultura, la educación, la salud" (IM-1, 2009).*
[10] *"[mangles] llama el agua…" (IP-1, 2009).*

Figure 4 Green Map created by the *Asociación de Pescadores de Portovelo* (2009)

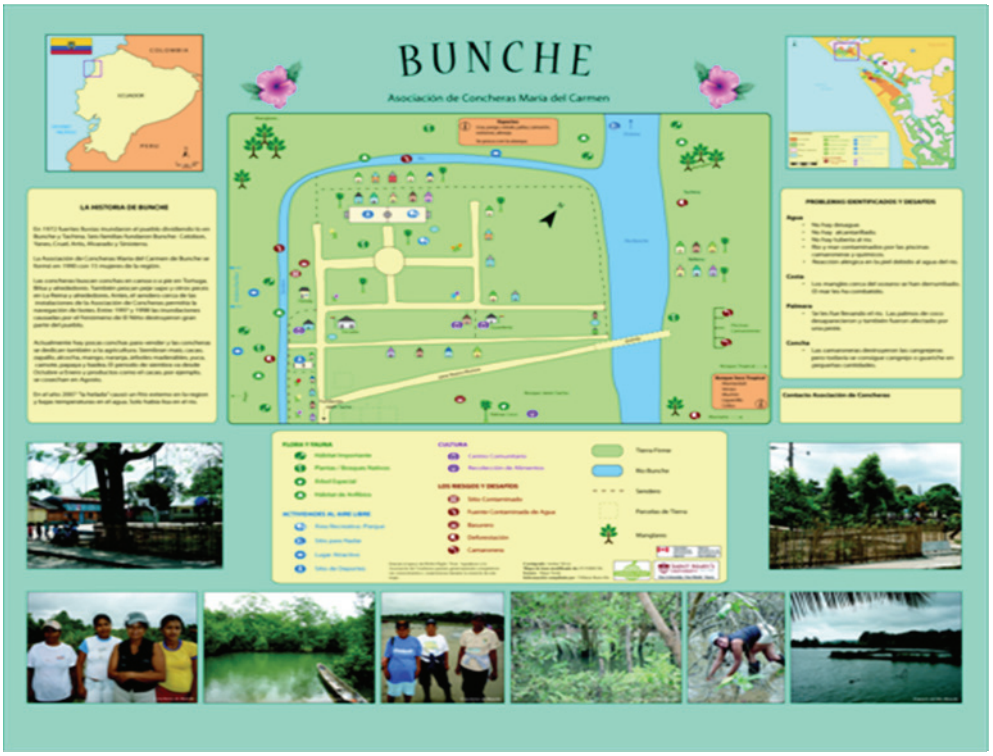

Figure 5 Green Map created by the compilation of maps and information shared by *la Asociación de Concheras María del Carmen de Bunche* (2009).

[11] *(GP-8, IP-1, IP-3, IP-2, IM-5, IM-1, 2009)*

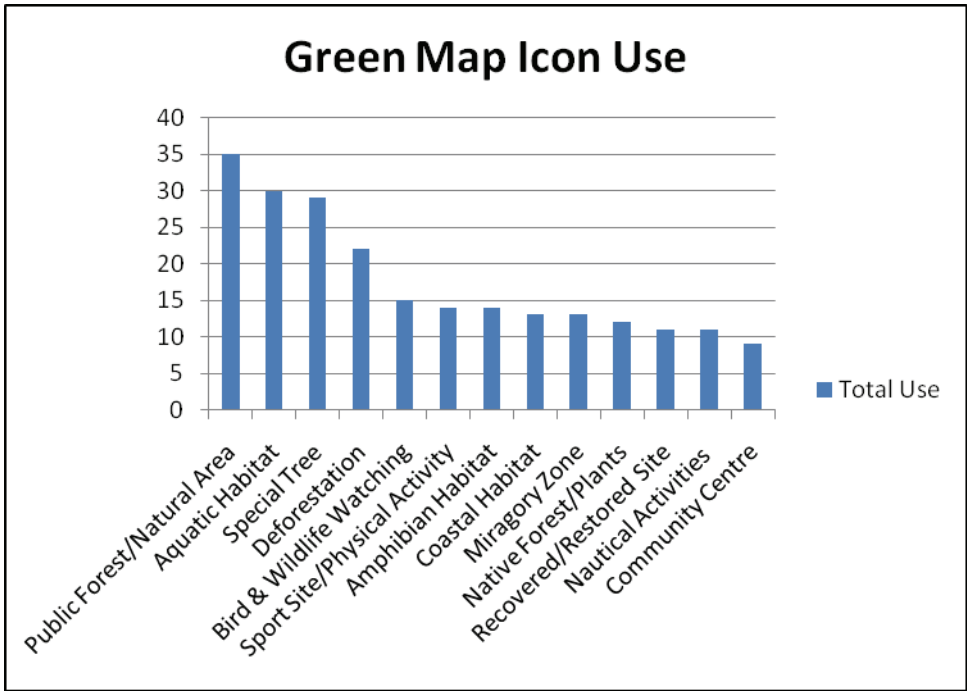

Figure 6 Green Map Icon use during community mapping activities in Ecuador (2009)

Though there are many socio-cultural and biophysical similarities between these two communities not all future impacts from climate change will occur at equal intensities in each coastal region and not all historical environmental change was identical. Participants expressed varying degrees of preoccupation when discussing changes in the seasons, temperatures, rainfall, and flooding with some more frequently mentioned or evident in one area than the other (Table 4). In Portovelo especially, emphasis was also placed on the El Niño phenomenon due to the extreme event experienced in 1997-1998 (For more information see Glantz, 2001). The coastal soils' poor natural drainage system, excessive precipitations, a coinciding rise in sea-level and the presence of numerous shrimp farms combined to cause an overflow of the rivers in Ecuador's coastal zone leading to flooding and the destruction of many houses, stores, and agricultural productivity (Ministerio de Salud Pública, n.d.). Vast quantities of soil rushed from the tropical forest mountains into the *Río Chone* estuary resulting in a radical reduction of the depth of the estuary from 29m to ~9m. This caused a drastic decline in fish species quantities and composition and, according to the artisanal fishermen, the disappearance of larger species such as *lagartos* (crocodiles) and *delfines* (dolphins). When the El Niño phenomenon is mentioned, it tends to encompass the excess rain, landslide, and subsequent sediment input as one event- '*El fenómeno*'. The vast and lasting damage caused by this phenomenon has etched

the memory in their minds. It is worth noting that though this phenomenon is natural, the drastic deforestation of both inland tropical forests and mangroves combined with the creation of walls around the shrimp farms affected water flow and exacerbated the flooding impacts.

> "The shrimp industry made it so the estuaries changed completely because if the mangroves existed, what's happening now wouldn't happen. We'd have an estuary rich in fish, we'd have an estuary with its complete depth, and we'd have the dolphins that we had during that time in the estuary[12].

Table 4 Frequently mentioned changes witnessed in Portovelo and Muisne, Ecuador

Portovelo	**Muisne**
• Changes in the seasons • Decrease in available fish, shrimp and mollusc species • Potable water quality issues • Potable water availability issues • Deforestation (tropical and mangrove forest) • Contamination of the *Rio Chone* estuary (shrimp industry) • Precipitation decline	• Erosion and flooding problems • Decrease in available fish, shrimp and mollusc species • Contamination of the *Rio Muisne* estuary (shrimp and monoculture industries) • Deforestation (tropical and mangrove forest) • Potable water quality issues

In Muisne, not only do they focus on the vast deforestation, subsequent decrease in fish and mollusc quantities and contamination of the estuarine water quality, they also displayed great concern about erosion and flooding, which has increasingly been affecting life on the island (Table 4). The author heard: "The Island is disappearing and people don't yet understand...[13]" or "coastal communities counted on a barrier and now it's simply not there. Houses have had to move up, places abandoned[14]" or "what I can tell you is that if you go to the beach, the sea is winning territory; the sea is coming in more and more. We don't know what will happen but the sea will reach [inland] at one point in life[15]". Another interesting point was a quote about sea level rise and erosion in Muisne which has already been witnessed and noted

[12] *"La industria camaronera hizo que totalmente se cambiaron los estuarios, porque si existieran los manglares no pasara lo que está pasando ahora. Tuviéramos un estuario rico en la pesca, tuviéramos un estuario con profundidad totalmente completa, tuviéramos los delfines que en ese tiempo había en este estuario" (IP-3, 2009).*

[13] *"La isla se está yendo y la gente no entiende todavía[13]" (IM-1, 2009).*

[14] *"Comunidades costeras contaban sobre una barrera ahora simplemente no está. Viviendas han tenido que subir, abandonar lugares" (IQ-4, 2009).*

as a concern: "if you are on the island on the left side, there are 16 shrimp ponds and it's very close to the sea. So one says "my God, what will happen here if this climate change comes? The island splits apart? We disappear, what?[16]". This reference to climate change as a looming event viewed almost like '*el fenómeno'* event may be due to their experience with drastic, large-scale environmental change over a short time period instead of a slower, creeping change. Interestingly, when immediate changes such as extreme weather events can be linked to longer-term climate change, stakeholders attributed more importance to them especially if volatile weather conditions had occurred in recent memory (Stantley & Deanwood, 2002; Tucker et al., 2010). Understanding that an event perceived as highly anomalous may convince people that conditions are beyond normal variation and may motivate adaptive changes is a consideration for future adaptation polities (Tucker et al., 2010). In the same vein, extreme events may also further encourage the perception of human-induced climate change (Meze-Hausken, 2004) and can be viewed as an educational opportunity and a chance for collaboration.

Understanding of climate change

Designing the interview guide in such a way that participants could speak freely of general environmental change using their choice vocabulary was critical in understanding awareness levels around climate change. Results show that climate change, global warming, greenhouse gases, and associated vocabulary were seldom used to describe change and responses ranged from no knowledge to minimal knowledge at the community level. Furthermore, at times terms were pooled together such as "ozone layer melting[17]". When asked directly about climate change (including changes in temperature, rainfall patterns, sea-level rise, etc.), climate was sometimes confused with weather, a common phenomenon (for example Bostrom et al, 1994). Fluctuations in heat and daily temperatures were mentioned, "Sometimes we're good and a cold appears, like now, but nevertheless at night we feel an atrocious heat and it's all due to climate change"[18]. According to C-CONDEM staff: "in other words, as a theme,

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[15] *"Lo que si te puedo decir que si tú te vas a la playa el mar va ganando terreno, el mar está metiéndose más, y más. No sabemos que vaya a pasar pero de que el mar va a llegar alguna vez en la vida hasta acá" (IM-1, 2009).*

[16] *"Si estuvieras en la isla al lado izquierda hay 16 piscinas y está muy cerca el mar. Entonces uno dice "Dios mío, que va a pasar aquí si viene esto cambio climático- se parte la isla. ¿Desaparecemos, que?" (IQ-1, 2009).*

[17] *"La capa de ozono se derrita" (IP-3, 2009).*

[18] *"A veces estamos bien y aparece un frío como los de ahorita pero sin embargo en la noche a veces empieza y sentimos un calor bárbaro y todo eso se debe al calentamiento global" (IP-7, 2009).*

global warming as a word the people don't assimilate it yet. However, there's a preoccupation with what's happening… with the changes"[19].

Above and beyond the devastating consequences of shrimp aquaculture and the El Niño phenomenon, when asked why some of these changes have occurred, participants mentioned external, non-anthropogenic explanations such as: the "climate is crazy[20]", God[21], and "mother nature seems displeased[22]" as reasons for the change. "Nature is giving us a warning, it's warning us, telling us "please stop, stop because I don't speak but I advise, I don't yell but I give signals"[23]. Other studies have shown similar results of farmers or others describing the causes of change as acts of God or unhappy ancestors as opposed to outside pollution (Conrad et al., forthcoming; Moser & Dilling, 2004; Patt & Schröeter, 2008). One participant from Muisne[24] described erosion as being the displeased sea taking back what is rightfully hers and that which has been so altered by human influence [shrimp farms]. This demonstrates how change is being attributed to causes outside of their control; an external force that is difficult to comprehend.

It is worth noting that in Spanish, though the term "*clima*" refers to climate, it is sometimes used to describe weather. In this case, when several participants mentioned "*el clima está loco*" meaning "the climate is crazy", they were indeed referring to a long-term pattern at a greater scale than the weather of that day alone. For example, participants in both Muisne and Portovelo mentioned a noticeable change in the seasons, especially between winter and summer.

> "Now there are no rules. During winter it hardly rains… the climate is crazy[25]"
>
> "Now we don't know when it's summer and when it's winter, it's all changed[26]"

Interestingly, the author also heard the phrase "*el clima está loco*" used in Quito, the capital, while speaking to taxi drivers or local Ecuadorians who have also witnessed a noticeable change in the Andes Mountains. Though few participants actually mentioned fossil fuels as a

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[19] *"O sea yo creo que como tema el calentamiento global como nombre la gente no lo asume todavía. Sin embargo hay una preocupación de que está pasando…con los cambios" (IQ-2, 2009)* .
[20] *"El clima está loco" (IQ-1, IP-7, 2009).*
[21] *(GP-8, IQ-1, 2009).*
[22] *"La naturaleza está como disgustada" (IM-5, 2009).*
[23] *"O sea la naturaleza nos está dando un aviso, nos está avisando, nos dice 'por favor paren, paren porque yo no hablo pero aviso yo no grito pero les doy señas'" (IM-1, 2009).*
[24] *"El mar esta como disgustado…" (IM-5, 2009).*
[25] *"En nuestro medio ya no hay reglas en los inviernos, llueve poquísimo, tenemos clima loco" (IP-7, 2009).*
[26] *"Ahora no sabemos cuándo es verano, cuando es invierno… todo ha cambiado" (IM-1, 2009).*

cause of change, they were aware of how their estuary and forest ecosystems have changed, and offered minute details about it such as leaf fall or water temperatures. This attentiveness is an opportunity to provide specific information and locally-relevant data about how the environment has been altered and transformed in one's lifetime. Certainly, knowledge and interest levels are not homogeneous, but though it may not be 'community'-wide, there is an opportunity. Local ecological knowledge and fisher's knowledge included temporal and spatial fishing patterns and the lunar influence on species catch- knowledge which has been passed down through generations of fishermen and fisherwomen. This long-standing ability to cope with variability and find alternative strategies is a skill developed by many who are dependent on the natural ecosystem and have a connection to the land.

3.4.2 Non-governmental organizations

Collaboration with the national and regional NGOs (C-CONDEM and FUNDECOL) during the research project allowed for a broader understanding of mangroves in Ecuador as it juxtaposed unique and common issues across all provinces. C-CONDEM unites NGOs nationally through spokespersons for each coastal province and sustains partnerships internationally as well. Generally, awareness levels about climate change and global warming were more developed with respondents from the NGOs and there was an understanding that education was lacking and that there needed to be a focus on this issue in the future. "We know of the theme but each individually, it hasn't been a collective matter. And neither has it been transmitted to the communities[27]". In the organizations, the awareness of climate change was not yet coordinated with action addressing it, though a more concerted focus was in process. Mangroves were consistently described as a "source of life" for the local communities; special ecosystems which contribute innumerable resources, and a strong cultural influence on which legends, myths and poems are based. However, consensus was that "as a theme, climate change is not recognized by the people, the term isn't common[28]" but that the people "live it, feel it, are worried [about the changes][29]". Furthermore, the same strong link between the deforestation of mangrove forests and the shrimp aquaculture industry were mentioned and the industry was viewed by many as the greatest risk and persistent cause of vulnerability as well as a contributor

[27] *"Conocemos del tema pero cada uno individualmente pero no ha sido una cuestión colectiva. Y tampoco esto ha sido transmitido a las comunidades" (IM-4, 2009).*

[28] *"Como tema el cambio climático no. Casi no pega mucho, O sea expresamente el tema cambio climático no es reconocido por la gente mucho en las comunidades" (IQ-3, 2009).*

to many problems coastal communities currently face. Climate change was said to be quite simply "nothing other than the destruction of our natural resources". Blame for climate change was also attributed in part to human behaviour, consumption patterns, and government-industry relations which favoured extractive development and politics. This broader link to human causes was not as evident during the interviews with the communities who attributed change mostly to the shrimp industry.

The mention of knowledge-sharing was present and the FUNDECOL participants expressed a wish to collaborate with government and experts around erosion and sea-level rise issues in Muisne. There was a need to describe the specific problems they face while also utilizing expert knowledge to find solutions to decrease vulnerability and adapt in the face of future climate change. For example, NGO staff vocalized a desire to confront erosion and sea level rise with the aid of experts, government, and science while also being involved in the conversation. C-CONDEM participants also made this connection to sharing knowledge between community, NGO and government.

3.4.3 Government and Institutes

The obvious climatic changes witnessed in Ecuador have led it to contribute to the United Nations Framework Convention on Climate Change (UNFCCC). Direct national effort has ensued since the creation of the National Climate Change Process in 1993 evolving recently into the *Subsecretaría de Cambio Climático* (SCC-Undersecretary of Climate Change) through the Ministry of the Environment which comprises both an adaptation and mitigation stream. During the initial field work (2009), an interview with the director of the National Climate Committee outlined a lack of resources and mechanisms to collaborate at different scales and he claimed that their work remained at the institutional level. Since then, the SCC has taken over and vastly advanced their work at different scales in an effort to communicate across boundaries. In fact, they are currently designing the national 4-year communication plan for Education and awareness of climate change in Ecuador. Findings from this research have contributed to its creation. This transition has resulted in more recent movement from institutional level work to more broadly applicable research and localized projects across the country.

[29] *"O sea si, la gente lo vive, lo siente… está preocupada la gente" (IQ-1, 2009).*

Climate change impacts are often difficult to model due to the presence of coastal, highland and forest regions in Ecuador. National institutes such as INAMHI, the Naval Oceanographic Institute (INOCAR), the SCC, and the Undersecretary of Risk provide excellent research but insufficient place-specific information makes decision-making for adaptation difficult due to the lack of certainty. Vulnerability maps by the Undersecretary of Risk aid in describing possible impacts and show Portovelo and Muisne as being highly vulnerable to tsunamis and flooding (Figure 7). While Portovelo is vulnerable to drought, Muisne will see increased precipitation patterns (Figure 7). On the other hand, some studies show a tendency for diminished precipitation along the entire littoral region of Ecuador and even a tendency toward desertification in the province of Manabí (Cáceres, 2001). This institutional level information is lacking the perspective from the ground up, and fails to draw on local understanding of change.

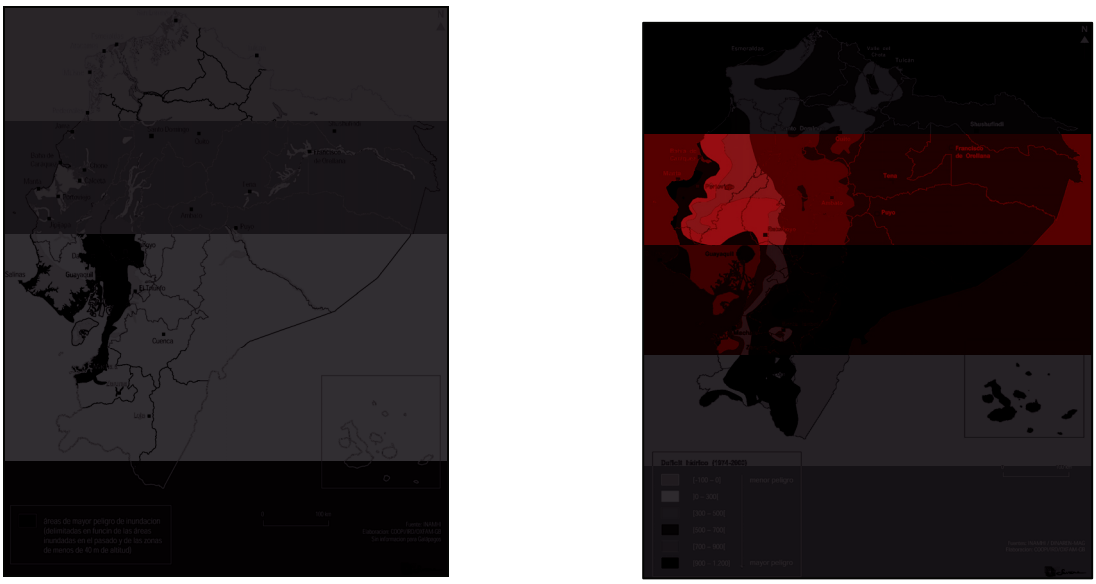

Figure 7 Vulnerability maps to flooding and drought in Ecuador. Source: INAMHI.

3.6 Discussion

Results demonstrate participants` clear connection to the mangrove ecosystems and well-developed relationships between the NGOs and many coastal communities. Not only has this served as an educational and capacity-building exercises around mangrove conservation and community development, it may also be key to future discussion and collaboration around climate change. FUNDECOL and C-CONDEM provide vital information about the natural

environment through their collaborative biophysical and socio-cultural research on mangrove species, water quality studies, crab and mollusc species monitoring and restoration programs, reports and evaluations regarding mangrove legislation, etc. For example, C-CONDEM created a map demonstrating the distribution of mangroves and shrimp farms in 1969 compared to 1999 (Figure 8). As a source of information contributing to climate change dialogue and adding a piece to the complex puzzle, there is certainly a role to play. Additionally, the various sources reviewed during this research such as IPCC, national institutes (INAMHI, INOCAR), the MAE, etc. are also necessary and provide an institutional and scientific framework. A group of national institutions which include the aforementioned proposed seven adaptation measures to confront climate change, which include the establishment of biophysical monitoring programs, the preservation and reforestation of mangroves, and the adaptation of shrimp aquaculture activities (Cáceres, 2001). These links between the mangroves and adaptation are once again apparent and important in the context of the study regions and offer an opportunity to work together. Interestingly, the CNC and MAE SCC demonstrated a keen interest in local perceptions of climate change which offers future opportunities for collaboration.

3.6.1 Local perceptions of climate change

Participants were aware of environmental change and discussed unpredictable and variable seasons, a sun that now burns, as well as a decrease and variability in rainfall. This knowledge of biophysical processes, many of them unique to the area, are the result of decades spent on the land living with mangrove ecosystems and learning from the intricate changes that occur over one's lifetime. Similar results were found with farmers in the Sahel who demonstrated a strong awareness of climate and possessed clear opinions on change (Mertz et al., 2009). Though humans sometimes have a limited capacity to perceive long term tendencies (compared to short-lived extreme events) if not very abnormal or catastrophic (Rebetez, 1996), several studies demonstrate how local people do indeed observe changes in weather patterns, species' life cycles, productivity and interrelationships (such as Turner & Clifton, 2009). Indeed, "people with such deep experience recognize anomalies readily" and can contribute with insights about weather, species, habits, etc. (Turner & Clifton, 2009, p. 185). Furthermore, results have shown that local people's perceptions of vegetation change are reliable and consistent with other sources (Lykke, 2000). This research not only focused on LEK, but also aimed to understand local perceptions of climate change.

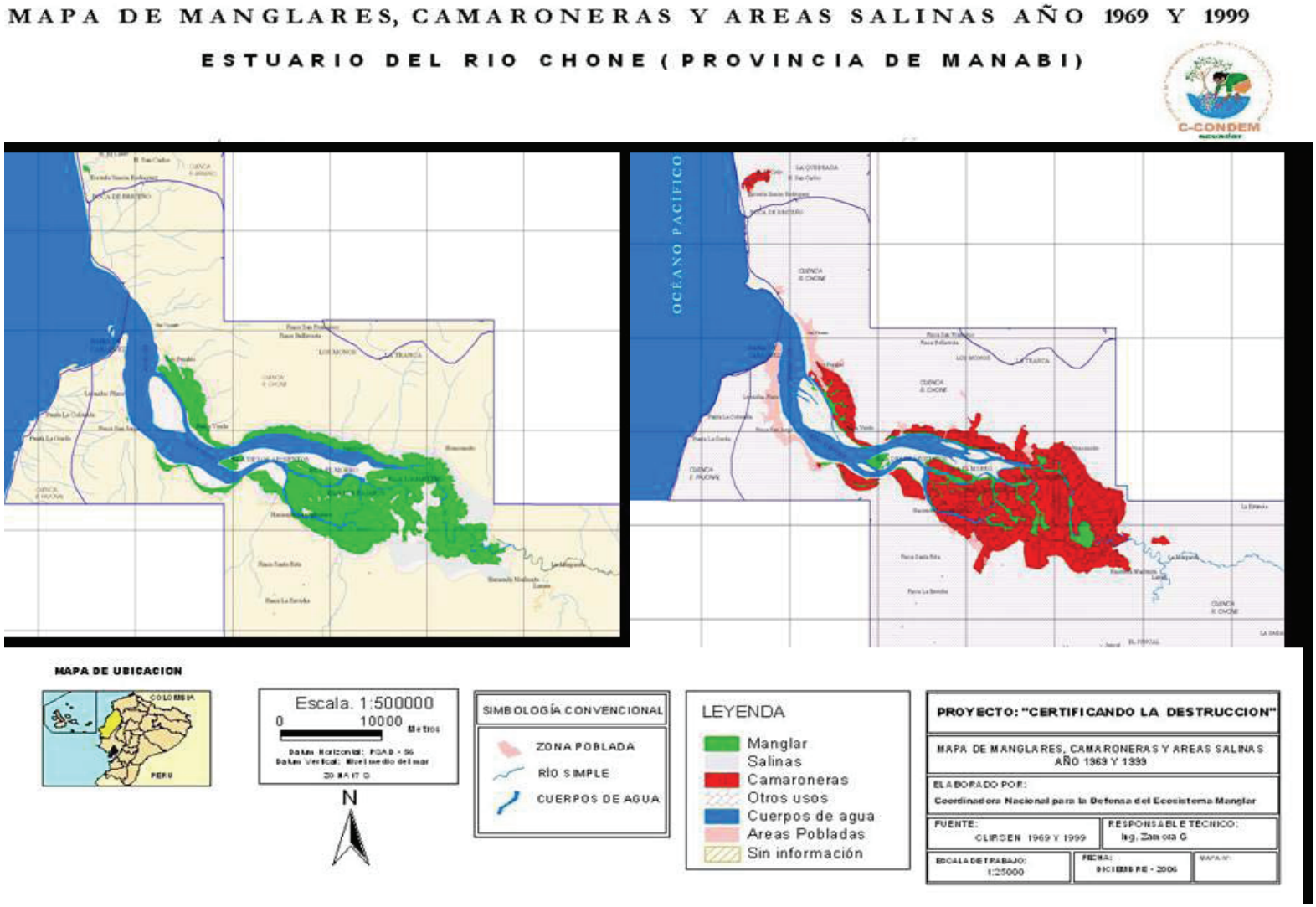

Figure 8 Extent of mangrove forest and shrimp farms in the *Río Chone* estuary, Manabí (1969 and 1999)

Results from this research demonstrate an incomplete understanding of climate change and global warming in Muisne and Portovelo. Often, (as discovered during this research) information about local weather or single cases is used to make inferences about global climate and people tend to conflate weather with climate (Bostrom et al., 1994; Moser & Dilling, 2004; Read et al., 1994). In Portovelo and Muisne, daily fluctuations were sometimes labelled as global warming and climate change. This type kind of confusion often occurs as people assimilate global warming through their personal understandings and misunderstandings of general environmental problems, in other words, through the use of their own mental framework, pre-existing frames of reference, experience with environmental change and existing set of knowledge and concerns (Dunlap, 1998; Moser & Dilling, 2004; Shackley & Deanwood, 2002). For some, causes of climate change are filtered into two categories: material causes and spiritual causes (Byg & Salick, 2009). Results demonstrated that change was also attributed to God, displeased nature and the climate being *loco* (crazy). Similar conclusions were found in The Gambia (Conrad, Grek-Martin, & Silver, forthcoming) and other regions (Moser & Dilling, 2004; Patt & Schröeter, 2008). These non-human causes of change were an interesting contrast to the frequent, recurring theme of the shrimp aquaculture industry and the vast deforestation caused by man's creation of shrimp ponds; the main source of historical environmental change in the areas. The scale of deforestation and conversion of mangroves is often irreversible and has specific repercussions for coastal households who depend directly on the mangroves to support coastal fisheries. Indeed, reasons for change were seldom attributed to climate, though it may have had an underlying influence (as found in Mertz et al., 2009). In this case, understanding how these land-use changes and various inland and coastal pressures influence perceptions of environmental change also clarifies how current vulnerability may be influenced by the predicted future climate change impacts.

Individuals may partially base their perceptions of climate change on climatological data, a combination of various environmental aspects, personal needs, or a link to climate's utilitarian aspect (Meze-Hausken, 2004; Read et al., 1994). Humans, from lay people to scientists, base their reactions to climate change on their own experience, especially tangible signs of climate change (Rebetez, 1996). It is evident that many participants had at least heard the terms global warming or climate change but an understanding of its significance was often minimal or incomplete. Information is thus reaching these communities through various means in sporadic and partial capacities leading to knowledge gaps between local and global scales. In a similar

study, people regarded changes as local phenomena, as they had not heard of global climate change (Byg & Salick, 2009). Therefore, not only are large-scale environmental changes dominating the discussion, but a lack of communication is thus partially to blame for the limited understanding of environmental and climatic change. In fact, one FUNDECOL participant summarized climate change as he imagined the people understanding it:

> For the people, it's the destruction of the mangroves. They will always talk to you about that- that before there were more cockles, that before there were more crabs, and that the shrimp farms arrived and they finished. That's climate change; those are climatic things....destruction of resources, destruction of resources because scholars [attribute] put words on it, no? But it's nothing other than the destruction of our resources. Is there destruction of our resources? Of course. If they destroy our resources the sun will come with more strength, there's no rain, it's going to diminish in certain parts...

This quote shows the link between destruction of the natural environment and effects that the coastal populations are feeling. Their priorities and foci lie with how their livelihoods are being affected, such as the diminished quantities of clams and crabs. He claims that climate change and environmental change and the many damages felt by the shrimp aquaculture industry fall under a similar umbrella, which are not distinguished at the community level. The importance of vocabulary is evident here, as change was perceived differently by individuals within the community (less awareness), as well as the NGOs (more awareness) often due to access to information. Either way, it is important to take into account the local perspective which may be the only available 'data' in the region and has an important role to play in recognizing change and participating in bottom-up monitoring.

Local perspectives are important for climate risk assessment "as risks identified from meteorological records may be different from those that communities perceive as the biggest climate risks, and where mobilising local experiences could be a key asset for identifying relevant indicators and adaptation options" (Klein et al., 2007, p. 39). Furthermore, whether or not the local perceptions of environment and change are supported by available data, people's actions based on these perceptions are real (Glantz & Degefu, 1991 in Meze-Hausken, 2004).

3.6.2 Comparing top-down and bottom-up information

What was evident from the literature review was that top-down climate change scenarios are insufficient and there is a need of more specific, locally-relevant information. Comparing the available data about climate change perceptions and predictions in the regions

surrounding Portovelo and Muisne provided insight about where knowledge gaps arise and local understandings of climate change. The information compiled from global scientists, top-down modeling, and national institutes allowed for the understanding of the most pertinent prediction related to climate change impacts on the *Muisne* and *Río Chone* estuaries and mangrove ecosystems. The most frequently mentioned vulnerabilities to coastal communities and mangroves according to these sources are sea-level rise and variability in rainfall. Furthermore, Ecuador is technically highly vulnerable to natural disasters (UNDP/UNPF, 2003) but participants rarely mentioned this as a preoccupation. There are also social and cultural vulnerabilities to consider which fall beyond the scope of this research.

When communities spoke of historical changes to their ecosystem and key vulnerabilities, certain aspects overlapped with these top-down sources. For example, Muisne participants often spoke of alarming changes to the island's composition due to erosion and because "the sea is gaining ground[30]" threatening their ability to live on the island. Ecuador's coastal region which includes the small island of Muisne (and its mangrove ecosystems) is predicted to be affected by sea level rise (IPCC, 2007; UNFCCC, 2000). Currently, as described by participants, non-climate related anthropogenic stressors (such as shrimp aquaculture) have had a greater effect on mangrove loss. However, relative sea-level rise is predicted to contribute disproportionately to future losses (Gilman et al., 2007b, 2008). Furthermore, the many other climatic variables predicted to be altered can influence mangrove responses to sea-level rise and exacerbate the problems (McLeod & Salm, 2006). Importantly, there is a connection here between the loss of mangroves' ability to act as a barrier and regulate water flow inland (described by Klein et al., 1997; Walters, 2008) and their disappearance exacerbating sea-level rise and erosion effects.

A loss of 80% of the mangroves in the *Río Muisne* estuary and 90% of mangroves in the *Río Chone* estuary has occurred (C-CONDEM, 2007). Shrimp farm expansion has caused the majority of these changes and transpired due to the absence of property rights, ineffective management regimes and incentives given by the Ecuadorian government to shrimp farmers (Ocampo-Thomason, 2006). It appears that the various effects of the shrimp aquaculture industry combined with the massive visual reminder of its presence and continued influence holds it in a prominent position in peoples' minds as a source of change, an ongoing threat, and

[30] *"El mar está ganando terreno"* (IM-1, 2009).

contributor to vulnerability; its visual saliency is a reminder of how and why the environment has changed. These relatively recent events produce strong emotional reactions and, in the case of shrimp farms, lingering resentment. The significant influence of both this industry and the El Niño phenomenon (the two 'culprits') may indeed obfuscate the visual effects of climate change that would otherwise be witnessed by the community. For example, though sea level rise may indeed be increasing visibly in the *Río Chone* estuary (as it is in Muisne), it is physically concealed from the minds of local residents due to the prominent barrier (shrimp pond) and land use stresses which accompany the industry.

As well, the deforestation may have altered ecosystem processes so drastically that the biophysical responses have been rendered even more unpredictable and climate change signs may be concealed. What is not evident, is whether certain impacts were not mentioned because of their absence in that area, human's (in)ability to comprehend long-term changes, or whether these discrepancies are based on the vast destruction of an ecosystem masking otherwise evident climatic changes in an ecosystem.

Portovelo residents also who spoke of problems with the estuaries water depth and quality, due to the impacts of severe mudslide during the 1997-1998 El Niño phenomenon. This event is often referred to when describing the evolution of the *Río Chone* estuary and the accompanying outpour of sediment which has not only resulted in a substantial decrease in water depth, but also a drastic reduction in species quantity according to local fishermen. This begs the question: are climatic changes such as sea-level rise even developing naturally or has the complete upheaval of the estuary changed the obvious processes? Furthermore, the occurrence of future El Niño Southern Oscillations may exacerbate the erosive process along the coast (as seen in Federici & Rodolfi, 2001); a process which can often be slowed by the presence of mangrove's complex root structures (Blasco et al., 1996). This presents an opportunity for mangrove restoration in adaptation in adaptation policies.

3.6.3 The role of various sources

When faced with an issue with such complexity and uncertainty, there is often insufficient information on which to base conclusions especially in rural areas when data is lacking. Considering the current impacts observed within present day climate variability, how history influences current vulnerabilities, and what is predicted for the future is a three-pronged

approach to understanding the vulnerability of these coastal communities. In order to answer these three components with any semblance of certainty, we must seek out a multi disciplinary perspective which includes community, NGO, government, institutes and global science. Each contributes different information and perspectives which can be overlaid to create a clearer picture of the situation. In fact, a more complete information base than that from scientific study alone ensues when community level knowledge and perspectives are considered (Berkes et al., 2000). Ample research concurs that the engagement of non-scientific knowledge and values improves the quality of research (van Asselt & Rijkens-Klomp, 2002). For example, when the observations of fisher's and scientists overlap, there is increased confidence in the result (Johannes et al., 2000). Combining the information from various sources elucidates key issues on which to focus climate change adaptation.

According to Nicholls et al. (2007) focusing additional observation and collecting better baseline information of actual coastal changes, local factors, sea level rise and drivers is a research initiative that would substantially reduce uncertainties. There is a need to improve monitoring systems and modeling of meteorological effects so that adaptive measures can be put into place; long-term monitoring operations could thus provide the required data in vulnerable locations (Vergara et al., 2007). This need to monitor biophysical changes was also put forth by a group of national institutes in Ecuador as one of seven adaptation measures for climate change (Cáceres, 2001). Most participants in this study had a clear idea about many of the ecosystem services provided by mangroves and demonstrated an awareness of how deforestation is impacting precipitation patterns and temperatures. The various perceptions of ecological change arise from the combined experiences of multiple generations who have lived and worked in mangroves along Ecuador's coastal zone. The participation of local resource users who share their ecological knowledge allows not only the discovery of locally-relevant data, but contributes to a broader climate change knowledge base. Several benefits of bottom up or regional monitoring are described:

- Critical element of community capacity building and adaptive learning for resilience (Reed et al., 2006 in Tschakert, 2007)
- Locality-specific research can elucidate info about widespread change (Wilbanks & Kates, 1999)
- Monitoring and studying changes (climate and non-climate drivers) systematically can aid in establishing baselines and noticing gradual changes, regional phenomena and local

effects- thus enabling educated adaptation (Gilman et al., 2008; Nicholls et al., 2007, 2009).

The involvement of local resource users in community-based monitoring can also be termed 'citizen science' and, in this case, would fall under the consultative and functional levels of participation described by Conrad and Hilchey (2010). Working from the bottom-up (based on the views of the vulnerable (Tsackert, 2007)) leads to an understanding of the breadth and depth of local realities, which, in this case include a complex and damaged relationship between the shrimp aquaculture industry and local populations. Indeed, "Representing normally excluded voices, vulnerable groups, or even values attached to the non-human world is a transformative process that can... [p]romote in-depth understanding of the issue at hand" (Dessai et al., 2004, p. 20). Participants from Muisne and Portovelo were knowledgeable about the natural environment, especially mangroves. Thinking ahead, the engagement of local stakeholders in vulnerability assessments and monitoring may also encourage the use of climatic information in order to proactively adapt to expected conditions (Tschakert, 2007). Systems of long-term observation, monitoring, and analyses of the implications of environmental and climatic change at the local scale are important (Wilbanks & Kates, 1999). The mangrove ecosystem was evidently important to communities as a source of life and could thus be utilized as critical indicators of the effects of climate change, as seen in Field (1995). For example, they are able to display sensitivities and changes to sea-level rise, temperature rise, variability in CO2, and water availability. These indicators can be regionally specific and take into account how the natural systems change- information that may be found through discussion with local residents or organizations.

Importantly, though local people may have important information about their surrounding environment, they may not have access to information on wider political, demographic, biological, and economic trends that threaten ecosystems and livelihoods (Russel & Harshbarger, 2003). For example, the International Centre for ENSO research (CIIFEN) offers up-to date seasonal prognoses for Ecuador which contributes baseline scientific information about future phenomenons but this information is not often presented at the community level. There is currently a lack of dialogue between groups and different stakeholders, and stagnant information flow which creates a gap in awareness at multiple levels; thus potentially inhibiting collaboration around local vulnerabilities. One of the important contributions of NGOs, government and institutes in Ecuador is to provide the information about the vulnerabilities in

that region. What is evident from the literature review around climatic trends in Ecuador and results at a local level is that various sources combine to create a more complete picture and inform climate change dialogue. What must happen in this case is dialogue that brings together all available data from and about Muisne and Portovelo to establish what the most pressing areas of concern are, and where knowledge gaps occur. The biophysical data and changes observed by local populations need to be superimposed on information provided by the IPCC, MAE, INOCAR, INAMHI and various NGOs in Ecuador to gain a clearer picture as all sources have something to contribute (Table 5). This is where organizations such as C-CONDEM and FUNDECOL may play a role as a middle man or conduit of information. Their objective is to facilitate the exchange of experiences by providing a space to reflect and evaluate what is happening in the communities and provinces. They also monitor, keep communities up to date with what is happening in neighbouring areas, politically and at a national scale, and facilitating their involvement through capacity-building. Using this foundation as a springboard for dialogue around climate change and sharing historical memory may indeed be most suitable to organizations that can connect the necessary players and sources of information able to provide insight about climate change impacts in certain regions. On the other hand, with SCC implementing a new Education and Awareness plan at the national level, they may have the necessary resources and opportunities to share climate change information but government distrust may need to be considered.

One of the main problems with insider/outsider research occurs when the knowledge and values of indigenous people (or community members) tend to receive less value than science-based perspectives brought forth by a researcher (Davidson-Hunt & O'Flaherty, 2007). On the other hand, oftentimes, outsiders or people marginally situated in the community social system are able to step back and evaluate from a distance, which allows them to come up with new ideas (Chuenpagdee & Jentoft, 2007). This iterative dialogue and understanding of how change and climate change are viewed or perceived is key. Or, as seen in Dessai et al (2004), we must look at what matters at the local level in order to determine how climate change may affect this in order to then communicate risk. Ensuring that climate change education addresses the communities' priorities in terms of changes seen and acknowledges their awareness of environmental change will allow the information to be more readily understood and accepted; tailored to an area or specific interests. In this case, climate change education must also occur

from the bottom up, since community levels can contribute important information to the dialogue around climate change impacts.

By establishing what the most pressing climate change concerns in the area are, and how these impacts fit into the local context, one is better able to assess vulnerability and possible adaptation options. Importantly, the public needs to be able to evaluate local and short term events by recognizing how they fit within the broader context and at the adequate scale (Rebetez, 1996). One must place climate info into the socioeconomic context in which it is being described, while also making the scientific knowledge more relevant to society (Tiessen et al., 2007). Indeed, a transformative process can ensue when scientists advise and guide community groups in monitoring, as opposed to setting the agenda themselves (Conrad & Hilchey, 2010). Increased collaboration and communication, innovative partnerships, and the development of interdisciplinary, multi-stakeholder groups to address a problem (Conrad & Daoust, 2008) may be an option for Ecuador's coastal communities in the face of climate change.

3.6.4 Mutual learning and collaboration

Recommendations from this research include a non-linear form of communication about climate change between the local level, NGO and government. This process of mutual learning through dialogue around climate change could enable knowledge-sharing that takes advantage of the various elements that each source can contribute to reducing vulnerability to climate change in these coastal communities (Table 5). The information displayed in Table 5 illustrates a potential framework for co-learning and knowledge-sharing where different players in the overall system contribute to the broader knowledge base surrounding climate change.

This concept of co-learners in a "learning community" (Wiber et al., 2009) or "integrative science" (Miller et al., 2010) is a way to acknowledge the different sources as legitimate and useful in climate change dialogue. In her work in the Sahel, Tschakert (2007) found that one's adaptive capacity was enhanced by shared knowledge and lessons learned from previous climatic stresses as these could be considered vital entry points for social learning. Learning from those who experience global change problems allows us to create additional knowledge, re-shape traditional scientific knowledge, while also setting a basis for the translation of knowledge, and triggering the process of mutual learning. The creation of a more complete picture of climate change impacts which takes into account perceptions and other contributing factors will allow us to assess more adequately the vulnerability of an area.

Table 5 Description of various sources consulted, their foci, key information and benefits to climate change dialogue

Group	Area of focus	Key information contributed to dialogue	Broad characteristics
COMMUNITY	Muisne (Santa Rosa, Bellavista, Bunche), Esmeraldas Portovelo, Manabí	- Locality-specific literature about ecosystems change - Awareness of change in seasons, temperature, - Focus on deforestation impacts to mangrove forests and tropical forests - Attribute much of the environmental change to the shrimp aquaculture industry and El Niño Phenomenon - Also attribute change to God, displeased nature, and "crazy climate"	- Have LEK to contribute to climate change conversation - Can help educate NGO and government about local level change, priorities and realities - Local perceptions of climate change affect behaviour and adaptation - Local integration of knowledge of various environmental influences
NGO	FUNDECOL *Fundación Ecológica* C-CONDEM *Corporación Coordinadora para la Defensa del Ecosistema manglar*	- Mangrove deforestation in Ecuador significant and mostly due to shrimp aquaculture industry - Research on mangrove species, crab and cockle populations, national and international legislation pertaining to mangrove, national and regional distribution of mangroves (MAPS)	- Already have relationship established with communities - Experienced in co-learning and collaborative monitoring of the estuarine ecosystems - Contribute baseline information about the ecosystem - Ability to function in academic, scientific, and local realms; ability to influence government and public - Opportunity for multi-disciplinary work -climate change representing only one component of objectives
GOVERNMENT AND INSTITUTES AND GLOBAL SCIENCE	MAE- *Subsecretaría de Cambio Climático* (Climate Change)	- Sea level rise threat along the coast - Fragile ecosystems include mangroves - Beginning to branch education, research and collaboration from institutional level to more regional and smaller-scale	- Legislative power and authority - Ability to influence change on a national level - Collaboration opportunities between departments National communication plan for climate change education and awareness currently being designed (Fall 2010)
	MAE- Subsecretaría de Riesgos (Risk)	- Vulnerability maps of coastal zone in Ecuador	- Scientific information and rigorous methodologies - Link to other departments in MAE - Creation of maps which can be widely distributed
	INOCAR INAMHI CIIFEN GLOBAL RESEARCH	- Scientific research and broad measurements of biophysical processes demonstrating sustained temperature increase, sea level rise and precipitation abnormalities. - Seasonal forecasts for ENSO	- Scientific information and rigorous methodologies - Highly technical - Function at broader institutional level - Lack of communication ('translation') of scientific information to lay person

3.7 Conclusion

It is important to consider how developing countries such as Ecuador deal with and understand environmental change- past, present, and future- and where coastal communities stand in terms of biophysical vulnerability to climate change since they are predicted to be affected. Comparing different sources of information and including a "bottom-up" perspective on environmental change and awareness is key to gaining a more complete understanding of an area's vulnerability, especially in light of historical change. Though results from this research demonstrate participants` incomplete understanding of climate change and its associated vocabulary at the local level, they were cognizant of change and attributed it to various causes. Deforestation was frequently mentioned and usually linked to the shrimp aquaculture industry. Utilizing the vast experiences of people and communities who have been impacted by climate variability will contribute more pieces to the puzzle of climate change dialogue, a process that could be mutually beneficial and facilitated through monitoring programs. A monitoring program that acknowledges local knowledge as legitimate, gathers baseline information about a complex and uncertain problem, and serves as a collaboration opportunity to discuss climate change may indeed be the best way to address the present knowledge gaps and deal with future impacts.

3.8 References

To avoid redundancy, the references for this paper are included in the reference section at the end of the thesis.

CHAPTER 4 FOOD, WATER AND MANGROVES: LOCAL PRIORITIES AND THEIR INTERACTION WITH CLIMATE CHANGE

Tiffanie Rainville was responsible for the research and writing of this manuscript. Anthony Charles was the thesis supervisor and Michelle Adams, Cathy Conrad, and John Kearney were thesis committee members. All provided guidance, revision, and feedback. This paper will be submitted for publication in an academic journal.

4.1 Abstract

Coastal communities worldwide are vulnerable to climate change due to both marine and inland stresses which may indeed have a compounding effect on current issues. Many development and climate concerns are inextricable and necessitate an understanding of how climate stress will affect adaptation potential in developing countries such as Ecuador. This research endeavoured to draw on the local-level awareness of climate change in two of Ecuador's coastal regions and discover what the community truly recognized as important vulnerabilities. What emerged from this analysis were preoccupations with food security and livelihoods; a focus on basic freshwater needs; and recognition of mangrove ecosystem importance to coastal livelihoods. In discussing these topics, there was also a resonating request for 'support' from government in addressing said vulnerabilities including authoritative, economic, and educational support in addition to protection of their natural resources. Importantly, while climate change was seldom mentioned directly and was largely overshadowed by the preoccupation with daily needs, it elicits concern about how climate change will negatively influence these very issues. By elucidating community priorities, one is thus in a better position to discover entry points on which to centre climate change dialogue and adaptation in an effort to make it relevant to coastal communities. This paper provides an example of the potential 'win-win' adaptation option of mangrove restoration that would take into account the local viewpoint, national climate change priorities, and could serve as a tool for knowledge-sharing and trust-building between stakeholders.

4.2 Introduction

Globally, climate change will have adverse effects on various coastal regions due to the many impacts of sea-level rise, erosion, storm surges, as well as changes in precipitation and ocean temperatures. Coastal communities which depend on their natural resources are

particularly vulnerable in that their livelihoods will be impacted by marine and inland pressures and stresses (Nicholls, et al., 2007; Pomeroy et al., 2006). Currently, over fifty percent of the world's populations reside within 100km of the coast –the most productive marine environment- and by 2025 these coastal areas will house 75% of the global population (United Nations, 2002). Whereas primary manifestations of climate change are physical, secondary manifestations vary in terms of social, ecological, and economic impacts (Byg & Salick, 2009). These significant and diverse effects will cause a major shift in the lives of local populations, necessitating individual and collective adjustments and responses.

The coast of Ecuador is more vulnerable to the impacts of sea-level rise than other Latin American countries, including coastal flooding and salinization of coastal aquifers (Vergara et al., 2007). In fact, an increase in average sea level would flood nearly the entire Ecuadorian coastline (UNFCCC, 2000) leading to saltwater intrusion into surface and groundwater in many areas (Nicholls et al., 2009). Research by the National Meteorological and Hydrological Institute (INAMHI) in Ecuador show a sustained increase of the average temperature with higher fluctuations in some regions in addition to uneven rainfall with a tendency to decline on the coast (Cáceres, 2001; Magrin et al., 2007; UNFCCC, 2000). Though the data is sporadic and lacking in certain areas, it is evident that change is occurring along Ecuador's coast which necessitates adaptation in many coastal areas and the surrounding tropical and mangrove forests. Especially in developing countries, sea-level rise, erosion, storm surges, and ocean temperatures will pressure ecological processes; this will in turn affect their ability to engage in adaptation activities (Kundzewicz et al., 2007; Nicholls et al., 2007).

In Ecuador, mangroves extend along the length of the coast in the provinces of Esmeraldas, Manabí, Guayas, El Oro, and the Galapagos Islands. They contribute innumerable ecosystem services to local populations and represent a critical part of the overall livelihood security of the coastal community (Walters, 2008). Mangrove forests are the most threatened coastal habitat in the world due, in part, to urbanization in the coastal zones and estuaries (Valiela et al., 2009). Human induced pressures exacerbate coastal climate change impacts and increase the risk to coastal communities and their natural ecosystems (Convention on Biological Diversity, 2003; Nicholls et al., 2007). Though global estimates of mangrove decline are at 30% or a loss of 1-3% per year (IPCC, 2007; Valiela, 2001), in Ecuador alarming rates of mangrove decline are as high as 80% due to aquaculture, agriculture, industrial and urban development (CLIRSEN, 1991; Macintosh & Ashton, 2003; Torres & Yepez, 1999 in Papuccio de Vidal, 2004).

Above and beyond the many threats from overexploitation, deforestation and diversion of freshwater for irrigation (UNEP, 1994), Primavera (1997) found that shrimp aquaculture accounts for 20% to 52% of mangrove loss worldwide making this industry the greatest (yet underreported) human threat to mangroves (Figure 9; McLeod & Salm, 2006; Valiela et al., 2001). In Ecuador, the region's history of significant environmental change in mangrove ecosystems greatly affects its natural ability to adapt to predicted climatic changes and has perhaps also masked local level knowledge of climate change (Chapter 3).

Figure 9 Shrimp ponds in Portovelo, Manabí, Ecuador

Latin America in general, is a region with an economy that depends heavily on natural resources and where poverty and inequality persist (Hoffman & Centeno, 2003 in Eakin & Lemos, 2010). This is significant because communities with high dependence on natural resources (such as mangrove and tropical forests) are particularly vulnerable to changes in the condition of the resource upon which they gain their livelihood (Pomeroy et al., 2006). Many of the issues on the coast are linked to indiscriminate deforestation and these rates in Ecuador are among the highest in Latin America, oscillating between 0.5% and 2.5% per year (UNFCCC Ecuador, 2000). Indeed, poverty affects over half of Ecuador's population (52%) and 20% live in extreme poverty (UNDP/UNPF, 2003). Poverty and inequality are indicators that have both direct and indirect links to vulnerability (Adger, 1999). This is pertinent to climate change because within socio-ecological systems, where individuals` ability to adapt is restricted there is an increased risk of intensified poverty and environmental degradation (Matthew et al., 2002). The concepts of adaptation and vulnerability are often referred to in climate change dialogue and social vulnerability encompasses both the disruption of livelihoods and loss of security, often linked to underlying economic and social situations (such as deforestation) (Adger, 1999). The concept of social vulnerability has been investigated extensively through the work of Adger et al. (2003, p.3) who found it:

> Important to develop our understanding of vulnerability by examining how it arises in a variety of contexts, paying attention to the relative importance of various social, economic, political, geographic and environmental factors in different countries, and also to the hazard-[31] specific nature of vulnerability

Importantly, factors that have constrained and contributed to peoples` past and present exposure and adaptive capacity are likely to similarly affect their future climate change responses (Ford et al., 2006). Similarly, Brklacich et al. (2007) found that the same processes which put one in harm´s way may also limit one´s options for avoiding these adverse outcomes. Understanding how the natural and human systems interact, is thus important to climate change adaptation in coastal communities. In a developing country (such as Ecuador) there is a high confidence that adaptation will be more challenging due to constraints on adaptive capacity; often the most important factor in human vulnerability hotspots (Nicholls, 2007). Social, economic, and political conditions in addition to associated social inequalities can produce an increase in vulnerability (Tiessen et al., 2007).

It is evident that "people of developing nations are not passive victims" (Adger et al., 2003, p. 181) and traditionally, people have innovatively adjusted to change and surprise by seeking alternative resources, new technologies, etc (Turner & Clifton, 2008). Historically, "the adaptive coping abilities of coastal, often rural, and often non-literate people have enabled their survival under stress" (Raynor & Malone, 1998, p.18) and adaptation is primarily a local process (Klein et al., 2007). Local people often have important ecological knowledge, unique experience and an understanding of their natural environment due to the traditional natural resource use which can contribute to climate change adaptation in various ways. For this reason, participatory methodologies and concepts were used during this research process; founded on the work and principles of Robert Chambers (1994a, 1994b, 1997, 2004), Paolo Freire (1968), David Crocker (1991), and Russel and Harshbarger (2003). The objective was to identify what matters to local communities in order to make climate information relevant, logical and easy to process. In general, there is a noteworthy lack of awareness, dissemination and training about the importance of climate change in Ecuador (Chapter 3; UNFCCC, 2001). Or, climate change can be incorporated into existing frames of reference as described by Stantley and Deanwood (2002)

[31] Hazard: physical manifestation of climatic variability of change such as drought, flood, storm, episode of heavy rainfall, etc (Brooks, 2003).

who described the use of extreme events as a 'window of opportunity' to illustrate and describe change.

The previous chapter illustrated how top-down climate scenarios, scientists and national institutes envisage Ecuador's climate future and layered this above local perceptions of environmental change and climate change. This paper aims to describe how government, communities and NGOs can collaborate to adapt to climate change and how this dialogue can use an 'entry point' as a hub on which to create a win-win scenario for stakeholders. Based on the predicted impacts from climate change on Ecuador's coastal communities (Chapter 3), broad ideas of adaptation and knowledge-sharing, this paper endeavours to describe the next logical step in tying the information together.

The research questions were:

1. What are the local perceptions of climate change in Ecuador's coastal communities?

2. What are the biophysical vulnerabilities of Ecuador's mangrove ecosystems and coastal communities to climate change according to various sources (global scientists, national institutions, government, national and regional organizations, and local people)?

3. How does the information from top-down sources and global predictions compare to local ecological knowledge and 'bottom-up' perspectives on change?

4. What role can the various sources (government, community) have in addressing vulnerability and contributing to climate change dialogue?

4.3 Methodology

Study Area Background

Ecuador has a territory of 256,370 km^2 marked by two highly differentiated rainfall seasons contributing to diverse physical, geographical and socioeconomic conditions. This small country is located on the Pacific coast of South America and 61% of the 13.8 million residents (Populations Reference Bureau, 2008) live within 100km of the coastline (Earthtrends, 2003). Two study areas were chosen for this research; Muisne in the province of Esmeraldas and Portovelo, Manabí (Figure 1). These coastal regions are exposed to high humidity and rainfall during the winter season (December to May) and drier temperatures during the summer. The two areas were purposively chosen due to their similar geographies (mangrove ecosystems),

high livelihood dependence on natural resources, small size, mixed culture and similar lifestyle and resource use practices which offer the opportunity for comparison and illustration of the diverse realities they face. The methodology was the same in Portovelo and Muisne and research was mainly conducted from May to August, 2009 whereas a return visit from June to July 2010 allowed the opportunity to discuss results and findings with the participants. The field season included semi-structured interviews, focus groups, and community 'Green Map' making.

Figure 1 Ecuador's provinces and the study sites (n.d.). Source: *Red de Centros Educativos*, redced-ec.relpe.org.

Portovelo, Manabí

Portovelo (80°22'6") was the initial community in which research was conducted from May 26th to July 4th, 2009 and June 2010. Portovelo is made up of approximately 150 families, including those who live in Puerto Portovelo, located one kilometre west (Figure 2). Portovelo is situated approximately 15 kilometres east of San Vicente, and across the *Rio Chone* estuary from Bahia de Caraquez. The community is nestled between the mangrove ecosystem and the *bosque seco tropical* (Tropical dry forest) on the inland, eastern and western sides. Of the working population in Portovelo, 90% are dedicated to fishing for their principal economic income, and as much as 30% also engage in agricultural activities during the winter months (U.E./PUCE-MANABÍ, 1999).

Figure 2 Portovelo, Manabí, Ecuador and surrounding area (2009). Source: GoogleEarth

Muisne, Esmeraldas

Muisne is a small island of 8km in length, 300m in width located on the western side of the northernmost coastal province of Esmeraldas (Figure 3). Research was conducted here in the three towns of Bellavista, Santa Rosa and Bunche from July 6th- August 10th, 2009 and a return visit in June 2010. The *Rio Muisne* estuary separates the 8000 inhabitants (INFOPLAN, 2001) from the mainland and is bordered mainly by mangrove forests and some sandy beaches with scattered palm trees. Many families not only participate in artisanal fishing for their subsistence, but also undertake agricultural activities in the *bosque húmedo tropical* (tropical forest). In fact, within the parish of Muisne, 50-60% of the economy relies on the products and species intricately linked to the mangrove ecosystems (CEGEL, 2008). The Red, black, white and botón or jelí mangroves are the dominant species in this region and most of Ecuador (FUNDECOL, 2000).

Bunche, Esmeraldas

Bellavista, Esmeraldas

Santa Rosa, Esmeraldas

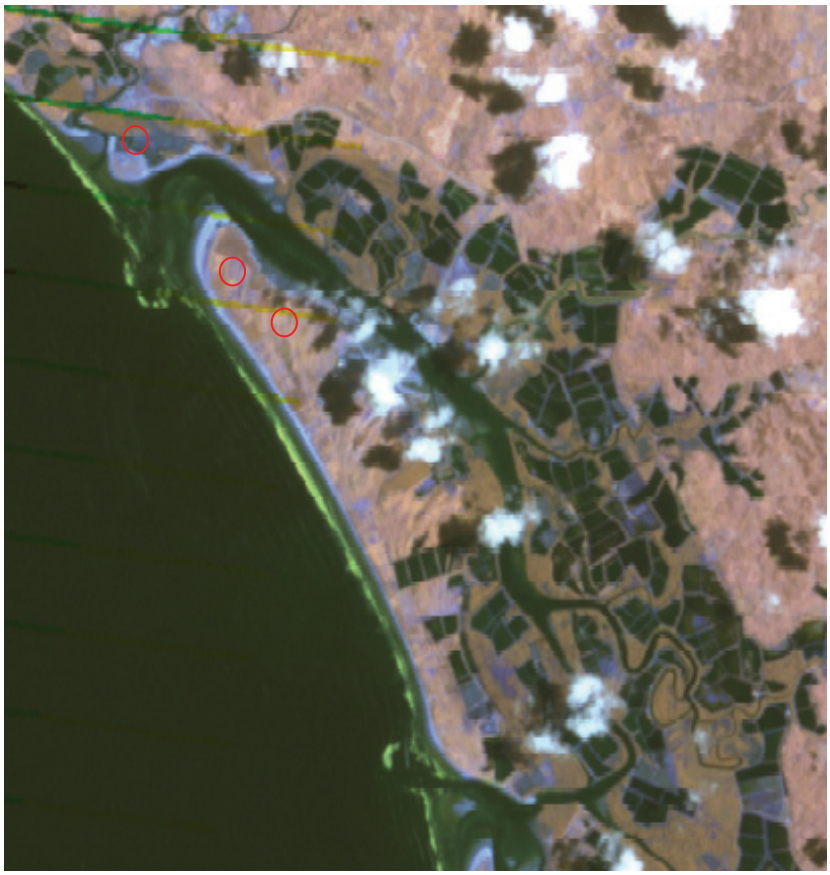

Figure 3 Island of Muisne, Esmeraldas (2008). Source: Landsat ETM, USGS.

Qualitative semi-structured interviews

During the 2009 field season (May-August), 18 qualitative, semi-structured interviews were conducted with members of Portovelo (N=6), Muisne (N=5), as well as non-governmental organizations FUNDECOL (N=3) and C-CONDEM (N=4). The participants were chosen through a mixture of purposive and convenience sampling (as informed by Patton, 1990; Sullivan, 2002) in order to gain an understanding of the environmental changes and biophysical impacts to mangrove ecosystems and the coastal zone; perceptions and awareness levels of climate change; water resources; and the management of resources. An exploration of these themes elucidated community[32] priorities and perceptions about environmental change, climate change and the local reality. Specifically, the interview explored what individuals know and understand

[32] It is important to recognize that that "community heterogeneity is the norm rather than the exception" (Kearney and Berkes, 2007). During this research, the PI was careful to adequately critique the geographical, political, and normative dimensions within the notion of community as well as how they embed into complex systems and global processes, as suggested by Kearney and Berkes, 2007. The PI was cognizant of the layered complexities that come from defining "community" and careful not to attribute this umbrella term inappropriately.

about climate change; how their natural ecosystems have responded and adapted to historical events (including flooding, deforestation, and sea level rise); the role of government and community in decreasing vulnerability; and the existing priorities and values with regard to the natural environment and its management. One set of objectives was to gather baseline information about the integrity of the natural environment, to summarize and document exposures and stresses, and assess vulnerabilities as perceived by local residents. Further aims were to explore the needs and challenges faced by the communities based on historical environmental change and to recognize how these have impacted them. This was done in an effort to elucidate options for adaptation and increasing resilience.

On average, the interviews with community members lasted 40 minutes; the shortest lasting 25 minutes and the longest 67 minutes. The 7 interviews with FUNDECOL and C-CONDEM lasted between 50 and 53 minutes and were conducted in their respective offices. All interviews were tape recorded, transcribed and analyzed in Spanish. Generally, interviews took place after the green mapping activity to ensure that the influence of the research questions did not influence the shared local ecological knowledge (LEK) and perceptions.

Community-mapping activity

The creation of community 'Green' Maps was an opportunity to delve deeper into the LEK contained in the study communities, and allowed the 117 participants to discuss their views on the region. In varying degrees of detail, the seven groups discussed ecological, social, economic and historical changes or points of interest in their community and neighbouring estuaries. In this case, the *Rio Chone* estuary and *Rio Muisne* estuary were prominently described. Base maps were retrieved from Google Earth, FUNDECOL, C-CONDEM, and the *Instituto Geográfico Militar*, and were used to display different visual images of the area and prompt reflection and discussion during the mapping activities. These resources were used by some participants to further understand their spatial area and complement their pre-existing viewpoint, and not by others who chose to either draw the area or write about it themselves. One of the tools provided was the list of universal Green map icons which allowed participants to concisely demonstrate areas of aquatic habitat, deforestation, school, important tree, contaminated site, etc. (complete list found in Appendix G).

Focus Groups

Four qualitative focus groups were conducted with 6-10 participants each (as informed by Marshall & Rossman, 2006; Morgan, 1998) and were generally comprised of individuals who were involved in an interview or mapping activities. However, in certain cases, when a participant was not able to partake in the previous activities, they were welcome to join the group. These rich discussions allowed the author to explore deeper into themes that emerged from mapping activities and interviews. Often, poems (*'amorfinos'*), anecdotes, stories, and songs were shared. The poem below is an example of an Ecuadorian *amorfino* shared during one focus group session during the 2009 field season.

En el centro de la mar	In the centre of the sea
suspiraba un camarón	A shrimp sighed
y en el suspiro decía:	and the sigh said:
"No te aflijas, corazón"	"Don't lament over it, heart"

Data Analysis

The data analysis from all sources took place in Spanish. Using qualitative analysis software, the transcribed interviews were coded in order to categorize and conceptualize the information into themes. Information from observation, interviews, literature review, focus groups and mapping activities were triangulated and cross-validated to ensure accuracy (as described by Bryman & Teevan, 2005). Each data source had specific characteristics that pertained to this research and applied to the research purpose and scope (Table 1).

Table 1 Summary of data sources for analysis of vulnerability and climate change in Ecuador

Data Source	Participants	Scope of research focus	Purpose
Qualitative semi-structured	Portovelo and Muisne Residents 11 interviews	o Selected through strategic purposive and convenience sampling. o Questions on historical changes and biophysical impacts to mangrove ecosystems and coastal zone, climate change, water and management of resources. Included Muisne (Bellavista, Santa Rosa) and Portovelo	o Gain an understanding of the local ecological knowledge, perceptions, realities, and priorities involving climate change
	Local NGO FUNDECOL staff 3 interviews	o Focus on county of Muisne where FUNDECOL is based. o Discover historical changes, work done within communities, issues faced, and key vulnerabilities. Influence of FUNDECOL in research community	o Comprehend the contributing factors to change and local vulnerabilities o Understand collaborative relationship
	National NGO C-CONDEM staff 4 interviews	o Focus mainly on Portovelo and Muisne but also other coastal communities in Ecuador. o Data on historical changes, work done within communities, organization goals and practices.	o Gain understanding of role within communities and broader scope of work at national and wider political level
Community Mapping Activity	7 groups 117 participants	o Creation of 14 visual maps in Santa Rosa, Bunche, Bellavista and Portovelo to represent social, environmental, economic, historical changes that have occurred. Compiled into 4 final maps.	o Share knowledge, gain understanding about context and issues, local priorities and values o Trust-building
Qualitative focus groups	4 sessions	o Qualitative questions on historical impacts, El Niño phenomenon, adaptations, mangrove ecosystem and estuaries. o Contributing factors to change and community perceptions and priorities. In Muisne (Bellavista (N=1), Bunche (N=1), Santa Rosa (N=1) and Portovelo (N=2)	o Expand upon information gained during interviews and mapping activities o Understand community dynamics within groups

4.4 Results

The interviews, focus groups and map-making activities involved discussions of biophysical changes witnessed over the last 10-50 years, how these have impacted participants' lives and culture, as well as their views on climate change and the management of their coastal resources. What emerged from this was that local knowledge about climate change was incomplete as compared to the way it is generally understood in other countries such as Canada. Perceptions of change were often centered on the shrimp industry and various external, non-human causes (see Chapter 3). The reason behind this, in part, has to do with a lack of information and dialogue between sources of information such as local, non-governmental organizations, government, academics, national and international institutes and scientists. However, this is not only a question of information provision, as most had indeed heard the term and concept but had not given it due attention. One component of this lacking emphasis on climate change may be due to the raw preoccupation with more pressing issues, many of which could fall under the umbrella of 'development issues':

> [W]hat the people talk about is the destruction. That the resources are diminishing. That they don't know why the hell when it should be hot it's cold; when it should be cold, it's hot. Now they don't know when to go fish... They say the world is becoming crazy. They've heard of global warming, climate change... but don't comprehend the subject… They are preoccupied with their things, what they can contain [control][33].

The above quote by C-CONDEM staff demonstrates how the coastal communities in question (and others in Ecuador) are not familiar with the climate change jargon or its implications; instead, they are more concerned with how to fulfill their immediate and everyday needs. Nevertheless, participants were cognisant of change and recognized its many facets. The link participants had to the natural environment was evident in all interviews, focus groups and mapping sessions where the LEK was shared. Both food security and water were continuously mentioned as concerns within each community, issues predicted to be negatively affected by and inextricably linked to future climate change impacts. Unfortunately, how climate change will impact people's everyday routines is not fully understood.

[33] "[*L*]*o que habla la gente es de destrucción. Que los recursos se están acabando. Que no saben por qué diablo que cuando debe hacer calor, hace frio. Que cuando hace frio, debe hacer calor. Que ya no saben cuando ir a pescar…dicen que el mundo se está volviendo loco... Lo oyen cuanto calentamiento global, cambio climático. Sino que ellos no manejen este tema. [preocupados por] lo de ellos. Como lo de ellos lo pueden contener digamos" (IQ-1, 2009)*.

Though the word 'sustainability' was seldom used, the concept trickled in during conversation throughout the field season. Comments included: "this house, this nature is rented[34]", or descriptions of ancestral users' rational use of their mangrove and tropical forests for thousands of years[35], and worry for future generations ("poverty levels felt by people who live from mangroves is going to be much harder in generations to come[36]"). Similarly, this long term view was described by Papuccio (2004) who found that communities in Muisne conserve many of their traditional cultural characteristics which include a self-sustaining relationship with nature. Mangroves are a source of myths, legends and stories as well as inspiration for songs, dances and poems in Ecuador (FUNDECOL, 2009). The losses of these cultural values in addition to biophysical and socioeconomic values contribute to several current issues and a preoccupation with future generations being more impacted and unable to meet their needs. For example, the lack of employment opportunities exacerbated by the destruction of the natural environment has resulted in the outmigration of youth to larger cities such as Quito, Santo Domingo or Guayaquil. For more information on outmigration in these communities and a dependence on informal and/or multiple jobs see work by C-CONDEM (2007). The people can no longer mimic traditional fishing lifestyles to the same degree because resources are so diminished and make their sustenance challenging. This is devastating to many who struggle with poverty and view mangrove ecosystems as "the unique inheritance we can leave for our kids"[37]. The socioeconomic situation of those living in mangrove regions is dire. Approximately 81.68% of the inhabitants lack basic needs, 89.07% lack basic services, 11.29% are illiterate and only 2% have access to medical care (C-CONDEM, 2007). In fact, the *Sistema Integrado de Indicadores Sociales* (SIISE v.4), which integrates socioeconomic statistics and indicators in Ecuador found that populations living within mangrove ecosystem zones are 20% poorer than the national average (C-CONDEM, 2007).

4.4.1 Food security

Fishing activities are the primary generators of income in Muisne, followed by agriculture, both of which are important to the local population and serve as principal food

[34] "*Esta casa, esta naturaleza eh, es arrendada" (IM-1, 2009).*
[35] *"Queremos recuperar nuestros territorios que han sido por miles y miles de años de nosotros, de la gente de las comunidades, de los usuarios de los Manglares, de la gente ancestral del manglar" (IM-1, 2009).*
[36] "*Los niveles de pobreza que vive la gente del manglar en este momento van a ser mucho más duros para las generaciones que vienen" (IQ-2, 2009).*

sources for many families. The species most frequently cultivated in agriculture are plantain, chontaduro, mandarin, papaya, pineapple, yucca, corn, rice, peanut and bean. Though agricultural tasks are undertaken mostly by men, women and their families participate by putting medicinal and aromatic species (garlic, onion, and ornamental plants) to good use (FUNDECOL, 2000). Pig and chicken are part of the local diet, though in smaller quantities than products obtained from the mangrove. All participants personally identified as children of *carboneros, concher@s,* and *pescadores* (wood charcoal makers, cockle gatherers, fishermen) and connected in some way to the mangrove forests. Many participants mentioned how fishing provided for their family: "what did I have to do? Throw myself into the sea to bring back food to my house"[38]; it is a skill intricately linked to their upbringing and learned from their parents and friends. Agriculture was similarly taught- primarily by the father and a machete- and contributes in combination with the artisanal fishing practices to meet livelihood needs.

The concepts of food security and *soberanía alimentaria* (food sovereignty) percolated through many of the interviews and focus groups; described in both obvious and subtle comments. Though the research focused initially on biophysical changes in the *Río Muisne* and *Río Chone* estuaries, it became immediately evident that the mangroves were inextricably linked to people's livelihoods, *cultura*, and social identity. Every participant expressed the need for mangroves and described many of their benefits from the resources (fish, crab, cockle, habitat, oxygen), to the protective barrier they provide along the coast; many went so far as to say "the mangroves are life". Studies show that within the parish of Muisne, 50-60% of the economy is linked to mangrove ecosystems (CEGEL, 2008 in Papuccio, 2004) and the productivity of mangrove ecosystems is calculated to be approximately 37 metric tonnes per hectare per year (CLIRSEN, 1991). For this reason, their livelihoods are inextricably linked to these forest systems hence the concept of food security and *soberanía alimentaria* was found to be a priority and worry in the communities and organizations. Discussion ensuing from the mapping activities pointed out this link to mangroves and their knowledge of the biophysical benefits (air, resources) and cultural benefits (myths, legends, traditions) they provide in Muisne and Portovelo.

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[37] *"La única herencia que podemos dejar para nuestros hijos" (IP-3, 2009)*.
[38] *"¿Qué tenía que hacer? Lanzarme al mar para traer alimento a mi casa" (IP-5, 2009)*.

> For the poor people, the mangrove offers some species that serve as the family's daily sustenance. They can go out, find some crabs, a few mangrove cockles, and if they have any fishing tools- better- because they can go out to fish in the estuary[39].

The demise of these mangroves was often linked to the very struggles they face in their lives and when the participants spoke of the environmental change witnessed in their lifetime they often focused blame on the shrimp industry that is largely responsible for the deforestation of mangroves in their surrounding estuary. For example, "As we lost the mangroves, we lost life, *cultura*, education and health[40]". According to a FUNDECOL staff and resident of Muisne, "it's been a criminal industry that without any, without any planning arrived in our towns and enriched few and impoverished more [many][41]. Research by CLIRSEN and C-CONDEM (C-CONDEM, 2007) demonstrates that 80-90% of the mangroves in Muisne and Portovelo were cleared between 1969 and 1999. The most recent data from Ecuador's National Institute for statistics and census (INEC) outlines that 1,028,581 people live within the mangrove ecosystem zone and that these ancestral populations are influenced by the shrimp aquaculture industry which affects their source of sustenance and culture (C-CONDEM, 2007). This was demonstrated as people spoke of the change in availability and prices of the native species they catch such as crabs; before they would give them away as gifts and now a single crab costs 1.00-1.50 USD which is expensive for many of these large families.

> In January, February the shrimp comes out from inside these river estuaries, from the estuaries and one goes there with his little canoe. One catches his 5, 10 pounds and they pay him his 5, 10 dollars and one takes it and defends his daily fare, right[42]?

The deforestation in these two ecosystems was mentioned in all interviews as a main source of change in both Muisne and Esmeraldas. In Portovelo, climate and rainfall inconsistencies are adding additional stress to their agricultural practices whereas in Muisne the monocultures were inhibiting the small-scale agriculture which feeds the local population.

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[39] "*Para las personas pobres, el manglar ofrece algunas especies que sirven para el sustento diario de la familia. Ellos pueden salir y encontrar algunos cangrejos, pocas conchas, y si tienen más herramientas de pesca mejor-porque pueden salir a pescar en el estuario" (IM-8, 2009).*

[40] "*A medida que se nos iba perdiendo el manglar se nos iba perdiendo la vida, la cultura, la educación, la salud" (IM-1, 2009).*

[41] *"Si porque ha sido una industria criminal que sin ningún, sin ninguna planificación llegó a nuestros pueblos y se enriquecieron pocos y se empobrecieron más" (IM-1, 2009)*.

[42] *"Enero y febrero, el camarón sale de adentro de los estuarios de los ríos, de los esteros y uno se va ahí con su canoíta, Uno se agarra sus cinco, diez librita ya le pagan sus cinco, diez dólar uno lleva ya defiende sus diario ¿ya?" (IM-5, 2009)*.

Through discussing the effects of monocultures on their agricultural lands, a government focus on planting African palm and eucalyptus, to the contamination of the water; the stresses felt were evident.

> For example now there's no plantain, right now here see there's a shortage of plantain because the majority of the, of the large lands that [could be used] to plant plantain- they've planted with African palm. So those are obstacles…the government needs to dedicate [themselves] instead to recuperating these lands that are... that they've [plantations]… invaded…and give back to whoever will plant yucca, vegetables...legumes[43].

The pressures on food systems in both mangrove and tropical forests are varied and affect local health while also contributing to economic stress in Muisne and Portovelo. Chronic malnutrition levels in children less than 5 years of age affects 45.46% and the township presents a poverty index of 74.36% (INFOPLAN, 2001). There was a need to "plant plantains, yucca, plant everything that are plants that will favour the "canasta" (food basket) of the home, the family, and the city[44]". All comments regarding environmental change demonstrated varying degrees of preoccupation about the diminished fish catches, contamination of the estuary, and clearly indicated a change that was affecting their way of life and ability to meet their needs.

4.4.2 Water

Estuarine Water quality

This shrimp aquaculture industry was often viewed as the main culprit for the vast deforestation and various changes witnessed in the *Rio Chone* and *Rio Muisne* estuaries. Among the worrying changes are: a decrease in fish quantities, and a poor water quality affecting human health. This occurs due to untreated effluents released into the estuary, leading to consequences to water quality (See also Stram et al., 2005). In Muisne and Portovelo, local residents complained of poor water quality causing skin rashes and infections on children who swam in the water or women who spent time digging for cockles. Additionally, fish kills and diminished quantities of shrimp, various fish, crab and cockles were also noted. One participant

[43] *"Por ejemplo ya no hay un verde como ahorita así ve nomás está escasez de verde porque la mayoría de las, de las tierras grandes que ha habido para sembrar verde las han sembrado de palma africana. Entonces esos son obstáculos. Nosotros tenemos que no así ya a la siembra de eso, de esos, de esas plantaciones y que el gobierno se dedique más bien a recuperar las tierras que sean… que han… invadido…sembrar lo que es verde, yuca, verduras..ósea legumbres" (IM-8, 2009)*.

[44] *"No más a la siembra de eucalipto, no más a la siembra de, de piñones ni de caña", sino que más bien a sembrar verde, a sembrar lo que es yuca sembrar todo lo que es ya le digo plantas que vayan a favorecer la canasta del hogar, de la familia y de la ciudad"(IM-8, 2009)*.

from Muisne summarized the need to fight "to avoid contamination of the waters because the shrimp farms, the palm oil and eucalyptus monocultures release chemicals which is affecting the health of fellow community members and the species in the mangroves"[45]. Interestingly, the integral mangrove ecosystem also serves as a barrier to contaminants by intercepting pollutants, nutrients, suspended sediments and preventing their arrival to deeper water (Valiela et al., 2001). Paradoxically, the shrimp aquaculture industry not only causes contamination due to their effluent, they also destroy the environment's natural cleansing and filtering capacity.

In Muisne, not only was there an active criticism of the shrimp farm contamination, but also clear dislike of the monocultures (African Palm and Eucalyptus) said to contribute heavily to the contamination problems being experienced. Furthermore, this was linked by some fishermen to the decrease in available fish species; they are now required to spend half to full days in order to catch what is now a fraction of historical catches and what used to be caught in a few hours. While echoed by many participants, one local from Muisne claims: "Before, the people caught 2000 *conchas* (cockles), 1000, and now they catch 50... [B]efore we would catch a canoe-full of fish and now we catch 2 pounds, 3 pounds or 4 pounds[46]". This decline was frequently linked to diminished mangrove integrity. In Portovelo, an additional factor was the landslide that occurred during the 1997-1998 El Niño phenomenon which caused the estuary depth to decrease drastically from 29m to 7 or 8m.

Drinking Water

Of all the changes witnessed and described during the interviews about the coastal and mangrove ecosystems, when asked "What is the most pressing necessity in your community?" the greater proportion of responses involved 'freshwater'. Though electric energy has been provided since 1989 on the island of Muisne, there is still a lack of suitable drinking water and wastewater treatment (INFOPLAN, 2001). In Portovelo, the basic services received are electricity, potable water services which arrive weekly for approximately a 24-hour period as well as a limited waste disposal program. Participants said: "potable water is not potable, it carries the name, but it's not guaranteed", "[water] is not apt for human consumption[47]",

[45] "*Por evitar la contaminación de las aguas porque las camaroneras, las palmiculturas y la eucalipteras botan demasiado químico que está afectando la salud de los compañeros y de las especies del manglar" (IM-4, 2009)*.
[46] "*Antes la gente cogía 2000 conchas, 1000, ahora cogen 50…Antes cogíamos una canoa de pescado ahora cogemos 2 libras, 3 libras o 4 libras" (IM-1, 2009)*.
[47] *"Una agua no apta para el consumo humano" (IM-1, 2009)*.

"we're missing water, a treated water[48]", and that they have had a "lifetime of problems with water"[49]. In spite of existing poverty, they must usually buy a container of water because the "other water is intolerable[50]". This was interesting because though the interview focused heavily on coastal zone changes and mangrove ecosystems which involve saltwater and estuaries, the pressing issues came down to the basic necessity of freshwater. Other comments included illness from parasites and future health and mosquito issues due to stagnant water in their tanks. This preoccupation with freshwater was distinct to many of the other coastal issues mentioned but is a basic necessity that must be met.

4.4.3 Role of government

In response to many of these difficult realities and environmental changes, the role of government and the management of coastal resources were explored in the final portion of the interview. Results showed that these unsatisfied basic needs were considered, in part, to be a failure by the government to listen to the people's needs and due to a disconnect between local and national priorities. The role of government to decrease vulnerabilities to climate change and respond to the aforementioned struggles in the study communities fell under the over-arching theme of SUPPORT. This theme encompassed 6 main elements (listed in decreasing frequency):

(a) Enforce laws and sanctions that already exist (to protect mangroves and thus their livelihoods)
(b) Act as an authority
(c) Transparent politics and lack of corruption
(d) Provide economic support to improve alternative livelihood options such as micro-business
(e) Reforestation initiatives and community tourism
(f) Education and capacity-building

Responses during the interviews and focus groups were fixed on the element of enforcement by the Ecuadorian government with regards to sanctions already present that protect the natural environment they depend on.

> The mangrove is a public good... but the mangroves have always been protected as our national goods that cannot be privatized; they are inalienable, indestructible, not seizable. Nevertheless, with impunity they've [shrimp aquaculture industry]

[48] *"Aquí nos falta el agua. Una agua tratada" (IM-8, 2009)*.
[49] *"Toda una vida hemos tenido problemas con el agua" (IP-3, 2009)*.
[50] *"A pesar de la pobreza existente se compra un bidón de agua porque esa agua no se pasa…" (IP-7, 2009).*

> abused. They put in the [shrimp] ponds, cut [mangroves], contaminated, and no one has said anything[51].

This speaks to the arrival of shrimp farms and their supposed lack of regulation. The authoritative role of government was said to be missing and disregarded in favour of corrupt exchanges between government and industry. There was a desire for *transparent politics* which would not only protect the mangroves, but consequently their dependent livelihoods. The struggle for many traditional mangrove users to meet their daily needs was evident and a recurring theme discussed during the research period. The lack of faith in government's honesty was fuelled the following opinion:

> I believe the role of the state [Ecuador], first should be clear politics. Second enter with true support for the people who live in the communities. Right? And that they don't come with support.. that makes them [communities] dependent like they have been until now. [Instead] support that permits them to form their own small micro businesses[52].

This 'true support' included a desire to be listened to and acknowledged in a way that takes into consideration their current needs and addresses the problems they face instead of constantly losing out to big industry or money. Several participants in Portovelo and Muisne declared that government should play a role in addressing these difficulties, and economic contributions were seen to be an option to supporting alternative livelihoods and the evident struggle for many ancestral mangrove users to meet their daily needs. For example, support to reforestation initiatives, community tourism, and micro-business initiatives were proposed as livelihood diversification options. A few participants offered examples of a desire for support that would enable them to purchase fishing tools (*Chinchorro* net) that would permit their cooperative to implement a rotational use and sharing of the net between community fishermen. Another fishermen's group in Muisne is working toward the creation of a central depot or collection centre whereby they could process their catches themselves and sell directly to the consumer. This would eliminate the intermediary and provide fairer prices in their opinion. Another participant suggested that the families dedicated to cockle-digging work

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[51] *"El Manglar es un bien de uso público…pero los manglares siempre estuvieron protegidos como bienes nacionales de nosotros que no pueden ser privatizados- Son inalienables, indestructibles, inembargables. Sin embargo, impunemente han abusado. Se pusieron las piscinas, talaron, contaminaron, y nadie ha dicho nada" (IQ-2, 2009).*

[52] *"Yo creo que el rol del estado, primero ser una política clara, segundo entrar con apoyo verdadero a la gente que viven en las comunidades ¿Si? y que no se vuelva con apoyo, no para que se vuelvan*

should be given another resource and told "'you're going to work in/at this'. And leave the mangroves so they can strengthen, for example the cockles can reproduce"[53]. In addressing resilience, we must consider potential alternatives to resource use and a diversification of livelihoods which can also be seen as a way to improve the resilience of both social and natural systems (Charles, 2004). For example, in Galapagos, Ecuador, a study from 1998-2000 found that key biodiversity marine areas, such as those including mangroves were worth over $2.7 million annually due to tourism compared to the $220,000 brought forth by local fishermen (Wilen et al., 2000). Thus, considering all of the possibilities (such as preservation with the goal of ecotourism or a new method in water conservation) as we approach an uncertain future will help communities adaptively manage their ecosystems. This is especially interesting in light of the work being done by the Ecuadorian government whose highest development priority in 2000 was the growing severity of poverty, affecting 75% of the country's population who lived below the poverty line (UNFCC Ecuador, 2000). According to FUNDECOL and C-CONDEM participants, one option includes a decentralized co-management system or stewardship program under an *Acuerdo de uso y custodia* (Custodial permit (*custodias)* as seen in Ocampo-Thomason, 2006). Currently, MAE has delivered 13 of these agreements to communities of traditional mangrove users which allocate mangrove areas for their traditional use and management (*El Ciudadano*, 2010). Both of the study sites are located in protected areas currently co-administered by MAE and traditional community users[54].

In both Portovelo and Muisne, part of government's role was said to be to disseminate the message on climate change, future natural disasters, and mangrove conservation to raise awareness in the communities. It is worth noting that a few participants attributed this role of awareness-building and education to the community itself in order to protect their natural environment and create a "chain of respect for the ecosystems"[55]. What was also mentioned by some participants in Muisne was the need to reach consensus with government, share information and LEK, and work together with local and central governments to decrease

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dependientes como son hasta ahora. Apoyo que permiten que ellos se vayan formando con sus propias pequeñas micro empresas" (IM-1, 2009).

[53] "*Para que esas familias que se dediquen a ese trabajo de la concha poderlos ubicar con un recurso y decir usted va a trabajar en esto. Y déjenme los manglares que ellos se fortalecen-por ejemplo vayan reproduciendo la concha" (IM-8, 2009).*

[54] *Plan de Manejo Refugio de Vida Silvestre Isla Corazón* e *Islas Fragatas*; *Plan de Manejo Refugio de Vida Silvestre del Sistema Muisne – Cojimíes*

vulnerabilities. This direct mention of collaboration offers hope that the relationship fraught with distrust can somehow be mended through future collaborative adaptation options; options that also address their pressing needs and priorities.

4.5 Discussion

The link between climate change and development

Many adverse effects are predicted for coastal regions due to climate change, sea-level rise, rainfall, etc (described in chapter 3). These communities live in the interface between the land and sea and have dealt with both environmental problems (deforestation, water pollution, salinization of estuary) and human problems (loss of land, access, decreased employment, impacts of degraded water quality); many of them interrelated.

Climate change may very well have a compounding effect on the socioeconomic and environmental issues being felt in Muisne and Portovelo. Livelihoods, poverty, mangrove ecosystem degradation and deforestation are all currently overshadowing discussions of climate change; a term and concept in its infancy within these study areas. Climate change can be viewed as both an environmental problem and a development problem (Ayers & Huq, 2009; Wardekker et al., 2009). Many underlying factors of vulnerability to climate change are 'low development' such as a high dependence on natural resources, resource degradation, an inability to secure basic needs, a lack of information or capacity (Sperling, 2003 in Klein et al., 2007). Hence, development assistance must be 'climate-resilient' and address the urgency of developing country adaptation (Ayers & Huq, 2009) and there is a need to tackle climatic and non-climatic conditions such as poor health, or rural unemployment (Tschakert, 2007). In fact, development problems and underlying causes of vulnerability should be dealt with simultaneously as climate change will exacerbate these (Schipper & Pelling, 2006).

Though coastal communities face pressures from sea-level rise, storm-surges, and ocean temperature fluctuations (IPCC, 2007), freshwater availability and quality was often viewed as most important at the community level; a pressing issue due to inadequacies in current quality and quantity. This is worrisome when looking at global projections since research suggests water availability and quality will be a main pressure on societies and the environment in the face of climate change (Bates et al., 2007). Inland (projected precipitation variability) and marine

[55] *"La comunidad también tiene que hacer su parte ¿no? entonces vamos haciendo una cadena de respeto*

sources (sea-level increases and salt water intrusion) as well as temperature increases will affect freshwater systems (Kundzewicz et al., 2007). In Ecuador, much of the southern and central Ecuadorian coasts have already dealt with severe water stress (Alcamo & Henrichs, 2002). There is an interesting interplay between coastal communities who are surrounded by estuaries and saltwater and depend on, live, and work in these systems daily, yet are preoccupied with freshwater. Quite simply, climate change may pose a risk to many of the development goals and deliverables such as water supply and food security.

Results by Perez (n.d.) also demonstrate how immediate concerns such as poverty reduction, economic security and general environmental degradation may mask the issue of climate change in most developing countries. This shadowing of climate change by everyday anxieties may restrict adaptation opportunities if not addressed correctly, or conversely, can act as segue into adaptation that addresses both climate change and the 'development issue' in question. Climate change thus remains a "creeping environmental problem" (p. 34) due to action being delayed by factors such as the time lags in climate and social systems, the disproportionately small effects felt by power elites, and the overshadowing of global warming by other problems (Moser & Dilling, 2004). This is especially pertinent in a place where the actual contribution to global warming is so minimal. The concept of 'development issues' and climate change thus merit further consideration.

> Climate change is inextricably linked to other issues such as poverty and threatens to reverse western-led efforts on human development in the poor world. There is no point in ignoring climate change and tackling other issues first such as poverty or malnutrition, as advocated by *rationalism*, if climate change will destroy all that progress and economic growth will leave the environment incapable of recovery (Doulton & Brown, 2009, p. 195).

The recognition of climate change issues often relate to their 'fit' with current institutional processes and programs and are often slotted into existing agendas (Stantley & Deanwood, 2002). Indeed, "the debate about climate change is often a surrogate for broader, so-far intractable political discourse about populations, lifestyles and international development" (Raynor & Malone, 1998, p.12). Sometimes, these agendas do not consider climate change to be a priority though it stands to affect the future. Indeed, policies should facilitate this adjustment by linking adaptation programs and development policy. Perhaps dealing with both may not require distinct measures.

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al, a los ecosistemas" (IM-1, 2009).

4.5.1 Role of Government

Looking forward in the face of development initiatives, climate change adaptation policies, and global education through media, we must look at government's role (such as Ecuador's Ministry of the Environment) and how it can complement the community priorities and realities described during this research. The results from this study demonstrate that local populations have several ideas for how government can best support them in the face of overwhelming environmental change and impending climate change. This theme of 'Support' was demonstrated through the description of six key components: (a) enforcement of existing laws and sanctions (b) act as an authority; (c) transparent politics and lack of corruption; (d) provide economic support to improve alternative livelihood options; (e) reforestation initiatives and community tourism; (f) education and capacity-building.

Theoretically, in Ecuador there are strict penalties and fines of 7000 USD per hectare and an obligation to replant deforested areas if mangroves are felled, but enforcement is lacking (Macintosh & Ashton, 2003). Participants also remarked that these laws were not followed and that there was a marked lack of authority and enforcement of the existing laws; including the 55 dispositions related to mangrove conservation in these areas. Additional research in Ecuador shows that over the last four decades, the loss of 70% of mangroves (254,503 hectares of 362,803 hectares) is attributed mainly to unrestrained shrimp aquaculture development and ineffective governance and management (Bodero & Robadue, 1998; C-CONDEM, 2007; Ocampo-Thomason, 2006). In 2001, the *Camara* Nacional de Acuacultura concluded that only 25% of shrimp farms were legal and the other 75% lacked government agreement (C-CONDEM, 2007). Another negative component to shrimp farms is their short lifespan (Gujja & Finger-Stich, 1996 in Rönnbäck, 1999), with 70% of ponds abandoned after a period of production (Stevenson, 1997 in McLeod & Salm, 2006). Furthermore, the socioeconomic benefits are incurred by only a narrow segment of the population. The shrimp ponds employ a mere 0.6% of locals, whereas 85% of households in Northern Esmeraldas depend on fishing and cockle gathering as their most important economic activity (Ocampo-Thomason, 2006). For example, during low tide local collectors flock to the mangrove forests for 3-4 hours to collect 50-100 cockles- down from historic numbers of 500 (FUNDECOL, 1998). Obviously, fisheries activities and their provision of food and income have an importance that cannot be overstated (Rönnbäck, 1999). However, risks are already apparent in the fisheries which support livelihoods in rural, developing country populations (Adger et al., 2003). The resulting need for alternative employment support

described during this research is echoed in Salas et al. (2007) who found this need in fishing-dependent areas to be frequently noted but less often addressed in policy measures. However, government involvement is no simple matter, and some research suggests that management runs deeper than simply formulating, enforcing and monitoring regulations and must instead challenge power relationships, and underlying economic interests (Armitage, 2002). Climate change may very well have a compounding effect on some of the intersecting pressures of over-harvesting and pollution, though it is difficult to separate many of the issues.

4.5.2 Government communications strategy

Currently, the *Subsecretarĺa de cambio climático* (SCC) in the Ministry of the Environment (MAE) has initiated the formulation of a 4-year communication plan to be completed in the fall of 2010. Their focus on Article 6 of the UNFCCC (Education, Training and Public Awareness) falls at an appropriate time as climate change is increasingly taking centre stage in Ecuador's media. In the research communities, information about climate change was still scarce, leading to misinformation and the confusion of weather and climate, as described in Chapter 3. As the MAE develops its communication plan, they should consider how various institutes, organizations and groups can supply pertinent information to enable them to garner appropriate conclusions about vulnerabilities to climate change and potential adaptation (Chapter 3). It becomes a question of communicating public information campaigns through shared frames of reference and opportunities created for shared action instead of focusing on overcoming so-called knowledge deficiencies (Raynor & Malone, 1998). Historically, the public adaptation process has shown a failure of communication between different disciplines (Grothmann & Patt, 2005). The number of sources received and the type of information influence belief (Patt & Schröeter, 2008) therefore, one must consider public perception of climate, biases and the strong influence of public expectations in order to achieve the effective transfer of scientific information (Rebetez, 1996).

Humans, from lay people to scientists, base their reactions to climate change on their own experience and local knowledge influences people's actions, decisions, and adaptive measures taken over the short and long term (Berkes and Jolly, 2001; Rebetez, 1996). As described by Dessai (2004, p17), when describing risk to dangerous climate change, you need to ask people what matters to them in order to then determine how climate change will affect these matters. Perhaps then, this offers an opening to commence the planned climate change

education by linking it to the poignant effects experienced due to the 1997-1998 El Niño phenomenon or the shrimp aquaculture industry which remains fresh in collective community memory (see Chapter 3 for more information). Furthermore, incorporating vulnerability reduction and adaptation strategies which consider the local priorities around food security and water should thus be a priority. In fact, both cultural factors and knowledge (including local contexts and perceptions) should form the basis of policy design and implementation (Tucker et al., 2010). Therefore, analyzing public perceptions and views on climate change and the need to adapt is important in assessing coastal adaptation options and determining a country's adaptive capacity (Klein et al., 1999).

In the case of Ecuador's two coastal communities, it seems that the loss of mangroves and water supply problems are both long term problems (historically and in the future) as well as immediate concerns due to their influence on food (fish) availability and health. There is a sense that these enduring problems were created by deforestation yet continue to pressure their livelihoods due, in part, to a lack of support from the government. When designing adaptation assistance, it should be tailored to address local vulnerabilities to create buy-in and interest; after all, capacity-building aimed at decreasing future vulnerabilities will likely also decrease current climate risks (Adger, 2003). Implementing adaptation policies require the involvement and engagement of local population from the beginning (Patt & Schröeter, 2008). Another way to promote behavioural change is to identify the leverage points which will convert perceptions into action (Dessai et al., 2004). What does not easily change farmer's perceptions is simply supplying climate change and climate risk information (Patt & Schröeter, 2008) and one must therefore find pertinent entry points as a foundation to begin discussion. Indeed, communicating risk from climate change needs to be done in conjunction with feasible adaptation options if we are to avoid people's reaction of denial or other avoidant, maladaptive responses (Grothmann & Patt, 2005). These same authors found that people underestimating their own ability to adapt creates a more significant 'bottleneck' for adaptation than objective physical, institutional, and economic constraints. In the case of Ecuador, adapting to climate change impacts locally and nationally requires entry points which address climate change education that aligns with MAE SCC goals and objectives while at the same time acknowledges and responds to local priorities and needs. After all, "adaptive measures that respond to existing local needs, contribute to other development goals, and can be locally driven, are among the most likely to succeed" (McGranahan et al., 2007, p.21). According to Adger (2003), adaptation

assistance should be tailored to address local vulnerabilities to create buy-in and interest; after all, capacity-building aimed at decreasing future vulnerabilities will likely also decrease current climate risks.

Actions such as communicating climate change information, maintaining well-being and building awareness of potential impacts all act to build adaptive capacity (Adger et al., 2004). Furthermore, investing in education and outreach can bring about changes in behaviour and attitude, help communities make informed decisions about the use of mangrove resources, and may increase political will for conservation and sustainable management (Gilman et al., 2008). This concept of collaboration and knowledge exchange to encounter solutions to vulnerabilities was echoed by FUNDECOL staff and Muisne residents[56] who stated that there is an opportunity to jointly look at the problem, discuss solutions with the municipality and arrive at a consensus with the local government. This is based on the great strength that they have locally in knowing and living the environmental problems and being able to transmit that. There is currently a lack of faith in how the government responds to the people's needs which could be addressed through the acknowledgement of community priorities and perceptions with regards to environmental change. For example, there may be discrepancies between the risks identified by scientific research and modeling versus those perceived as most important by communities such as Portovelo or Muisne. Importantly, these perceptions may still affect the behaviour of local people. People's local values and beliefs have a role to play in responses to climate change as they affect behaviour (Turner & Clifton, 2009) and personal income, crime reduction and education are a cause of greater concern (Lowe et al., 2006). If adaptation practices are to be adequately implemented and supported at the local level, perhaps collaboration and knowledge-sharing from different levels (not only top-down) is required. Discovering what these needs are involves the use of participatory tools.

Green Mapping as an information-sharing mechanism

Community mapping (Green mapping) was not only a methodological tool used during this research, but could also be used as a way to create relationships, mend distrust and exchange knowledge between communities, organizations and government. The maps create a visual image of the information that is viewed as important by local people and are a tool to break language and discipline barriers. While the importance of verbal communication must not

be emphasized (Kerber & Smith, 1972, as cited in Fife, 2005), "words are a starting point" (Chambers, 2004, p.8). Visual media, on the other hand, can help overcome the barrier of miscommunication through the provision of a common language (Burch et al., 2009). Visualization and emotional involvement can serve to further climate change understanding and lead to behavioural change and action in a way that is different from only cognitive engagement (Burch et al., 2009; O'Neill & Hulme, 2009). Risk mapping, for example, can be an elaborative and comprehensive way to assess dangers and trends and recognize significant threats that can be discussed in the context of adaptation (van Aalst et al., 2008). When discussing environmental change, this can also act as a conduit for further conversation about climate change, including local perceptions of various scenarios based on stakeholders' LEK of the area. Through active participation in the process, the local's experience and knowledge is further validated and emphasized. Indeed, engaging people in the mapping process and purpose from the beginning cultivates ownership and decision-making power and allows participants to reveal their different perceptions of a problem or situation (Shah, 2000). Importantly, empowerment comes from participatory method when the process is generated by the local people (Chambers, 1994).

According to Senge et al. (2008) what holds the greatest promise for systemic change are three capabilities: seeing systems, collaborating across boundaries, and creating desired futures. This can be related to the idea of mapping in that it allows for the sharing of one's perceptions and values; describes how they see the whole system they are contained within; it can serve as a tool which demonstrates collaboration opportunities between individuals and different groups (e.g. government and local groups); and can also be used as an entry point upon which desired futures and win-win solutions can be found. Since sustainability issues cut across all arbitrary boundaries (Senge et al., 2008); we must look to new methods (such as community Green Mapping?) and interdisciplinary means for solutions. During the return field season in 2010, the completed maps were returned to the communities, C-CONDEM, FUNDECOL, and the MAE SCC. Interestingly, MAE SCC showed a keen interest in these maps and requested both paper and digital copies, the methodology used, and results in hopes of using similar tools in the future to address their objectives in their national climate change education and awareness communication plan.

[56] (IM-4, IM-6, IM-8, 2009)

4.5.3 Entry points

Perhaps what is needed is a "declaration on integrating climate change adaptation into development co-operation" which would raise awareness on climate change, identify appropriate entry points for integration and assist developing countries in integrating climate change into adaptation (Klein et al., 2007, p. 37). Encountering 'win-win' or 'no regrets' options to address vulnerability to climate change and development needs are desired. As Kelly et al. (1994, p.50) describes:

> A precautionary approach to climate impact mitigation and adaptation must involve identifying "win-win" situations in which action to reduce future risk also minimizes vulnerability in the present day: to climate change, to other environmental problems, or to social and economic threats.

The mangrove is a natural resource which has tremendous social and ecological value (McLeod & Salm, 2006) and was a critical part of life according to locals from Muisne and Portovelo. Mangrove ecosystems serve as habitat and nursery habitat for countless migratory birds, crustaceans, reptiles, small mammals, insects, molluscs, microorganisms and marine creatures (Gilman et al., 2008; McLeod and Salm, 2006) and offer multiple ecosystem services that benefit coastal communities (Walters et al., 2008). Since these mangroves were demonstrated to be so linked to livelihoods and culture, it appears that collaborating around these forest systems would be a key entry point that addresses the aforementioned local priorities while also overlapping with organizational and national interests. For example, according to the Ecuadorian Environmental Plan and the Environmental Strategy for Sustainable Development[57], noteworthy specific concerns along the coast are natural disasters and fragile ecosystems such as mangrove ecosystems (Cáceres, 2001). However, according to C-CONDEM staff,

> There's not a single consciousness of this, if you listen to journalists, nor politicians present the theme of a restoration of the ecosystems to face or at least detain climate change… it's possible to reforest with native plants… it's possible to face all of this with a change of conduct ecologically-speaking… it's possible to commit ourselves to leaving a planet with life for our children[58]

[57] *La Estrategia Ambiental para el Desarrollo Sostenible del Ecuador*

[58] *"O sea no hay ninguna conciencia de eso si tu escuchas ni periodistas, ni políticos plantean el tema de una restauración de los ecosistemas como para enfrentar o al menos detener el cambio climático… es posible reforestar con plantas nativas de que es posible enfrentar todo esto con un cambio de conducta en el tema ecológico…Es posible comprometerse a dejar un planeta con vida a nuestros hijos e hijas" (IQ-2, 2009).*

The concept of entry points includes a perspective that reconciles local priorities and preoccupations (taking into account mistrust in and expectations of government), top-down adaptation options, and vulnerabilities to climate change. To gain a complete picture, one must acknowledge the locally embedded realities and constraints that affect community responses to climate change (Moser, 2000, 2005 in Nicholls, 2007). In fact, addressing many non-climate factors may in fact more effectively and comprehensively reduce vulnerability than implementing a new technology (Klein et al., 2007). In the case of Muisne and Portovelo, results show that many of the predicted impacts of climate change involve the coastal zone and mangrove ecosystems; which can conversely play a role in preventing certain adverse effects (storm surge and sea level rise impacts). Unfortunately, though the surrounding mangrove ecosystem and tropical forests play a critical role in fulfilling local needs and livelihoods, the vast devastation of both these forests has caused various social, cultural and ecological issues.

Mangrove Restoration

Biophysically-speaking, the preservation of these natural ecosystems can serve to mitigate climate change (Trumper et al., 2009). One of the most pertinent adaptation options to improve the resilience and resistance of mangroves in coastal regions is the "no regrets" management and reduction of biophysical stresses described by Gilman et al. (2008, p. 243). This includes the elimination of non-climatic stresses on mangroves which augments overall ecosystem health, reduces vulnerability and increases resilience to stresses irrespective of climate change (Gilman et al., 2008). Raynor and Malone (1998) also promoted this no-regrets strategy to enhance sustainability and provide strong imperatives that, with or without climate change, help prevent or adapt to climate change. Obviously, these ecosystems provide an opportunity to 'multi-task'; offering a solution that helps replenish fish species through the provision of habitat and greater ecosystem integrity; filter water and improve its quality; etc. Historically, water quality problems have existed since 1986 due to a lack of enforcement of water quality regulations, an increase in pollutants from shrimp farms and agricultural pesticides, improper and insufficient collection of water quality information, and a lack of sanitation facilities among other things (Montaño & Robadue, 1995). Mangroves can play a key role in improving water quality and removing pollutants from the shrimp pond effluent which is rich in suspended solids, nutrients and organic compounds. For example, Primavera et al. (2007) calculated that 1.8-5.4 hectares of mangroves are required to remove nitrate wastes from one

hectare of shrimp pond. Further management options have been suggested by Gauthier et al. (2001) among many others.

Economic models used by N.H. Tri et al. (1998, p. 58) demonstrate that mangrove rehabilitation is "desirable from an economic perspective based solely on the direct benefits of use by local communities", which does not even account for the physical protection against storms, among other things. A key function here is mangrove's ability to improve water quality and maintain levels through the assimilation of sediment and nutrients, stabilization of coastal land, trapping (Walters, 2008). In short, mangrove rehabilitation enhances habitat and offsets anticipated losses from climate change (Gilman et al., 2008). Restoration of abandoned shrimp farms should thus be evaluated as an adaptation option as it can help maintain sustainable livelihoods for local communities. In Northern Ecuador, restoring mangroves is also recommended specifically as a response to erosion (Federici & Rodolfi, 2001).

The results of this research demonstrate that mangrove restoration may indeed be critical in decreasing both biophysical and socioeconomic vulnerabilities to climate change. In the last decade, communities such as Muisne and Portovelo have collaborated with national NGOs (C-CONDEM), regional NGOs (FUNDECOL), and government (PMRC) to initiate reforestation programs in an effort to restore the mangrove ecosystem to support their livelihood needs. In Ecuador, over 500 hectares have been reforested by communities in the provinces of El Oro, Manabí, Esmeraldas, and Guayas (C-CONDEM, 2007, 2009). Propelled by important capacity-building from C-CONDEM and FUNDECOL in proper reforestation methods, communities have enjoyed growing success rates; especially when using proper techniques (as in Kaly & Jones, 1998).

If the government is to address some of the preoccupations voiced by the research participants (livelihood diversification support and reforestation support), they should note that the perceived benefits of mangroves influence community participation in such activities (Stone et al., 2008). For example, household benefit, community welfare, or even possible altruistic motivations were found to encourage involvement in reforestation programs (Stone et al., 2008). In fact, according to some, funding appears to be of secondary importance to mangrove rehabilitation success when compared to site and species selection, community involvement and commitment, etc. (Primavera & Esteban, 2008). Due to these various factors, mangrove restoration may indeed help increase the adaptive capacity of Ecuador's coastal communities by

addressing the very issues that currently preoccupy them and obfuscate climate change dialogue. The adaptive capacity is often limited by a lack of resources (Smith et al., 2003 in Klein et al., 2007) and can thus be enhanced by improving the living conditions and access to resources of those experiencing climate change impacts (Klein, et al., 2007). Adaptive capacity can also be enhanced by shared knowledge and lessons learned from previous climatic stresses which can be vital entry points for social learning. The idea is to increase security and resilience to existing shocks in order to develop flexibility and a buffer against future climate change consequences (Schipper & Pelling, 2006). Collaborating around reforestation projects thus meets government objectives as well as community priorities. Recently, with Ecuador's new constitution, the national government emitted decree 1391 in an effort to regulate the shrimp industry and ensure they comply with the norms and regularization of the *Subsecretaría* of Aquaculture. The Ministry of the Environment is now in the second phase, offering environmental licenses and determining the percentage of land that they must replant[59]. This creates opportunities for vacant areas to be offered to communities and organizations for reforestation. This is especially pertinent in these two areas due to the evident and critical importance of mangrove ecosystems to their culture and livelihoods through the provision of food. Examples to draw from include the Green Coasts community based coastal restoration project. This project is a collaboration between IUCN, WWF, Wetlands International and Both Ends to effectively rehabilitate coastal nature through mangrove restoration in order to improve the resilience of coastal communities to climate change. Their recommendations coincide with the results of this research and include both a wide, global application of Green Coasts and its inclusion in climate change adaptation strategies.

4.5.4 Knowledge barriers and further considerations

Patt and Shcröeter (2008) support the incorporation of participatory risk appraisal and response in a way that includes people in the conversation and allows them to participate in the design of response strategies: telling them and ordering certain responses does not work. Insufficient locally and personally relevant, accessible information as well as a lack of knowledge around the issue were the significant barriers in Ecuador (as seen in O'Neill & Hulme, 2009).

[59] Those who illegally cut mangroves in defiance of the law prohibiting the felling of mangroves (1999) after its commencement will be ousted from the area. Those who deforested before 1999 must obey the limit they began with and are obligated to hand over the area for reforestation if the area was magnified.

Furthermore, the information is sometimes irrelevant or inaccessible to individuals (Moser & Dilling, 2007). This is a problem since incorrect or misunderstood information may be worse than no information. According to O'Neill and Hulme (2009), an adequate understanding of climate change, motivation and an ability to take action are key to meaningful engagement in individuals. Work by O'Neill and Hulme (2009) merits consideration for future communication strategies as they used an iconic approach for representing climate change and found that participants needed to connect in a knowable spatial dimension, an imaginable timescale and preferred non-technical language. Their case involved polar bears as icons, but the work in coastal Ecuador might involve the mangrove tree, or one of the key species deemed important at the local level. Placing climate change information in a local context which can be internalized and understood during local people's lifetime and in vocabulary that considers their literacy and interests are therefore some of the implications. The information needs to be relevant to people and describe how it will affect them and their livelihoods. One way to achieve this is though mapping.

Furthermore, cultural awareness is an important element in transnational communication (Raynor & Malone, p. 51). The persistent mode of understanding climate change and 'communication-as-transmission' is one in which knowledge is generated by scientists and transmitted to the public (cf. Lubechenco 1998 p. 491 in Burch et al., 2009). Historically, the assumption that lay people and the public were ignorant led to the provision of simplistic information and led to misconceptions about the causes and consequences of climate change (various in Lowe et al., 2006). If experts underestimate or overestimate the public's knowledge, it can lead to controversies in risk communication; they should thus assess the current level of knowledge and which information is critical to their decisions (Bostrom et al., 1994). Accounting for the public's diverse literacy levels requires the use of various mechanisms to enable a proper understanding of the message; including an output in the language of those impacted by research (Tiessen et al., 2007, p. 52). Pertinent information on language and knowledge-creation can be found in Gibbs (2001), Beckers et al. (2007), Fife (2005), and Chambers (2004).

4.6 Conclusion

The stresses from both marine and inland sources contribute to coastal community vulnerability and may be compounded by climate change thus increasing present vulnerabilities. Though the focus was on biophysical impacts to mangrove ecosystems, the interplay between these and socio-ecological systems were inevitable Preoccupation with food security, freshwater needs and estuarine water quality, as well as the long-standing effects of the shrimp farm industry on mangrove ecosystems were among the emerging themes. Attached to this, there was a resonating request for 'support' from the Ecuadorian government in addressing these vulnerabilities and protecting their natural ecosystems and way of life which is so inextricably linked to the mangrove. While climate change and its associated vocabulary were largely overshadowed by more pressing daily concerns, these very same issues may conversely exacerbate climate change impacts. By gaining an understanding of community priorities through collaborative dialogue and tools such as community Green Mapping, there is opportunity to discover entry points and win-win adaptation options which address multiple needs (government, NGO, community). For example, collaborating around a central adaptation option such as mangrove reforestation is relevant to communities, meets the Ministry of the Environment's Climate Change Division objectives, and can be facilitated by NGOs such as FUNDECOL and C-CONDEM who have experience with such processes. Research shows that there are many considerations to address when dealing with climate change education, adaptation options and community priorities but finding entry points on which to collaborate may yield more accepted results.

4.7 References

To avoid redundancy, the references for this paper are included in the reference section at the end of the thesis.

CHAPTER 5 DISCUSSION

5.1 Main Findings

This discussion section will describe the main and secondary findings of this research by returning to the four key research questions described in the introduction.

5.1.1 Climate Change in Ecuador: what is happening?

(1) What are the biophysical vulnerabilities of Ecuador's mangrove ecosystem and coastal zones?

The projected impacts from human-induced climate change will likely exacerbate community and ecosystem vulnerability in Ecuador's coastal communities due to various factors. Coastal communities are inherently exposed to natural hazards and face pressures from both inland and marine stresses which may help or hinder their vulnerability and ability to adapt to climate change. The main historical changes to the natural environment in these communities include vast destruction and deforestation of mangrove ecosystems for the shrimp farm industry, significant effects from the El Niño phenomenon, and pressures to surrounding tropical forests due to monocultures. The combinations of these factors, along with additional socio-economic stressors have affected the coastal systems and the native mangrove users' way of life. Throughout this research process, the objective was to gauge awareness levels around climate change in rural, coastal Ecuadorian communities and more fully understand the many facets that come into play around these perceptions of environmental change. Though the initial focus was biophysical changes, the socioeconomic elements of life in Portovelo and Muisne emerged as priorities for the participants which could not be overlooked.

The past and present conditions of poverty and marginalization, illiteracy, inadequate infrastructure and poor basic services (water) render these communities less able to adapt to changing environmental conditions. Themes of food security, sustainability, and poverty are linked to climatic conditions and the communities' high dependence on the degraded mangrove ecosystem is an exacerbating pressure. In Muisne, 50-60% of the economy relies on products and species intricately linked to mangrove ecosystems whereas in Portovelo approximately 90% of the working population are dedicated to fishing for their primary economic income and traditional lifestyle (CEGEL, 2008; U.E./PUCE-MANABÍ, 1999). Mangrove ecosystems are not only

critical to local livelihoods but also offer various ecosystem services which stand to be affected by the predicted impacts of climate change. Changes to the conditions of the natural resources upon which communities highly depend will add particular vulnerability to their livelihoods (Pomeroy et al., 2006). These are important considerations for Ecuador's coastal communities.

5.1.2 *"El Clima está Loco":* Local understanding of climate change

(2) What are the local perceptions of climate change in Ecuador's coastal communities?

Results show that climate change and its associated vocabulary were not fully understood at the local level. People tended to (1) have little or no knowledge of climate change or global warming, (2) confuse global warming or climate change with weather or other processes (ozone depletion), or (3) relate it to external forces outside of their control. For example, most participants were unable to describe climate change or global warming but many had at least heard the term or vaguely understood the concept. Staff from C-CONDEM and FUNDECOL had greater awareness of climate change and related its impacts to the mangrove ecosystems and coastal communities. When participants elaborated and gave examples, they often spoke of short term temperature fluctuations or a very hot day and related it to climate change or global warming. Often, these single cases of local weather are used to make inferences about global climate leading to people's confusion of weather with climate (Bostrom et al., 1994; Byg & Salick, 2009; Read et al., 1994; Moser & Dilling, 2004). Another example of this incomplete understanding was evidenced by one participant's description of 'ozone layer melting' which conflates ozone depletion and global warming; results from various studies demonstrate this association (Dunlap, 1998; Kempton 1991 in Bostrom et al., 1994). Finally, participants also described change as God's will, the climate being crazy, or mother nature demonstrating her displeasure; a warning. Similarly, studies have found that these changes were attributed by local communities to acts of God or unhappy ancestors (Conrad et al., forthcoming; Moser & Dilling, 2004; Patt & Schröeter, 2008). Indeed, according to C-CONDEM staff, "as a theme, global warming as a word, the people don't [adopt/use] yet. However, there's a preoccupation with what's happening...with the changes". Though the people do not fully understand the scientific vocabulary and concepts around climate change and global warming, they are noticing, and worried about the changes they have witnessed.

There are various reasons why the community level lacks awareness about climate change including lack of information, overshadowing of climate change by other factors, drastically altered ecosystems.

First, there is simply a lack of information provided to the communities (ex. by popular media) and several participants commented on education and capacity-building being a desired component for decreasing vulnerability in Muisne and Portovelo; they stated the need for an increase in consciousness in the communities. However, research on farmers in Mozambique found that simply supplying climate change and climate risk information does not easily change their perceptions of climate risk (Patt & Schröeter, 2008). Humans tend to base their reactions to climate change on their own experience and tangible signs of climate change (Rebetez, 1996). For this reason, climate change education must be a flexible and locality-specific endeavour for it to be relevant to their understanding of change.

Secondly, when participants conversed about historical change to their natural environment, they spoke from their own experience and shared their local ecological knowledge (LEK). The destruction from the shrimp farm industry plays a predominant role in their LEK of the area and the industry was often referred to as the culprit for the changes which have occurred: "it's been a criminal industry that without any, without any planning arrived in our towns and enriched few and impoverished more [many][60]". In each of the interviews, when discussing change over their lifetime participants repeatedly laid blame on the shrimp aquaculture industry and linked the deforestation of mangroves to the many biophysical and social changes that have occurred. Changes include (1) diminished water quality in the estuaries causing health effects and concerns due to polluted effluent; (2) a decrease in available fish species to support community livelihoods; and (3) reduced provision of ecosystem services. The untreated effluent released into the *Rio Muisne* and *Rio Chone* estuaries was said to negatively affect women gathering cockles and children swimming in the water in the form of skin rashes. In Muisne, pollutants are also released from inland monocultures (African palm, Eucalyptus) and were noted to affect fish and mangrove health in addition to human health. Description of untreated effluent impacts from shrimp ponds can be found in Stram et al. (2005). Fishermen described the necessity to spend longer hours fishing, the disappearance of certain mollusc species ('*pata de burro'*) and the diminished availability of shrimp, mangrove cockles, fish (ex.

Chame). Paradoxically, the same mangrove ecosystems destroyed for these industries is also capable to improving water quality through the interception of pollutants, barrier and filtering capacities (Valiela et al., 2001). Finally, participants were cognizant of the importance of mangrove ecosystems to their natural environment (and provision to livelihoods) and described the important ecosystem services such as habitat, oxygen, and the trees' influence on rainfall. Importantly, participants in Portovelo recognized that the *bosque seco tropical* (tropical dry forest) offered many of these same benefits but were under threat (or already altered) from deforestation.

Thirdly, little is known about how the vast upheaval of the mangrove ecosystems has affected natural occurrences due to climate change and whether the influence of the shrimp aquaculture industry has indeed altered the biophysical (chemical, geological, etc) processes that could otherwise be witnessed. For example, in Portovelo participants rarely spoke of sea-level rise (though it is predicted to affect that coastal area). What is not known is whether this is because residents of Portovelo have a physical separation between them and the estuary (by shrimp ponds) which visually disconnects them, whether these ponds are a visual reminder (visual saliency) of destruction in their minds which obfuscates their detection of change, or whether the sea level is rising in that precise location after all. This final point is an interesting reflection but not the main objective of the research.

5.1.3 Knowledge gaps and overlaps: bringing together various voices

(3) How does the information from top down-sources and global predictions compare to local ecological knowledge and 'bottom-up' perspectives on change?

Results from the literature review indicate that various sources such as communities, non-governmental organizations, government, national institutes, and global science have important information to contribute to climate change dialogue. Each have differing sets of objectives or foci but together enable us to draw a clearer picture of vulnerabilities and adaptation options in Ecuador's coastal communities. For example, the contribution of vulnerability maps and scientific research (Figure 7) by national institutes, regional species-specific and socioeconomic studies by NGOs (Figure 8), key local ecological knowledge and

[60] *"Si porque ha sido una industria criminal que sin ningún, sin ninguna planificación llegó a nuestros pueblos y se enriquecieron pocos y se empobrecieron más" (IM-1, 2009)*.

behaviour-affecting priorities and perceptions at the local level, and broader climate change impacts (IPCC) add the rich data required to address such a complex issue (Table 5).

Depending on the region, overlaps did occur. For example, Muisne residents spoke of issues of sea level rise and erosion affecting their way of life, which is one of the key predictions to affect Ecuador's coastal region and mangrove ecosystems. These kinds of overlaps should be seen as important points of collaboration and opportunities to focus adaptation policies due to the enhanced confidence they provide (as seen in Johannes et al., 2000).

5.1.4 Local ecological knowledge and recognition of change

(4) What role can community have in addressing vulnerability and contributing to climate change dialogue?

Though these various more imminent and obvious preoccupations are at the forefront of participants' minds, there was still a strong awareness of biophysical change in the *Rio Muisne* and *Rio Chone* estuaries. In Muisne, there is also a strong focus on the erosion of the island and problems with flooding which has removed the (mangrove) barrier that coastal communities once counted on, forcing them to abandon houses and migrate inland. In short: "the sea is winning territory[61]".

In general, Ecuador's coastal regions experience two much differentiated seasons involving oscillating wet and dry periods, with higher humidity during the rainy season from December to May. Participants pointed out a link between the deforestation of mangroves and tropical dry forests leading to changes in precipitation patterns because: "The water goes looking for trees"; "The trees call the water[62]"; "Winter [rainy season] always goes looking for air [from the trees]"; "More trees attract more cold, attract more rain"; "The forests can retain clouds"; "Mangroves and forests attract the rain and now lots have been cut down"[63]. To this end, they drew conclusions that the deforestation experienced around them has influenced the natural systems to the point that ""Now we don't know when it's summer and when it's winter, it's all changed[64]"; "Now there are no rules. During winter it hardly rains… the climate is crazy[65]".

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[61] "*Lo que si te puedo decir que si tú te vas a la playa el mar va ganando terreno, el mar está metiéndose más, y más. No sabemos que vaya a pasar pero de que el mar va a llegar alguna vez en la vida hasta acá". (IM-1, 2009).*

[62] *"[mangles] llama el agua por ejemplo el agua no habiendo arboles se va el agua para buscar donde hay árboles" (IP-1, 2009).*

[63] *(GP-8, IP-1, IP-3, IP-2, IM-5, IM-1, 2009)*

[64] *"Ahora no sabemos cuándo es verano, cuando es invierno… todo ha cambiado" (IM-1, 2009).*

Additionally, one participant from Portovelo described how the frigate bird has changed its nesting habits on the nearby island in order to adjust to changing temperatures and seasons. Participants were aware of many environmental changes which have occurred during their lifetime and discussed the unpredictable seasons, a sun that now burns, variability in rainfall, and a decline or change in species composition within the estuaries. This knowledge of biophysical processes and unique understanding of the area are the results of a lifetime living connected to these ecosystems. Indeed, local people observe changes in weather patterns, species life cycles, productivity and interrelationships; thus contribute insights about weather, species and habits as they are capable of recognizing anomalies (Turner & Clifton, 2009).

This is important due to the fact that climate change information is often incomplete and locally-relevant data is missing. Top down predictions which rely on models have led to increasing dissatisfaction and scenarios which are too broad to adopt at a local scale; we must instead turn to bottom-up and locally relevant scales to further understand climate change (Riedlinger & Berkes, 2001; van Aalst et al., 2008). The complexity of such an issue renders it difficult (if not impossible) to deal with if local people are not involved. The importance of including non-scientists or local knowledge is recommended by many (Byg & Salick, 2009; Dolan & Walker, 2004; van Aalst et al., 2008) and was a key component of this participatory research. Through the interviews, focus groups and green mapping activities, participant LEK was viewed as a critical source of information and offered an opportunity to build trust and relationships through knowledge-sharing.

5.2 Secondary Findings: The importance of 'Development Issues'

A critical reason behind climate change's lagging role in people's minds may be due to their preoccupation with daily struggles. Though many have at least heard of the terms, there was a strong focus on several more pressing issues:

(1) Food security: includes the ability to meet one's livelihood needs through traditional resource use lifestyles (*pesquero, carbonero, concher@*; the physical decline of fish species; stress to agricultural systems inland in the tropical forests

(2) Freshwater availability: includes quantity and quality

[65] *"En nuestro medio ya no hay reglas en los inviernos, llueve poquísimo, tenemos clima loco" (IP-7, 2009).*

Food Security

Fishing activities are primary generators of income in Muisne and Portovelo which, along with agriculture, provide the principal food sources for many families. All participants self-identified in many ways as children of *pescadores*, *concher@s*, carboneros (fishermen, clammers, wood charcoal makers) and many of them continue to partake in these traditional activities. Indeed, the connection to the mangrove ecosystem was evident through their words "*el manglar es vida"* (the mangrove is life) and actions. Indeed, over 1 million people in Ecuador live within these mangrove ecosystem zones and depend on them (C-CONDEM, 2007). Food security was mentioned more explicitly by the NGO FUNDECOL which focuses on *Soberanía alimentaria* (food sovereignty) and is prioritizing this alarming issue in their work. However, as one fisherman from Muisne put it: there is a need to "plant plantains, yucca, plant everything that are plants that will favour the "canasta" (food basket) of the home, the family, and the city"[66]. The felling of mangroves by the shrimp aquaculture industry and destruction of the tropical forests for monocultures were said to be the dominant contributors to this stress. Land access in Muisne was also mentioned as a present and future concern and unfavourable climatic conditions (low rainfall) was mentioned as an additional limiting factor in Portovelo.

Freshwater

The availability of freshwater as a predominant issue came to light when participants were asked what the most pressing and main necessity is for their community. In both Portovelo and Muisne, over half the participants mentioned the need for freshwater to meet household needs and described a lack of availability and quality in the water they do have. This significant issue was witnessed throughout the field season as both Muisne and Portovelo residents must buy their water despite the present poverty due to water quality issues. Both the lack of suitable drinking water in Muisne (INFOPLAN, 2001) and the basic service received from the municipality in Portovelo (for one 24-hour period every week) are indicative of a "lifetime of problems with water[67]". Health impacts, intolerable or contaminated water and the missing guarantee of freshwater quality were pressing issues in both areas. Importantly, on the island of Muisne several families rely on well water which is vulnerable to saltwater intrusion, flooding and even

[66] *"No más a la siembra de eucalipto, no más a la siembra de, de piñones ni de caña", sino que más bien a sembrar verde, a sembrar lo que es yuca sembrar todo lo que es ya le digo plantas que vayan a favorecer la canasta del hogar, de la familia y de la ciudad"(IM-8, 2009)*.
[67] *"Toda una vida hemos tenido problemas con el agua" (IP-3, 2009)*.

contamination due to the estuaries' water quality. The threat of saltwater intrusion into freshwater systems is predicted in the face of climate change in certain regions (Kundzewicz et al., 2007; Nicholls et al., 2009). As expected, there is little wonder why climate change fails to take precedence when there are so many pressing factors (meeting one's daily needs) which take priority.

5.3 Recommendations

This idea of collaboration was a central element to this research and included government, academics, national institutes, NGOs, and community. Though scientific information exists about climate change in the area (Alcamo & Henrichs, 2002; Cáceres, 2001; Nicholls et al., 2009; UNFCCC, 2000; Vincent et al., 2005) and impacts to mangrove ecosystems (Field, 1995; Gilman et al., 2008; McLeod & Salm, 2006; Saenger, 2002), it is important to consider the viewpoints of various stakeholders who can contribute to climate change dialogue. For example, an increased awareness of climate change at the NGO level combined with their available scientific data about species and mangroves can contribute necessary baseline information. There is indeed a need for better observation and the collection of actual coastal change and local factors (Nicholls et al., 2007); locality-specific research which can elucidate information about widespread change (Wilbanks & Kates, 1999). In Muisne and Portovelo, recognizing what local people view as the most significant change, their priorities and their perceptions of climate change- if acknowledged as legitimate- can serve to educate climate change dialogue in a way that makes it more relevant and specific. Indeed communities may perceive climate risks differently than what meteorological records suggest, thus mobilizing local experiences allows us to identify relevant indicators and adaptation options (Klein et al., 2007). This is especially true since people's actions based on their perceptions are real whether or not they are supported by available data (Glantz & Degefu, 1991 in Meze-Hausken, 2004).

In order to understand current vulnerability to climate change it must be placed in the historical context. Delving into the past environmental history through the eyes of the local community not only allowed the researcher to prioritize predicted impacts, but to more fully comprehend how the change might pronounce itself. Local people were able to provide information about changes to the natural resources they live and work in and how the mangrove ecosystems had been altered. Research by Lykke (2000) also showed that local people's perceptions of vegetation change were reliable and consistent with various sources. A

recommendation of this research is thus the involvement of these local communities and NGOs in monitoring the coastal zone in order to establish baselines and begin to notice changes. Locality-specific research can elucidate information about widespread changes (Wilbanks & Kates, 1999); not only is this involvement a critical element of community capacity-building and adaptive learning for resilience (Reed et al., 2006 in Tschakert, 2007) but also key to achieving meaningful and feasible adaptation and improving livelihood resilience. Furthermore, due to climate change's inextricable link to issues such as poverty, there is a concern that ignoring climate change to first tackle poverty issues will ultimately destroy any progress that has been made and render the environment incapable of recovery (Doulton & Brown, 2009). The issues described in Portovelo and Muisne need to be addressed jointly with climate change adaptation and education if they are to actually decrease these coastal communities' vulnerability.

5.3.1 Climate change education and communication

In light of Ecuador's Ministry of the Environment's current creation of a national communication plan for Education and Awareness around climate change (to be completed fall 2010), we must look at how knowledge will be shared and what form education will take. The government has a role to play due to their decision-making power and their access to resources. Their role in diminishing vulnerabilities, according to participants, includes a call for support: acting as an authority and enforcing the present laws in place to protect their livelihoods; education and capacity-building; as well as monetary support to allow for livelihood diversification. Both FUNDECOL and C-CONDEM mentioned the need for education, a keenness for more climate change information and resources, as well as a goal of incorporating climate change adaptation into their current projects. In Muisne, they also saw an opportunity for collaboration with municipal governments in such a way that their specific knowledge could aid in brainstorming solutions while at the same time including expert science and government contributions. People's local values and beliefs play a key role in climate change response due to their effect on behaviour (Turner & Clifton, 2009); their local knowledge influences actions, decisions, and adaptive measures (Berkes & Jolly, 2001). However, local communities might not have access to some of the wider political, social, demographic and economic information which is predicted to affect them in the face of climate change. For this reason, and in accordance with their desire for more information, there is a need for iterative and multi-level education. The government must take into account the historical context of the shrimp aquaculture and its

continued negative influence on the coastal communities of Muisne and Portovelo, including how it obfuscates some of the effects of climate change.

Furthermore, in moving forward with climate change education and multi-directional collaboration and knowledge-sharing, it is important to consider vocabulary, context, education, and communication mechanisms. Understanding how to communicate global change involves many components which must be incorporated (Bostrom et al., 1994; Burch et al., 2009; O'Neill & Hulme, 2009; Raynor & Malone, 1998; Patt & Schröeter, 2008; Tiessen et al., 2007, etc.).

5.3.2 Community mapping as a starting point

One of the recommended methods to access such information is through collaborative community mapping such as Green mapping. Additionally, it may be an opportunity to mend distrust and build relationships by breaking down the barriers between government and local communities through acting as a conduit into dialogue. This type of activity elucidates both some of the broader issues at a community scale, as well as unique and specific perspectives about the natural environment; an opportunity to educate government about what is important 'on the ground'. The inherent flexibility of this collaborative knowledge-sharing process allows for mutual learning and thus a potential enhancement of adaptive capacity. A more complete knowledge base is thus achieved through the incorporation and engagement of local resource users which may also fill the knowledge gaps in data-poor regions such as Muisne and Portovelo. According to Tiessen et al. (2007) there is a need to place climate information into the socioeconomic context in which it is being described and to make the scientific knowledge relevant to society. In this case, Ecuador's Undersecretary on Climate Change must take into account how freshwater and food security needs currently dominate conversation in Muisne and Portovelo, how climate change is understood, and what historical environmental change is attributed to. In this case, the collective memory of environmental change is inextricably intertwined with the shrimp aquaculture industry and the El Niño phenomenon.

Examining the applicability of these research methods to other coastal communities in Ecuador or any additional countries would allow the researcher to glean more information about some of the broader themes that affect climate change understanding and adaptation. This valuable information can add to larger scale adaptation options. Additionally, comparing these results to a 'developed' country such as Canada would provide additional insight.

5.3.3 What matters locally and how does it align with other stakeholders?

In order to suitably implement adaptations to climate change there is a need to discover 'entry points' or 'win-win' scenarios that meet various needs. An entry point can be seen as a way to integrate development needs and climate change adaptation in a way that also raises awareness about climate change (Klein et al., 2007). A precautionary approach to climate change mitigation and adaptation was described by Kelly et al. (1994) who suggested identifying "win-win" situations which reduce future risks while also minimizing various environmental problems, social and economic threats and climate change vulnerabilities in present day. In this case, the reforestation of mangroves is offered as a possible entry point upon which government, NGO, community needs and science align. The mangrove ecosystems have been called noteworthy specific concerns as a fragile ecosystem ("*Estrategia Ambiental*", 1999) according to the Ministry of the Environment and there is a push by the Undersecretary of Aquaculture to return portions of converted land or abandoned shrimp ponds to communities for reforestation. Furthermore, according to C-CONDEM staff, there is a push to decentralize the management of mangrove areas by awarding custodial agreements of mangrove areas to traditional users for more localized and traditional uses; to date, 13 of these *custodias* have been awarded (*El Ciudadano*, 2010).

Mangrove ecosystems have tremendous social and ecological value and serve as habitat or nursery habitat for migratory birds, crustaceans, molluscs, microorganisms, marine species, etc (Gilman et al., 2008; McLeod & Salm, 2006). According to scientific studies mangroves play a role as protective buffers, hotspots for biodiversity, have 'blue carbon' sink capacities and store carbon in the form of sediment; and can even be used as indicators of the effects of climate change (Duarte, 2009; Field, 1995; McLeod & Salm; Nelleman et al., 2009; Nicholls et al., 1997; Walters et al., 2008). The restoration of mangroves aligns with the interests of FUNDECOL and C-CONDEM while also addressing some of the issues raised during the interview (decreased species availability, flooding, poor water quality, etc). Acknowledging the locally embedded realities and constraints in community responses to climate change (Moser 2000, 2005 in Nicholls, 2007), we are able to discover points of consensus on which to base collaborative dialogue to address vulnerability to climate change.

5.4 Conclusion

The conclusions of this research can be described as follows:

(1) Climate change is predicted to have various impacts on coastal communities and mangrove ecosystems in Ecuador with sea level rise and rainfall variability being predominant.

(2) Local level awareness of climate change is incomplete and historical change tends to be attributed to the shrimp farm industry, El Niño phenomenon, and deforestation.

(3) However, participants demonstrated awareness and understanding of ecological processes and change through local knowledge thus revealing an important role in bottom-up monitoring; which has been found to be lacking.

(4) Various sources such as communities, government, global science, NGOs, and institutes have different but important information to contribute to climate change dialogue.

(5) In considering adaptation strategies and climate change education, one must consider which 'entry points' will enable greater success; in this case, mangrove restoration is suggested as a potential option which satisfies multiple needs and objectives.

It appears that participants' preoccupation lied with the daily struggles of meeting their livelihood needs more than the issue of climate change. The concept of sustainability underlay many of the comments and conversations shared during this research project. Participants spoke of a worry for future generations and their ability to meet their needs, increasing poverty levels for native mangrove user communities, their historical link to (and dependence on) mangrove ecosystems, as well as broader comments about the planet being rented, not owned. This is a similar concept to the "seventh generation" philosophy of Native American people's which encourages us to consider the impacts of our decisions with seven generations ahead in mind. The community of Muisne, for example, has held a self-sustaining relationship with nature (Papuccio, 2004); which is under constant and recurring stress from the long term effects of the shrimp industry. It seems unlikely that climate change adaptation and vulnerability reduction will be able to occur if the current stresses that these communities face are not addressed as well. Identifying win-win situations which decrease vulnerability to present day stresses as well as to predicted climate change impacts are thus desired.

APPENDIX A Results Sharing and Distribution of Materials

SUMMARY REPORT

A six page summary report (including introduction, methodology, results and discussion sections) was provided in Spanish and distributed in hard copy to:

- Bunche, Esmeraldas
- Santa Rosa, Esmeraldas
- Bellavista, Esmeraldas
- Portovelo, Manabí
- C-CONDEM in Quito
- FUNDECOL in Muisne, Esmeraldas
- *Ministerio del Ambiente* (MAE) *Subsecretaría de cambio climático*(SCC)

THESIS CHAPTERS

Two of the chapters from this graduate thesis (Chapter 3 and 4) will be translated into Spanish and distributed to C-CONDEM, FUNDECOL, MAE SCC, and the Municipal Governments of Muisne and Portovelo. Chapter 2 (Methodology) has already been provided in English to MAE SCC. The thesis in its entirety will be provided digitally in English to the aforementioned groups and any other interested parties.

MAPS

Hard copy

A total of 26 hard copy maps were provided by the researcher to the following groups:

- Portovelo x 4 (Front and Back)
- Bellavista x 3
- Santa Rosa x 3
- Bunche x 2
- MAE SCC Portovelo map, Santa Rosa map
- FUNDECOL x Portovelo, Bellavista, Santa Rosa, Bunche
- C-CONDEM x Portovelo, Bellavista, Santa Rosa, Bunche

All four of the maps were also printed and mounted for Saint Mary's University (CIDA-Citizen Science) Green Map exhibit on campus in March 2010.

Digital

In Ecuador, digital maps were provided freely to FUNDECOL, C-CONDEM and MAE SCC who further distributed them to their partner universities and organizations. In Canada, digital maps were uploaded to the Green Map website (www.greenmap.org) and provided to persons by personal request.

MEETINGS AND PRESENTATIONS

Several meetings were had with the MAE SCC during the return visit in 2010. The initial presentation of results and discussion involved staff from the SCC Adaptation stream including the Director of Adaptation and the Director of Communication. Further collaborative meetings took place with both directors to discuss current research and work being done by SCC.

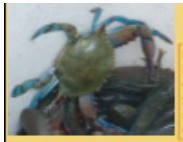
Official presentations of findings took place with both FUNDECOL staff (N=3) and C-CONDEM staff (N=4). The PowerPoint was also distributed to additional staff members.

PRESENTATION AND POSTER

- Coastal Zone Canada Youth Forum (presentation)
- Coastal Zone Canada (presentation and poster)
- Green Map website
- Saint Mary's University library exhibition

APPENDIX B COMMUNITY GREEN MAPS

El Manglar



La Isla Corazón está ubicada al sur del Puerto de Portovelo en el estuario de Río Chone, Manabí. En el 2002 la isla fue declarada Refugio de Vida Silvestre por el Ministerio del Ambiente debido a su rica biodiversidad de especies de aves, moluscos, crustáceos, etc.

En el pasado se podían encontrar cocodrilos, delfines, tiburones, peine en un caudal bastante profundo de 15-20 metros. Se pescaba alta camarón y concha con atarraya y trasmallo. Con un pedacito de media cuadra se podían obtener entre 15-20 canoas de camarones o 40-60 libras.

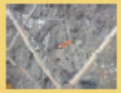
En la isla se pueden encontrar más de 60 especies de aves tales como: ibis, garzas, cormoranes, tórtolas, mariposas, martín pescador grande y verde, pelícanos, y fragata. Cuatro especies de mangle cubren la isla, siendo el Rhizophora mangle (mangle rojo) el más predominante.

Desde 1997 la gente de Portovelo con el apoyo de varias comunidades, PMRC* y la C-CONDEM** han logrado sembrar más de 37,500 semillas reforestando más de 50 hectáreas de la Isla Corazón. La semilla del mangle rojo es alargada y puntiaguda y cuando se cae puede flotar y conservar su viabilidad por varios meses.

*Programa de Manejo de Recursos Costeros
**Coordinadora Coordinadora Nacional para la defensa del Ecosistema manglar

En 1988, la Isla Corazón era llamada la Isla de los Aposentos. La misma media 700 hectáreas durante la marea baja y 50 hectáreas en marea alta. En la punta oeste de la isla había una laguna llamada "La Posada la Isla" y se pescaba lisa, bagre, y corvina hasta 25 libras de peso. De igual forma había abundancia de camarones pudiéndose atrapar 15-20canoas aproximadamente en media cuadra.

Antes se pescaba hasta en las áreas adjacentes a Salinas y Tosagua, sin embargo, actualmente los niveles de agua son demasiado bajos. En periodos cortos (2 horas aprox.) se podía obtener entre 40-50 libras inclusive quintales, de los cuales una parte se vendía y el resto era para consumo personal. Actualmente solo se obtiene entre 1 hasta 5 libras durante largos periodos de 4 a 5 horas o inclusive durante todo un día de pesca.



AsoManglar

Es un grupo de guías que trabajan en el sector ecoturismo enfocándose en la conservación del mangle. Los mismos realizan actividades educativas con la colaboración de científicos y organizaciones nacionales e internacionales. Todos los días del año estos guías dirigen visitas a la maravillosa Isla Corazón dónde se puede observar diferentes especies de aves, el museo del mangle, explorar senderos dentro del mangle y disfrutar de la rica comida manabita. Además, los mismos cuentan con hermosas, acogedoras y silenciosas cabañas de hospedaje, totalmente rodeadas por la naturaleza para el disfrute de los cantos de las aves.

Para contactarlos marque al (593) 99 384 425 o (593 -5) 2 399 460 para organizar un tour y visitar la Isla Corazón y el pueblo Portovelo.

La Vida en Portovelo

Portovelo se ubica a 80°22´6" de longitud Oeste y 0°38´35" de latitud Sur, a 10 km de la parroquia de San Vicente y diagonal a la comunidad de Puerto Ébano en el cantón de Chone. Las raíces del "Puerto bello" empezaron en 1975 cuando los primeros fundadores llegaron a este hermoso lugar. La pre cooperativa se convirtió en cooperativa y poco a poco llegó a ser El Portovelo que conocemos hoy. Ahora viven unas 175 familias.

Muchos hombres se dedican a la pesca artesanal y la agricultura pero algunos alternan con otras actividades tales como, compra y venta de mariscos, empleados de las camaroneras, el comercio, construcción o la descabeza del camarón. Un 70% de la gente trabaja 2 o 3 veces a la semana descabezando los camarones de las piscinas- por ejemplo unos 100 quintales requieren que 90-100 personas trabajan. Las chicas se quedan en casa y trabajan con sus madres, las mismas cocinan, lavan la ropa, arreglan la casa, cuidan los niños y a sus esposos. La mayoría de las mujeres son casadas y con hijos. En su mayoría solo estudian hasta primaria (el sexto grado o 13 años).

El fenómeno de El Niño y la tragedia del terremoto del 10 de mayo de 1998 tuvieron impactos tremendos sobre la población de Portovelo. Los mismos causaron derrumbes que a su vez formaron embalses que obstruyeron el cauce del Río Burro Burro. Al ceder los embalses se produjo una fuerte corriente que destruyo más de 60 casas incluyendo sus enseres básicos pertenencias tales como herramientas de pesca, canoas, remos, muebles entre otros.

Las especies que sacan del mar: cocudo, guapuro, ayanque, camarón, corvina, lisa, chogorro, robalo, bagre, etc.

Bosque Seco Tropical

Algunas de las variedades de plantas y árboles importantes en el bosque seco tropical.

- Plantas **Medicinales**: el cascól, el algarrobo, la ceiba, el eucalipto
- Plantas **Comestibles**: el ovo se come la fruta
- Plantas **Aromáticas**: el palo santo sirve para los insectos
- Plantas **Maderables**: la bruja y el guayacán son buena madera

El algarrobo
- Sabe dulce/amargo y es medicinal
- La flora es un buen alimento para ganados y burros
- Se saca un vino de la vaina como miel y es bueno para la tos
- Uno pone la cascarita sobre muelas para aliviar dolor

La Ceiba
- Planta que da semilla y lafo como algodón

El Cascól
- Ayuda con dolor de muela y es buena madera

12 Instituciones en Portovelo:

INFA, el Comité de damas, la Casita, la Procapilla (Iglesia), la Asociación de pescadores, la Asociación 12 de octubre, AsoManglar, la Brigada barrial, la Escuela, el Grupo de la cancha, el Grupo de Jóvenes, la Comuna (el comedor).

Gastronomia

Desayuno
El más tradicionales el café con pan sin embargo la mayoría come la misma comida que en el almuerzo. Incluye huevo frito, estofado de carne, arroz, jugo, salprieta, maní, encebollado y pescado frito

Almuerzo
Usualmente comen sopa de caldo de pollo con arroz. La mayoría comen segundo sin sopa, agua helada, cola, jugo.

Merienda
Seco de pollo, pescado, chancho siempre carne. Por ejemplo comen menestra de lenteja, carne, arroz.

Usualmente comen mucho marisco (afrodisiaco)

Bebida: Jugo de Zapallo, Camote, Harina, Chocolate con leche, Café, otros jugos incluyendo maduro y arroz

Platos típicos: Viche de pescado, camarón, cangrejo, Carapacha de guariche, Arroz con pollo

Ejemplo de comida compartida durante la fiesta

En el pasado: Tostaban el café, hadan tortillas hornadas de maíz o yuca en horna de leña, pan de almidón y tostaban el maní

La Mayoría comen arroz en cada comida

Asociación de Pescadores

Es un grupo formado en 1976 comprendido de múltiples generaciones de pescadores de Portovelo. Trabajan principalmente como pescadores artesanales para la subsistencia de sus familias. Los mismos han percibido severos cambios en el estuario. Ellos tienen mucha experiencia y conocimientos y han trabajado incansablemente para conservar su estuario y su estilo de vida.

La Casita

La casita fue creada en Julio 2007 como centro comunitario y social. Un grupo de mujeres se reúne no solamente para hacer proyectos y capacitaciones sino para compartir la vida, chismes, y tener un apoyo social entre mujeres. Sus proyectos corrientes incluyen la fabricación de chalecos y ropa.

El Comedor

El comedor es un lugar de encuentro para los 'niños de la tercera edad'. Se reúnen durante el almuerzo y comparten comida, cariño, chismes, bromas y historias.

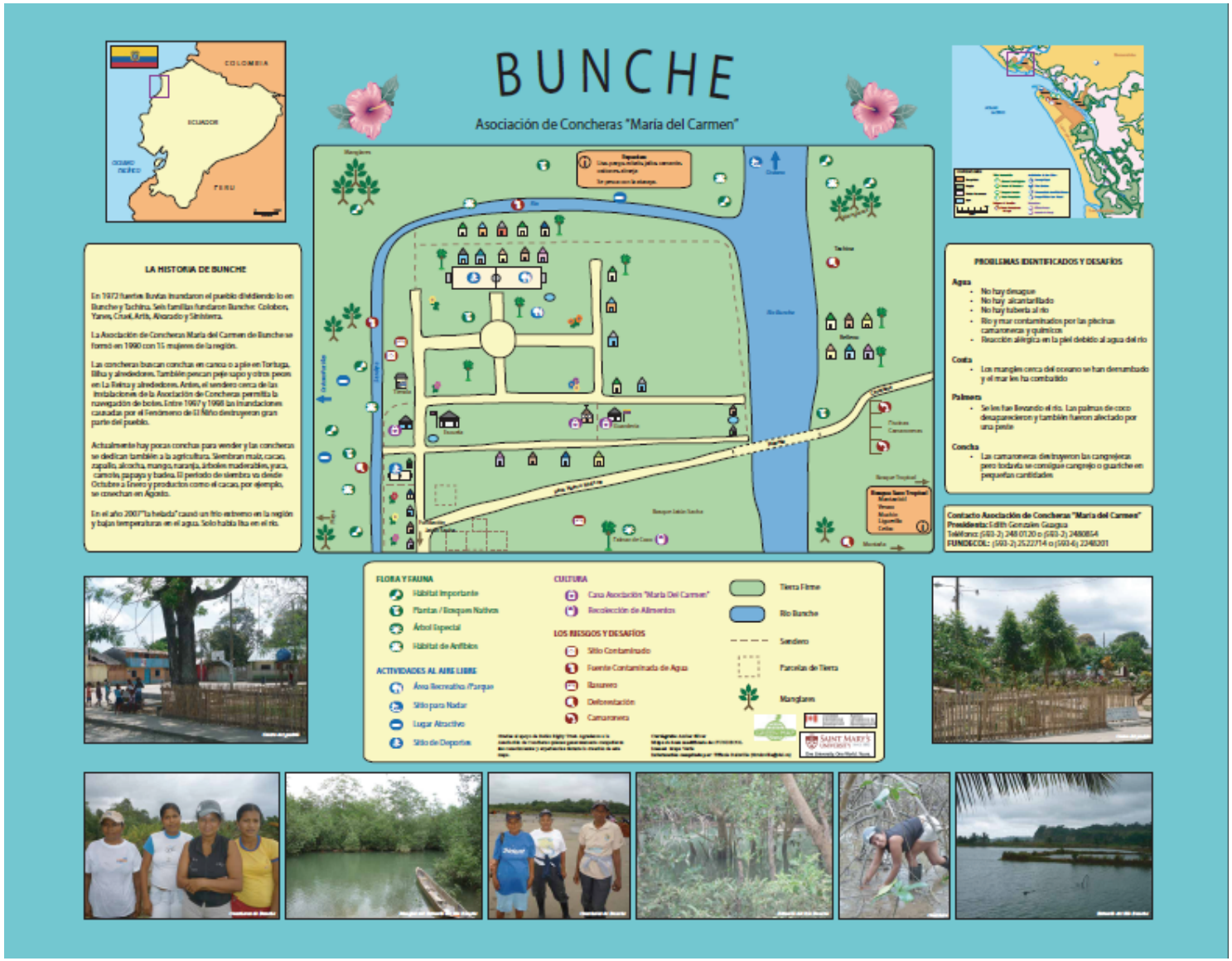
Foto1: Grupo de Mujeres de la Casita
Foto 2: Grupo de Guías AsoManglar
Foto 3: Asociación de Pescadores

El Grupo de mujeres de la casita, la Asociación de Pescadores, AsoManglar y la comunidad de Portovelo generosamente compartieron sus conocimientos, sus experencias, y su vida durante la creación de estos mapas. Agradezco con todo corazón la bienvenida que me dieron, su pacencia y su amistad incondicional.
¡Jamás los olvidaré!

Tiffanie K. Rainville (tkrainville@dal.ca)
Maestría en Estudios Ambientales, Mayo-Agosto 2009

Muchas gracias a **Robin Rigby Trust** y los siguientes para su apoyo:


COLOMBIA
ECUADOR
PERU
Santa Rosa, Isla de Muisne
Esmeraldas
Asociación de Pescadores Artesanales 7 de febrero
LA HISTORIA
1966-1990
MAR ABIERTO
REQUERIMIENTOS
ESPECIES QUE SE ENCUENTRAN EN EL MAR
PROBLEMAS DE CONTAMINACION AMBIENTAL
ASOCIACIÓN DE PESCADORES DE SANTA ROSA
MIRANDO HACIA EL FUTURO
Esmeraldas
Bocana de Idrotine
OCEANO PACÍFICO
Santa Rosa
Isla de Muisne
Bocana de Las Manchas
Las Manchas
150 000 m
700 m
50 m
CONVENCIONES


BUNCHE
Asociación de Concheras "María del Carmen"
COLOMBIA
ECUADOR
PERU
OCEANO PACIFICO
LA HISTORIA DE BUNCHE
En 1972 fuertes lluvias inundaron el pueblo dividiendo lo en Bunche y Tachina. Seis familias fundaron Bunche: Colobon, Yanes, Cruel, Artis, Alvarado y Sinisterra.
La Asociación de Concheras María del Carmen de Bunche se formó en 1990 con 15 mujeres de la región.
Las concheras buscan conchas en canoa o a pie en Tortuga, Isla y alrededores. También pescan pejesapo y otros peces en La Reina y alrededores. Antes, el sendero cerca de las instalaciones de la Asociación de Concheras permitía la navegación de botes. Entre 1997 y 1998 las inundaciones causadas por el Fenómeno de El Niño destruyeron gran parte del pueblo.
Actualmente hay pocas conchas para vender y las concheras se dedican también a la agricultura. Siembran maíz, cacao, zapallo, alcachofa, mango, naranja, árboles maderables, yuca, camote, papaya y badea. El período de siembra va desde Octubre a Enero y productos como el cacao, por ejemplo, se cosechan en Agosto.
En el año 2001 "la helada" causó un frío extremo en la región y bajas temperaturas en el agua. Solo había Ika en el río.
PROBLEMAS IDENTIFICADOS Y DESAFÍOS
Agua
No hay desague
No hay alcantarillado
No hay tubería al río
Río y mar contaminados por las piscinas camaroneras y químicos
Reacción alérgica en la piel debido al agua del río
Costa
Los mangles cerca del oceano se han derrumbado y el mar les ha combatido
Palmeras
Se les han llevando el río. Las palmas de coco desaparecieron y también fueron afectado por una peste
Concha
Las camaroneras destruyeron las cangrejeras pero todavía se consigue cangrejo o guariche en pequeñas cantidades
Contacto Asociación de Concheras "María del Carmen"
Presidenta: Edith Gonzales Guagua
Teléfono: (593-2) 248 0120 o (593-2) 2480854
FUNDECOL: (593-2) 2522714 o (593-6) 2248201
FLORA Y FAUNA
Hábitat Importante
Plantas / Bosques Nativos
Árbol Especial
Hábitat de Anfibios
ACTIVIDADES AL AIRE LIBRE
Área Recreativa /Parque
Sitio para Nadar
Lugar Atractivo
Sitio de Deportes
CULTURA
Casa Asociación "María Del Carmen"
Recolección de Alimentos
LOS RIESGOS Y DESAFÍOS
Sitio Contaminado
Fuente Contaminada de Agua
Basureros
Deforestación
Camaroneras
Tierra Firme
Río Bunche
Sendero
Parcelas de Tierra
Manglares
SAINT MARY'S UNIVERSITY

Barrio Bellavista

"Breve Historia"

Manglares:

84% de las 20,093 hectáreas en el cantón de Mataje se han perdido. Hoy solo quedan 5,073 hectáreas. Además, existen 475 camaroneras en la zona.

El manglar daba madera, carbón, cascara de mangle, y concha en abundancia. Se pescaba entre 500 y 1000 conchas diarias y grandes cantidades de pescado (hasta un quintal con la atarraya).

Comida en Bellavista:

"Agua salada y camarón dulce"

Concha de coco, churro, jalba, sopa de tasquero con coco, pato barro, almeja, hacha, cangrejo, conchas, camarones del río (agua salada y dulce), masato de maduro, chucula, guineo o chontа, tapaos de carne de monte, panda de camarón de agua dulce, sancocho de camarón o pescado, chocolate con muracumbus... etc.

En el pasado se utilizaba olla de barro, cuchara de mate, se horneaba con leña, después con carbón y ahora gas.

También se hacían "mingas" o "cambio brazo" con carne de puerco, guarapo y chicha.

Fauna:

- Crocodrilos, fieras (tiburones), el pez martillo, y la tintorera, etc.
- El armadillo, el conejo, la guacharaca, el tigrillo, la ártabra, el loro, el guachi, el calero, la tatabra, etc.
- La garza, el pelicano, el cuervo, etc.

Hoy en día las especies han disminuido. En el estuario solo queda un 80% de la concha, el cangrejos y la pesca, en cantidad y calidad.

Paisaje:

Anteriormente, era montaña con abundante vegetación incluyendo gran cantidad de palmeras. Nadie compraba coco criollo debido a su abundancia. Hoy en día, la diversidad de palmeras ha disminuido y hay más pipa que coco.

Agricultura:

En el pasado vivían de la tagua, el caucho del bosque húmedo tropical, etc., cultivados en las fincas en el continente. Los 'cambio brazos' les facilitaban el intercambio de trabajo. Actualmente, los cultivos se centran en el coco, el verde, y otros productos agrícolas.

Fuente de trabajo:

La pesca artesanal y la agricultura eran las fuentes principales de trabajo, pero con los cambios en el estuario del río Mataje muchos migraron a las ciudades para buscar trabajo. Ahora la comunidad está conformada por pescadores artesanales, agricultores, carboneros, obreros como carpinteros, etc.

Plantas Medicinales:

El mate se calienta con hierba de monte que ayuda con el dolor de cabeza. Siguen manteniendo las tradiciones de uso como: la albahaca para el cólico, la manta de palma o el orégano para el cólico y el dolor de estomago.

	Antes	Ahora
Transporte	Hasta el 1978: • canoa a vela, velera • flotial, canoa a remo Existieron buenos para transporte de quineos y entregueros a Esmeraldas	• Bote con motor • Trinchi • Bote Fuera de borda y principal

FLORA Y FAUNA
- Animales de Granja
- Árbol Especial
- Manglares

PELIGROS & DESAFIOS
- Deforestación
- Camaronera

ACTIVIDADES AL AIRE LIBRE
- Área Recreativa / Parque
- Sitio de deportes
- Bosque Público / Área Natural
- Observación de Aves / Vida Silvestre
- Transporte Acuatico

Tierra
Río
Edificio
Rompeolas

Agradecimientos

Gracias al apoyo de Robin Rigby Trust. La Asociación de Carboneros y la comunidad de Bellavista generosamente compartieron sus conocimientos, experiencias y su vida durante la creación de este mapa. Agradezco con todocorazón la bienvenida que me dieron, su paciencia y su ayuda incondicional.

Cartógrafo: Aislen Silver
Mapa de base modificado de: FUNDECOL
Iconos: Maps Vesle
Información compilada por: Tiffanie Sutcliffe (tiffanie@ucla)
Contacto Bellavista: Don William Chila (593-2) 3400371
Contacto FUNDECOL: (593-2) 2522 714 o (593-6) 2540501

APPENDIX C Interview Schedule for C-CONDEM and FUNDECOL

Translated into Spanish

All answers will be kept anonymous and confidential with regards to the individual as described in the oral consent described at the beginning of the interview. The oral consent will also indicate if the person interviewed gives consent to be contacted at a later date for further clarification.

1. Background
    a) How long have you worked for C-CONDEM?
    b) What is your educational background and work experience?
    c) What is your research background and primary interest within mangrove conservation?
    d) Explain any other relevant affiliations.
    e) How did you join C-CONDEM? What was your motivation or interest in becoming involved?
    f) What do you enjoy most about your work? What do you enjoy least?
    g) Tell me about an interesting find or observation from your field studies this past year, or while conducting your research.
    h) What makes your organization unique?

2. Community
    a) Which communities does C-CONDEM work in? What is your relationship with [Muisne/Portovelo]? What role does C-CONDEM have with them?
    b) How do people contact you to voice concerns about their mangrove ecosystems?
    c) Have any communities expressed an interest in Climate change research?
    d) What are the most common environmental changes in these two communities and how have they impacted the mangrove ecosystems? (water resources, communities)

3. Research and work done by C-CONDEM
    a) Explain the research done by C-CONDEM.
    b) Why is your research important? Timely? Relevant to coastal communities?
    c) What do you feel are the most important things to know about mangrove ecosystems with respect to water resources and climate change?
    d) What are some of the most common environmental changes happening within these mangrove ecosystems, water resources and surrounding communities?
    e) In your opinion, what vulnerabilities exist in the two identified communities- specifically with regards to sea level rise, changes in precipitation, storm surges and increased extreme storm events?
    f) What is the biggest threat?
    g) What role does the municipal and provincial government have to play in addressing climate change vulnerabilities? What legislation is pertinent to the two identified communities?

h) What are two principal challenges, barriers and opportunities at the moment with regards to decreasing vulnerability (or increasing adaptive capacities) to climate change?
i) What is the most significant contribution C-CONDEM makes to science/environmental policy/etc?

4. Project

a) What were your reasons to suggest Muisne and Portovelo?
b) Do you have personal knowledge or experience that could help with this research project?
c) Can you suggest possible contacts in the communities?

APPENDIX D Interview Schedule for Community Members

Translated into Spanish

All answers will be kept anonymous and confidential with regards to the individual as described in the oral consent described at the beginning of the interview. The oral consent will also indicate if the person interviewed gives consent to be contacted at a later date for further clarification.

1. Identification and interesting facts/background to enrich/personalize the interview
   a) How long have you lived in [community]?
   b) Do you have family in the community?
   c) What is your profession? How did you learn it?
   d) Do you have any association with C-CONDEM? What work do they do in your community?

2. Perspectives on Coastal Environment
   I. Mangroves
   a) Do you use mangroves for anything in your day to day life?
   b) Are mangroves important to you? Your community? How?
   c) Have you seen a change in the mangrove forests over the last 10, 30, 50 years/during your lifetime? Since the last El Niño event?
      - What other changes have you seen?
      - How did the mangroves respond to these events? How did they adapt?
      - Are there different species of mangroves now?
      - Are there certain areas that are less damaged (more resilient)?
   d) In your opinion, of all the changes witnessed, which most affects the mangrove ecosystem and coastline? What are the most common changes?
   e) Why has the mangrove ecosystem and coastline changed?
   f) Have your cultural practices had to change because of these changes? Explain.

   II. Water
   a) Do you have access to clean, drinking water?
   b) Have you noticed changes in the water quality? Why?
   c) Have you seen changes in the water quantity?
   d) Does water quality affect mangrove ecosystems in your area?

3. Perspectives on Climate Change and Global Warming
   a) What do climate change or global warming mean to you?
   b) Do you see change or the effects of climate change here? (sea level rise, variability in rainfall, storms, flooding)
   c) Have you seen changes in the coast?
   d) What might some vulnerabilities be to climate change be in your community/environment?

4. Management of resources
   a) What are some priorities for the management of mangrove resources?

b) What are the two biggest obstacles and challenges for the conservation of mangrove ecosystems?
c) What are some of the most important needs of your community? What barriers exist to meeting those needs?
d) What role should the community have in decreasing vulnerabilities to global warming/climate change?
e) What role should the government have in decreasing vulnerabilities to global warming/climate change?

Is there anything else you would like to contribute? Do you have any questions?

APPENDIX E Consent Form for Participants

Translated into Spanish

School of Resource and Environmental Studies
Faculty of Management

Title of research:

Impacts of Environmental Change on Water Resources and Mangrove Ecosystems: A Case Study of Vulnerability and Resilience.

Principal Investigator:
Tiffanie Rainville
Master's of Environmental Studies Candidate
School for Resource & Environmental Studies
Dalhousie University, Halifax, Nova Scotia
Email: tkrainville@dal.ca; Phone: 902-482-1855; Fax: 902-494-3728

Academic Supervisors:
Dr. Anthony Charles
School of Business/Environmental Studies Program
Saint Mary's University, Halifax, Nova Scotia, Canada

Dr. Michelle Adams
School for Resource and Environmental Studies, Faculty of Management
Dalhousie University, Halifax, Nova Scotia, Canada

Dr. Cathy Conrad
Chair, Department of Geography
Saint Mary's University, Halifax, Nova Scotia, Canada

Dr. John Kearney
Adjunct Professor, Marine Affairs Program
Dalhousie University, Halifax, Nova Scotia, Canada

Introduction

We invite you to take part in research being conducted by Tiffanie Rainville, a graduate student at Dalhousie University, as part of her Master's of Environmental Studies degree. Your participation in this study is voluntary and you may withdraw from the study at any time. The study is described below. This description tells you about the risks, inconvenience, or discomfort which you might experience. Participating in the study might not benefit you, but we might learn things that will benefit others. You should discuss any questions you have about this study with Tiffanie Rainville.

Purpose of the study

The purpose of this study is to gather information on the localized vulnerabilities to water resources and mangrove ecosystems due to environmental change. Components of this study

(focus groups, interviews) will provide insight into potential vulnerabilities and the role of mangrove ecosystems in increasing a community's resilience.

Study Design

This study will involve 10-12 interviews of key informants and two sets of focus group meetings, first with key resource users, Elders, and community members who are involved with C-CONDEM and the second with other interested community members. The map materials produced will be given to the community for their specific use and in accordance with their wishes. Those who indicate an option to be contacted will potentially be contacted for individual follow-up interviews (2-5 people).

With permission from the study participants, interviews and focus groups will be digitally recorded and transcribed. The transcripts of these interviews and focus groups may be analyzed by Tiffanie Rainville using computer software to find common themes among the responses. Results will be presented in an academic thesis, and may be communicated in academic articles, at academic conferences and the thesis (including recommendations) will probably be made available on the internet. A short summary of study results will be presented to you upon a return visit in April 2010.

Who can participate in the study?

You may participate in this study if you are a resident of [name of town] and interested in contributing to the study.

Who will be conducting the research?

Tiffanie Rainville is the Principal Investigator for this project. She will conduct the interviews, transcribe the audio files, and analyze the transcripts. Only the PI will have full access to the audio files or transcripts. The Academic Advisors (Dr. Anthony Charles, Dr. Michelle Adams, Dr. John Kearney or Dr. Cathy Conrad) may be called upon to assist with the analysis of portions of the files or transcripts. In all cases, confidentiality will be preserved.

What you will be asked to do

As an interview participant, you will be asked to spend 1-3 hours responding to questions about your natural environment, namely mangrove ecosystems and water resources. As a member of the focus group, you will be invited to one focus group meeting with the possibility of a follow-up interview (if you indicate your interest in this). The meeting will be conducted within the community and at a time and place that is convenient to focus group participants. The focus group is expected to take one full day of your time and meals will be provided.

Possible risks and discomforts

This study is expected to involve minimal risk. You may experience some distress while talking about frustrating experiences or if you disagree with other focus group participants. If you feel discomfort at any time, you may decline to answer questions and you may withdraw from the study at any time.

In the event that you experience any stress or discomfort from your involvement in this study, we ask that you contact [a local counselling service or mental health professional, which will vary for each community] to discuss the situation.

Possible benefits

No direct benefits are anticipated for this study. However, you may share knowledge with other community members and possibly learn more about the natural environment, mangroves and water resources in your community. You will assist in the creation of a large map that will belong to the community and can be displayed and used for educational purposes depending on the communities' wishes. The information gained from this study and the resulting recommendations will contribute to knowledge about local issues and potential adaptation to climate change impacts.

Compensation

Meals and refreshments will be supplied during focus groups, and gratuities will be in the form of a community gift reflecting the needs and desires of the community while also adhering to financial limits of the PI. If this is not deemed appropriate based on the temporal, social and cultural state at the time of the research project, every possible step will be taken to ensure that compensation is fair and meets the expectations of the community members while not influencing the validity of the data. Every effort will be made so that the focus groups and interviews occur at no cost to the individual (other than time).

Anonymity and confidentiality

The Principal Investigator will make sure that the confidentiality of all participants is protected throughout their participation in this study as much as possible. Fellow participants will be asked to keep the comments and observations discussed in the focus group within the focus group, and not discussed afterwards.

With your permission, anonymous direct quotations will be included in the presentation of final results. Direct quotations may be associated with your sex, age group (i.e. Elder, adult, youth), role in the focus group (i.e. educator), or community, but no names will be used. Direct quotations included in the final results will not contain information that may indirectly identify you as the speaker unless you have agreed to this within this consent form. The Principal Investigator will contact you by telephone or email after transcription/summarization of the focus group to confirm that you give consent to have a specific quote used.

Only the Principal Investigator will hear the full recordings of the interviews and focus groups; the Academic Supervisors (as listed at the top) may see or hear portions of the transcripts so long as this is needed assist with analysis. In this case, the anonymity of the participants will be ensured. Only the Principal Investigator will have access to electronic files containing transcribed interviews and focus groups. Your name will not be associated with the audio files or transcripts. The written transcripts of the interviews from this study will be kept in a locked filing cabinet at the School for Resource and Environmental Studies at Dalhousie University.

Since the principal investigator is a student in Halifax, Canada, she will have to travel with some of the interview and focus group data. While traveling back to Canada, she will encrypt all files to ascertain anonymity.

Questions

If you have any questions about this study, please contact the principal investigator, Tiffanie Rainville (contact information is on the first page of this consent form).

Problems or concerns

If you have any difficulties with, or wish to voice concern about, any aspect of your participation in this study, you may contact Tiffanie Rainville (the principal investigator of this study) or Patricia Lindley (the Director of Dalhousie University's Office of Human Research Ethics Administration) for assistance by phone at 902-494-1462 or by email at patricia.lindley@dal.ca.

DALHOUSIE UNIVERSITY
Inspiring Minds

School of Resource and Environmental Studies
Faculty of Management

SIGNATURE PAGE 1 OF 2

Researcher: Tiffanie Rainville
Title of the research: Impacts of environmental change on water resources in Ecuador's Coastal Communities: A Case Study of Vulnerabilities and Resilience.

Consent to participate in the study: I have read the explanation about this study. I have been given the opportunity to discuss it and my questions have been answered to my satisfaction. I hereby consent to take part in this study. However I realize that my participation is voluntary and that I am free to withdraw from the study at any time.

_____ _____
Signature of research participant Date

_____ _____
Signature of researcher obtaining consent Date

Consent for audio recording: I hereby consent to allow this focus group to be audio recorded.

_____ _____
Signature of research participant Date

_____ _____
Signature of researcher obtaining consent Date

Consent for use of direct quotations: I hereby consent to allow the researcher to use direct quotations from my responses in this focus group in writing and presenting study results. With my consent, I understand that these quotations may refer to my sex, age group, and community but will not refer to my name unless I formally agree to the use of my name in association with my quote.

_____ _____
Signature of research participant Date

_____ _____
Signature of researcher obtaining consent Date

School of Resource and Environmental Studies
Faculty of Management

SIGNATURE PAGE 2 OF 2

I agree that the researcher may use my full name in association with the information I provide today: (Please circle) YES or NO

I prefer that the researcher refer to my sex, age group, and/or community but not my name (Please circle) YES or NO

Consent to be contacted for a follow-up interview:

 Yes, the researcher can contact me for a follow-up interview.

 No, I would prefer that the researcher not contact me for a follow-up interview.

APPENDIX F Script for Oral Consent

Translated into Spanish

This script will be adapted for the intended role of the person from which consent is sought. This is a sample script written for oral consent from the focus group participants.

<u>At the start of the focus group meeting:</u>

This will be read aloud to the participant(s) in Spanish, the local language (by the PI):

> If you agree, I would like to ask you questions concerning your traditional and local ecological knowledge about mangrove ecosystems and water resources in your community. This information will help in the assessment of local vulnerabilities and the creation of a map.
>
> I would also like to ask you questions about the ways in which environmental changes are affecting you and your community.
>
> I will not record your name or any identifying information, and I will not disclose in any way your identity in future publications, conference presentations and academic reports. I will be audio recording this focus group session.
>
> I will not be giving a payment, but I will provide a small gift to the community to show my appreciation for your contribution.
>
> Since I am a student in Halifax, Canada, I will have to travel with the interview and focus group data. While traveling back to Canada, I will encrypt all files to make sure you remain anonymous.

The participant(s) will then be encouraged to ask questions for clarification or further information. After this, the PI or translator will continue:

> Do you agree to this arrangement, and that I may ask you these questions?

Focus group participant will each be asked this in turn, and only those who answer 'yes' will remain in the focus group. This will be recorded and witnessed by another participant. Next the PI will ask for permission to use direct quotes.

> If you agree, I will use direct quotations from your responses in this focus group in writing and presenting my study results. These quotations will refer to your sex and general characteristic (fisherman, elder, etc.) but will not refer to your name unless you formally agree to the use of your name in association with your quote.

The participant(s) will then be encouraged to ask questions for clarification or further information. After this, the PI will continue:

> Do you agree to this arrangement, and that I may use direct quotations? Would you prefer that I never use your name when quoting the information discussed today? Do you agree that I can use your name in association with the information we are about to discuss?

Focus group participant will each be asked this in turn, and only those who answer 'yes' will have their contact information recorded so the PI can contact them in the future if a direct quotation is to be used. This will be recorded and witnessed by another participant.

<u>At the end of the focus group meeting:</u>

At the end of the focus group meeting, the participants will be asked the following:

> Because you have contributed to the development of this educational material (map) that may be used in the local school in the future, I may contact you after these materials have been produced and the research has been analyzed.
>
> I may contact you in person [give approximate timeframe].

The participant(s) will then be encouraged to ask questions for clarification or further information.

If the participant has chosen to use their name in association with their quotes, the PI will then ask:

> Do you still feel comfortable allowing me to use your name in association with the information provided today?

After this, the PI will continue:

> Do you agree to this arrangement and that I may contact you in person during the summer 2009 to ask you further questions?

Focus group participant will each be asked this in turn, and only those who answer 'yes' will have their contact information recorded and will be contacted in this next stage of the research. This will be recorded and witnessed by another participant. Oral consent will again be sought when these participants are contacted for their follow-up interview.

APPENDIX G Green Map Icons

APPENDIX H Electronic copies of Green Maps (DVD)

An electronic copy of the community Green Maps are included in the rear pouch. They are saved as PDF and Adobe illustrator files for each of the four maps: Bellavista, Bunche, Santa Rosa, and Portovelo (front and back).

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