The “Other” Cancún: Exploring Knowledge, Attitudes, and Practices Towards Water, Sanitation, Hygiene and Health in Two Ejido Settlements in Cancún, Mexico

by

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AUTHOR'S DECLARATION

I hereby declare that I am the sole author of this thesis. This is the true copy of the thesis, including any required final revisions, as accepted by my examiners. I understand that the thesis may be made electronically available to the public.

ABSTRACT

Hundreds of millions of people globally are without access to water, sanitation, and hygiene (WASH) and face a higher likelihood of contracting waterborne illnesses like cholera, dysentery, and typhoid. While the majority of the global population without WASH tend to be those living in low-income nations (LICs), this problem also affects those in upper-middle (UMIC) and high-income countries (HIC), like Mexico and Canada. Despite reductions in the proportion of the population in UMICs and HICs without access to WASH since the inception of the Millennium Development Goals (MDGs), the most marginalized and vulnerable communities continue to be without these essential services. This inaccessibility and need to cope with lack of services may result in the continued spread of waterborne illnesses at household and community levels. This research is set in the irregular zones of two ejido[1] settlements in the peri-urban zone of the City of Cancún, Quintana Roo, Mexico. These zones are characterized by a lack of infrastructure and land regulation. The objectives of this research are threefold: to explore the WASH and health knowledge, attitudes, and practices of residents living in these two settlements; second, to investigate the WASH and health knowledge, attitudes, and practices of researchers and professionals who work in the space of WASH and health service provision; and third, to uncover the differences in understanding between residents and key informants of the facilitators and barriers to achieving safely managed services in irregular zones of ejido settlements. Results of semi-structured interviews with residents (n=18) and key informants (n=10) indicate a combination of social, economic, and legal factors that interact to create barriers to achieving access to safely managed services of WASH in these settlements. The issue of land regulation and therefore the inability to be recognized in urban planning was mentioned with the greatest frequency by both residents and key informants. The findings of this research can be utilized to elucidate the gaps and understanding between residents of these irregular zones and the professionals and researchers who actively work to improve access to WASH for all members of the population. Results can also be used to inform future interventions that are both culturally appropriate and sustainable.

[1]Ejidos are a form of collective ownership of land which designates the lands of common property used for harvesting or livestock activities, according to the Agrarian Law of 1915 (Alarcón, 2014)

RESÚMEN

Cientos de millones de personas en todo el mundo no tienen acceso a agua, saneamiento e higiene (ASH) y enfrentan una mayor probabilidad de contraer enfermedades transmitidas por el agua como el cólera, la disentería y la fiebre tifoidea. Si bien la mayoría de la población mundial sin ASH suele ser aquellos que viven en países de renta baja (PRB), este problema también afecta a aquellos en países de renta media-alta (PRMA) y de renta alta (PRA), como México y Canadá. A pesar de las reducciones en la proporción de la población en PRMA y PRA sin acceso a ASH desde el inicio de los Objetivos de Desarrollo del Milenio (ODM), las comunidades más marginadas y vulnerables siguen sin estos servicios esenciales. Esta inaccesibilidad y la necesidad de hacer frente a la falta de servicios puede resultar en la propagación continua de enfermedades transmitidas por el agua a nivel doméstico y comunitario. Esta investigación se desarrolla en las zonas irregulares de dos asentamientos ejidales[2] en la zona periurbana de la ciudad de Cancún, Quintana Roo, México. Estas zonas se caracterizan por la falta de infraestructura y regulación de la tierra. Los objetivos de esta investigación son tres: explorar el conocimiento, las actitudes y las prácticas de ASH y salud de los residentes que viven en estos dos asentamientos; segundo, investigar el conocimiento, actitudes y prácticas de ASH y salud de los investigadores y profesionales que trabajan en el espacio de ASH y la provisión de servicios de salud; y tercero, descubrir las brechas y superposiciones en el entendimiento entre los residentes y los informantes clave acerca de los facilitadores y las barreras para lograr servicios administrados de manera segura en zonas irregulares de asentamientos ejidales. Los resultados de entrevistas semiestructuradas con residentes (n = 18) e informantes clave (n = 10) indican una combinación de factores sociales, económicos y legales que interactúan para crear barreras para lograr el acceso a servicios de ASH administrados de manera segura en estos asentamientos. La cuestión de la regulación de la tierra y, por lo tanto, la incapacidad de ser reconocerla en la planificación urbana fue mencionada con mayor frecuencia por los residentes y los informantes clave. Los resultados de esta investigación pueden utilizarse para dilucidar las brechas y la comprensión entre los residentes de estas zonas irregulares y los profesionales e investigadores que trabajan activamente para mejorar el acceso a ASH para todos los miembros de la población. Los resultados también se pueden utilizar para informar futuras intervenciones que sean culturalmente apropiadas y sostenibles.

[2] Los ejidos son una forma de propiedad colectiva de la tierra que designa las tierras de propiedad común utilizadas para la agricultura o actividades ganaderas, de acuerdo con la Ley Agraria de 1915 (Alarcón, 2014)

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TABLE OF CONTENTS

AUTHOR'S DECLARATION.....ii

ABSTRACT.....iii

RESÚMEN.....iv

ACKNOWLEDGEMENT.....v

LIST OF FIGURES vi

LIST OF TABLES vii

LIST OF ACRONYMS viii

CHAPTER ONE – INTRODUCTION

1.1 Research Background ..……..……..1
1.2 Research Rationale ……..……...2
1.3 International Research Partnerships and the WASH-Health Nexus ……3
1.4 Potential Contributions of Research ……...4
1.5 Thesis Organization ……....4

CHAPTER TWO – LITERATURE REVIEW AND THEORETICAL CONTEXT

2.1 Introduction ……6
2.2 Health Outcomes Associated with Inadequate WASH ……..6
2.3 International Declarations of the Importance of WASH ...……..…8
2.3.1 The Millennium Development Goals (MDG) ……8
2.3.2 The Sustainable Development Goals (SDG) ……..…10
2.4 WASH in Low-Income Communities in High-Income Countries …..……..…12
2.4.1 Access to Services of WASH in Low-Income Communities in Mexico ……..…13
2.5 Theoretical Context ……...…...15
2.5.1 Health Geography and the WASH-Health Nexus ……...……16
2.5.2 Ecosocial Theory ……...…17
2.5.3 Political Ecology of Health Framework ……...18
2.6 Knowledge, Attitudes, and Practices Research ……19
2.7 Chapter Summary ……....21

CHAPTER THREE – METHODOLOGY

3.1 Introduction ..……22
3.2 Research Setting ..……22
3.3 Research Design and Methodology ……...……..26
3.3.1 Data Collection Methods ...……..26
3.3.2 Participant Selection and Recruitment, and Sampling…….……27
3.4 Data Analysis ...……....30
3.5 Challenges with cross-cultural qualitative studies .....……...31
3.6 Qualitative Rigour and Reflexivity ……..……32
3.7 Chapter Summary ……33

CHAPTER FOUR – RESULTS
4.1 Introduction ……..35
4.2 Resident sociodemographic characteristics ……..35
4.3 Resident KAP of Water ……37
4.4 Resident KAP of Sanitation ……40
4.5 Resident KAP of Hygiene ……42
4.6 Resident KAP of Health and Healthcare ……..43
4.7 Key Informant Profiles and Organizational Attributes ……52
4.8 Key Informant KAP of Water ……..58
4.9 Key Informant KAP of Sanitation ……62
4.10 Key Informant KAP of Hygiene ……65
4.11 Key Informant KAP of Health and Healthcare Options ……66
4.12 Resident's KAP on Facilitators and Barriers to Achieving Services ……..68
4.13 Key Informant KAP on Facilitators and Barriers to Achieving Services ……..72
4.14 Chapter Summary ……..79

CHAPTER FIVE – DISCUSSION AND CONCLUSION
5.1 Introduction……..……82
5.2 Summary of Key Findings ……...82
5.2.1 Gaps and Overlaps in Key Informant and Resident KAP of WASH and Health….82
5.2.2 Facilitators and Barriers for Accessing Safely Managed Services of WASH……..87
5.3 Contributions ……....…….90
5.4 Limitations ..……..……...91
5.5 Directions for Further Research……92
5.6 Conclusion ……94

REFERENCES ……96

APPENDICES ……...106

LIST OF FIGURES

Figure 2.1 – Diarrheal disease risk reductions associated with transitions in sanitation and drinking water ……..……..7

Figure 2.2 – Timeline of international targets and actions related to access to drinking water and sanitation ……..……8

Figure 2.3 – Updated service ladders per the JMP Progress Report……..11

Figure 3.1 – The State of Quintana Roo within the country of Mexico ……23

Figure 3.2a – The municipalities of Isla Mujeres and Benito Juárez, Quintana Roo ……25

Figure 3.2b – Research sites of Ejido Alfredo V. Bonfil and Ejido Zona Urbana Isla Mujeres (Rancho Viejo) ..……25

Figure 3.2c – Isla Mujeres and Benito Juárez municipalities relative to City of Cancún and the Hotel Zone ……25

Figure 3.3 – Systematic and iterative qualitative data analysis approach and technique ……31

LIST OF TABLES

Table 2.1 – SDG global goals, targets and indicators for drinking water, sanitation and hygiene……...10

Table 2.2 – Rates of coverage in Mexico for safely managed services of water and sanitation as of 2015……14

Table 3.1 – Population Statistics as of 2015 – Municipalities of Isla Mujeres and Benito Juárez…….26

Table 4.1 – Sociodemographic Profile of Residents from Rancho Viejo and Alfredo V. Bonfil Ejidos ……36

Table 4.2 – Resident KAP of Water ……39

Table 4.3 – Resident KAP of Sanitation ……41

Table 4.4 – Resident KAP of Hygiene ……..43

Table 4.5 – Resident KAP of Health and Healthcare ……50

Table 4.6 – Profile of Key Informants Recruited for Interview ……52

Table 4.7 – Key Informant Organizational Attributes ……..57

Table 4.8 – Key Informant KAP of Water ……61

Table 4.9 – Key Informant KAP of Sanitation ……64

Table 4.10 – Key Informant KAP of Hygiene ……..……66

Table 4.11 – Key Informant KAP of Health and Healthcare Options of Residents ……68

Table 4.12 – Resident and Key Informant Insight on Facilitators and Barriers to Achieving Services in Irregular Zones of Ejido Settlements ……..77

LIST OF ACRONYMS

CAPA – Comisión de Agua Potable y Alcantarillado (Water and Sewerage Commission)

CFE – Comisión Federal de Electricidad (Federal Electricity Commission)

CICY – Centro de Investigacion Cientifica de Yucatán

COFEPRIS - Comisión Federal para la Protección contra Riesgos Sanitarios (Federal Commission Against Sanitary Risks)

CORETT – Comisión para la Regularización de la Tenencia de la Tierra (Commission for the Regularization of Land Tenure)

DALYs – Disability-Adjusted-Life Year

DIF – Desarrollo Integral de la Familia (National System for Integral Family Development)

FONATUR – Fondo Nacional de Fomento al Turismo (National Fund for Tourism Promotion)

GNI – Gross National Income

HICs – High-income countries

ISSSTE – Instituto de Seguridad y Servicios Sociales de los Trabajadores del Estado (Institute of Social Security and Services of State Workers)

IMSS – Instituto Mexicano de Seguridad Social (Mexican Social Security Institute)

JMP – Joint Monitoring Programme

KAP – Knowledge, Attitudes, and Practices

LMICs – Low- and middle-income countries

MDGs – Millennium Development Goals

NGOs – Non-governmental organizations

NPOs – Non-profit organizations

PAN - Partido Acción Nacional (National Action Party of Mexico – Conservative)

SDGs – Sustainable Development Goals

UMICs – Upper middle-income countries

UN – United Nations

UNICEF – United Nations Children's Fund

WASH – Water, sanitation, and hygiene

WHO – World Health Organization

WI – The University of Waterloo's Water Institute

CHAPTER ONE – INTRODUCTION

1.1 Research Background

Inaccessibility to water, sanitation, and hygiene (WASH) affects hundreds of millions of people globally and results in a host of health issues such as cholera, dysentery, and typhoid (Prüss-Ustün et al., 2019). Access to safely managed WASH is a driver of other metrics for development including education, nutrition, and gender equality and provides the foundation upon which other benchmarks for sustainable development are achieved (WHO/UNICEF, 2017). Most of those experiencing a lack of access to these services are people who live in low- (LIC) and lower-middle-income countries (LMIC) and tend to be rural dwellers and those in the lowest wealth quintile (WHO/UNICEF, 2019). Access to WASH is also a gendered issue, with women and girls disproportionately facing the burden of collection and household water management (WHO/UNICEF, 2017; 2019). What is lesser known, these same issues with inaccessibility to WASH impact populations in upper-middle income and high-income countries.

While significant gains in access to WASH have been made in several upper-middle-income countries (UMIC) and high-income countries (HIC), like Australia and New Zealand, others continue to struggle in closing the gap on the intra-regional variation between those with access to basic versus safely managed WASH. In Mexico, where the percentage of those without at least basic WASH has declined sharply and the discrepancy between access to services based on wealth and proximity to an urban centre has narrowed since the inception of the Millennium Development Goals (MDGs) in 2000, 57% of the population remains without safely managed water and 50% are without safely managed sanitation (WHO/UNICEF, 2019). In the context of the Yucatán Peninsula, located in the southeastern region of Mexico, the porosity of the landscape makes mismanagement of sanitary waste an especially dangerous issue to the local environment and to the larger water supply that serves the local population (Vieyra & Merediz-Alonso, 2011).

Lack of access to WASH further contributes to inequities within the population. This thesis explores the knowledge, attitudes, and practices (KAP) of residents living in irregular zones of ejido settlements as well as the KAP of key informants who work in the space of service provision in Mexico to increase the understanding of the facilitators and barriers that exist to achieving universal access to services of WASH.

1.2 Research Rationale

Goal 6 of the Sustainable Development Goals (SDG) aims to "ensure availability and sustainable management of water and sanitation for all" by 2030 (UNESC, 2019). This goal is intended to build on the progress of its predecessor, Target 7c of the Millennium Development Goals, and contains a number of targets and indicators to guide the international community in efforts to obtain this goal of universal access to WASH. Basic services of WASH include using improved sources of drinking water that require no more than 30 minutes per trip to collect, using an improved sanitation facility not shared with other households, and in the case of hygiene, living in households with a handwashing facility with soap and water available on the premises (WHO/UNICEF, 2017). The progress made towards achieving basic access to WASH since the inception the Millennium Development Goals (MDGs) in 2000, has been marked on both international and sub-national scales. Despite this progress, there continues to be significant portions of the global population who are without services of WASH.

It is important to note that while access to basic WASH is a key target for sustainable development, basic services does not equate to safely managed. Certain countries, particularly upper-middle- and high-income countries, struggle to attain this top rung of the service ladder for all members of their respective populations. This problem is evident in all North American countries. Safely managed services of water and sanitation in particular (a safely managed benchmark for hygiene has not been developed as of yet) refers to sources of water free of contamination and available when needed, and excreta that is handled and disposed of safely (WHO/UNICEF, 2017). Discrepancy in access is further amplified when considered in urban versus rural contexts. In each element of WASH: water, sanitation, and hygiene, countries report lower rates of access to both basic and safely managed services for rural dwellers. Regardless of urban versus rural setting, lack of access increases the susceptibility of the population to preventable WASH-related diseases.

More work must be done not only to increase overall national levels of access beyond basic to safely managed WASH in UMICs and HICs, but also to reduce intraregional inequities between urban and rural populations and within intra-urban settings as well. In order for variation in access to WASH and the number of cases of preventable WASH-based health illnesses to decrease, it is imperative the solutions account for local context, namely knowledge, attitudes, and practices of those who experience inaccessibility to services as well as that of the professionals in the WASH and health spaces who actively work to improve access. Incorporating the insight from both

respective groups as to the facilitators and barriers to achieving universal access to basic and, eventually, safely managed services, long-lasting and sustainable solutions are more likely to be found.

1.3 International Research Partnerships and the WASH-Health Nexus

The development of international research partnerships to further investigate inequities in WASH, regardless of Gross National Income (GNI) per capita, is beneficial. An example of such a partnership to explore these inequities in higher-income countries was established between the University of Waterloo's Water Institute (WI) and the Centro de Investigacion Cientifica de Yucatán (CICY). During an initial visit by researchers of CICY to the WI to discuss nutrient cycling and contaminant transport in groundwater supplies of Southern Ontario and the state of Quintana Roo, Mexico, it was mutually agreed that potential for collaboration beyond this area of research existed. Researchers and highly qualified persons from both the WI and CICY recognized the two institutions could work jointly to accomplish the common goal of reducing environmental and health outcomes related to WASH in low-income communities in both countries. In a Canadian context, Indigenous Peoples disproportionately experience a lack of WASH at a higher rate than non-Indigenous members of the population (Harper et al., 2015). In the Yucatán Peninsula, Mexico, those members of the population lacking access to WASH typically live in irregular zones of ejido settlements. Residents in irregular zones tend to rent or lease ejido lands and therefore are not legally recognized in urban planning and are excluded from receiving many essential services including WASH. To be "regularized" is to own the deeds of one's property and be recognized by the municipality. This thesis has three specific research objectives:

1. To explore the water, sanitation, hygiene and health-related knowledge, attitudes, and practices of residents living in irregular zones of ejido settlements
2. To explore the water, sanitation, hygiene and health-related knowledge, attitudes, and practices of key informants
3. To uncover the differences in understanding between residents and key informants with respect to the facilitators and barriers to WASH

By addressing these objectives, an improved understanding of the connections between WASH and health at a multitude of scales, the individual, community, and state, will emerge. These findings can better clarify to stakeholders where future directions for research and potential

policy interventions would be most effective in removing barriers to accessing WASH and subsequently reducing the health outcomes associated with this lack of access.

1.4 Potential Research Contributions

This research aims to contribute to a gap in the current literature pertaining to the links between WASH and potential WASH-related health outcomes, specifically in a Mexican context. Exploring the lived experiences of residents who currently lack access to safely managed WASH and have higher incidence of health problems utilizing qualitative methodology is relatively absent from the current literature. This gap was identified during the initial steps of a systematic review that many researchers in the WASH-health space typically utilize quantitative methodologies when investigating this topic (Hall et al., in preparation).

While this research topic, the chosen methodology, and the interpretation of results by a health geographer is relatively unique in a Mexican and HIC context, this thesis adds to the existing body of literature investigating the knowledge, attitudes, and practices (KAP) of marginalized populations who experience lack of access to this basic human right. Contrasting the KAP of residents in low-income communities in higher-income countries, who must cope daily with the burden associated with inaccessibility to safely managed services of WASH with that of key informants who work to provide these services, will provide direction as to the potential misinformation that persists among both groups and to bridge this gap.

Not only will this research provide evidence informing other researchers of the current perceptions and practices of residents and key informants in a Mexican-setting, it will also support future research projects in the larger WI-CICY partnership, and in other UMIC and HIC contexts. Furthermore, the findings will help to determine potential opportunities for sustainable interventions in these settlements as an alternative to formalized infrastructure and to work alongside the key informants in the WASH-health space to leverage the knowledge and resources of CICY and the WI to achieve universal access to services of WASH in these settlements.

1.5 Thesis Organization

This thesis comprises five chapters, including this introductory chapter. The following **Chapter 2** provides the theoretical framework and includes a literature review on the WASH-health nexus at global and sub-national levels. An orientation of this research within the sub-discipline of health geography and health inequalities research is also provided in this chapter to

define the contributions to these respective fields in understanding accessibility to basic services among low-income populations. The chapter concludes with an introduction to the existing research on knowledge, attitudes, and practices (KAP).

Chapter 3 discusses the research design and methodology, detailing the methods utilized for data collection and analysis. An explanation of the method chosen for data collection, semi-structured interviews with key informants and residents, is provided along with a discussion of their strengths in health geography and qualitative research more generally. An in-depth description of the data analysis techniques and the use of the qualitative data analysis software, NVivo 12 for Mac to house the coding manuals is also described. The chapter concludes with the methodological challenges associated with conducting research in cross-cultural settings and the processes and checklists employed to ensure rigour.

Research results are presented in **Chapter 4.** The results are organized according to the research objectives, which aimed to explore the knowledge, attitudes, and practices of residents, key informants, and uncover the differences in understanding between residents and key informants with respect to the facilitators and barriers to WASH in ejido settlements. The results of the interviews for each category of respondent are intentionally separated, with a thorough explanation on the gaps and overlaps in understanding presented in the subsequent chapter.

Chapter 5 concludes the thesis with a discussion of the third objective, determining the variations in knowledge, attitudes, and practices between residents and key informants regarding WASH and health services. The interpretation of the potential facilitators and barriers that exist in irregular zones of ejido settlements in terms of efforts to provide WASH and other services by both respective groups is also given. Limitations are presented in this chapter, which aim to guide future research and relevant WASH-health interventions. Suggestions are given for future research to further existing efforts to provide WASH services in this research setting as well as other UMICs and HICs. The thesis concludes with the contributions of this work in the context of health geography and health inequalities research.

CHAPTER TWO – LITERATURE REVIEW AND THEORETICAL CONTEXT

2.1 Introduction

Hundreds of millions of people around the world lack access to safely managed water, sanitation, and hygiene (WASH). This lack of access manifests in both physical and psychosocial health outcomes and are predominantly experienced by the world's most vulnerable and marginalized people (WHO/UNICEF, 2017).

Chapter 2 examines the literature pertaining to the inequitable distribution of WASH-related health outcomes, the major international frameworks intended to address and end this inequity, and the orientation of the WASH-health nexus within health geography. Next, the theoretical concepts of ecosocial theory and the political ecology of health framework are presented in the context of this research and their appropriate application to exploring the WASH-health nexus at a multitude of scales including the individual, regional, and national. Factors embedded into social, legal, economic, and political structures in this research setting are also explored. Finally, the application of previous knowledge, attitudes, and practices (KAP) research to address the research objectives is provided.

2.2 Health Outcomes Associated with Inadequate WASH

There are several health outcomes associated with lack of access to WASH, many of which are waterborne and can be bacterial, viral, or parasitic. Examples include *Vibrio cholerae* (cholera), pathogenic *Escherichia coli* (*E. coli*), *Cryptosporidium parvum* (*C. parvum*), *Giardia lamblia*, *Salmonella* Typhimurium (*S.* Typhimurium or typhoid fever), *Shigella*, and helminths (Taylor et al., 2015). The global burden of disease associated with WASH has been estimated throughout the decades, often providing values that vary tremendously based on methods, scope of estimates, and as ongoing improvements to services of WASH are made around the world (Clasen et al., 2014). However, these assessments are critical to identify priorities for improving population health and to track changes in the relative importance of different diseases, injuries, and risk factors (Murray and Lopez, 2013). Recent estimates for the year 2016 indicated nearly 1.6 million deaths and 105 million disability-adjusted life years (DALYs) were attributable to inadequate WASH – 829,000 of which were diarrheal diseases (Prüss-Ustün et al., 2019). Per the World Health Organization's Global Health Observatory, diarrheal diseases alone account for 1.9% of the Global Burden of Disease (WHO, 2016). Efforts to reduce diarrheal-related diseases, as scale of intervention and improvements to quality and coverage of service of WASH increase, result in a sharp decline in

health risks (Figure 2.1). Interventions that break the fecal-oral transmission route might include installing protected wells, distributing chlorine tablets to address water quality, or improving methods of construction for latrines (Taylor et al., 2015).

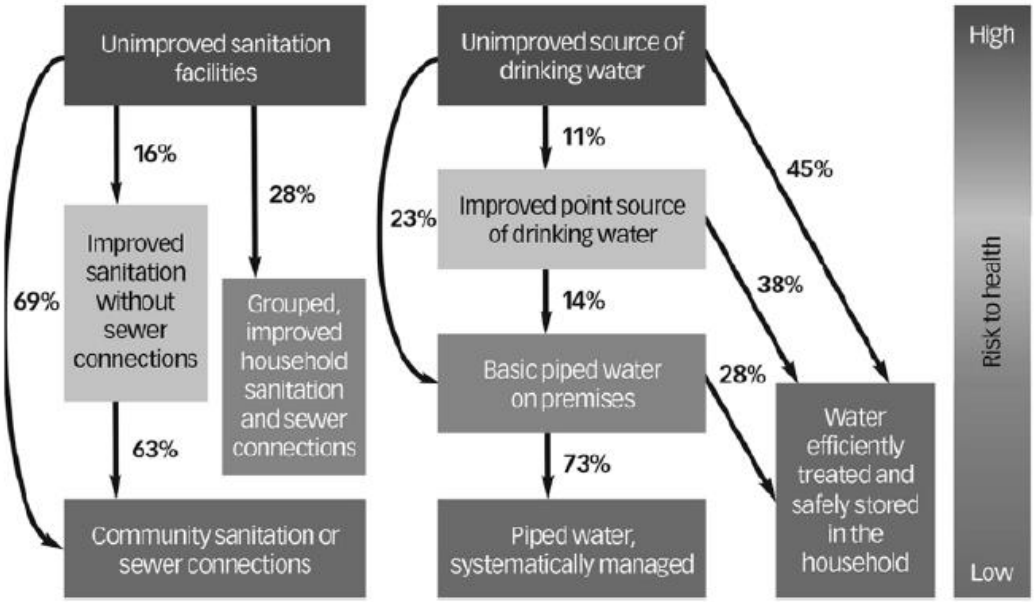

Figure 2.1: Diarrheal disease risk reductions associated with transitions in sanitation and drinking water (Satterthwaite, 2016)

In addition to the physiological manifestations associated with lack of WASH, there are also psychosocial health outcomes including feelings of harm, suffering, and stress (Bisung & Elliott, 2017a; Bisung & Elliott, 2017b; Sultana, 2011; Wutich & Ragsdale, 2008; Sapolsky, 2004; Evans & Cohen, 1987). These emotions can be produced through the everyday realities of access, use, and control of WASH such as the burden of collection, negotiating access, the opportunity cost of buying from informal sources (Bisung & Elliott, 2017b; Sultana 2011). These realities can be situated within the environmental and social conditions of the individual and the broader community and can arise from cultural and social norms, responsibilities and expectations surrounding the use of WASH, and the physical barriers to access (Stevenson et al., 2016; Krieger, 2011).

Psychosocial health is embedded within an iterative process whereby individuals evaluate the risks and threats posed by a stressor followed by an appraisal of the coping resources and mechanisms available to them to deal with the stressor (Bisung & Elliott, 2017a). Coping and dealing with stressors is seen to be the second step in this process but in low-resource settings,

psychosocial concerns can be exacerbated as available solutions are limited (Bisung & Elliott, 2017a; Sahoo et al., 2015). Individuals with fewer mechanisms to cope and manage stressors have been found to experience emotions like stress and frustration with greater frequency than those with more social and economic assets (Wutich & Ragsdale, 2008).

2.3 International Declarations of the Importance of WASH

The importance of WASH to sustain life and maintain good health has been acknowledged and recognized throughout the decades (Figure 2.2). Prior to the formal declaration of water and sanitation as a basic human right in 2010, national and state governments, international organizations, and non-governmental organizations (NGO) developed policies with clear timelines to secure access for those without WASH. In 1976 at Habitat I, the first UN Conference on Human Settlements, governments came together to make commitments to universal provision for water and sanitation. The International Drinking Water Supply and Sanitation Decade followed in the 1980s to help ensure universal provision by 1990 (Satterthwaite, 2016). In 2002, the United Nations Committee on Economic, Social and Cultural Rights adopted its general comment No. 15 on the right to water stating that: "The human right to water entitles everyone to sufficient, safe, acceptable, physically accessible and affordable water for personal and domestic uses." Universal access to sanitation is, "not only fundamental for human dignity and privacy, but is one of the principal mechanisms for protecting the quality of water resources" (UNCESCR, 2002). In 2010, access to water and sanitation was explicitly recognized as essential to the realization of all other human rights by the United Nations General Assembly through Resolution 64/292 (UN DESA, 2010).

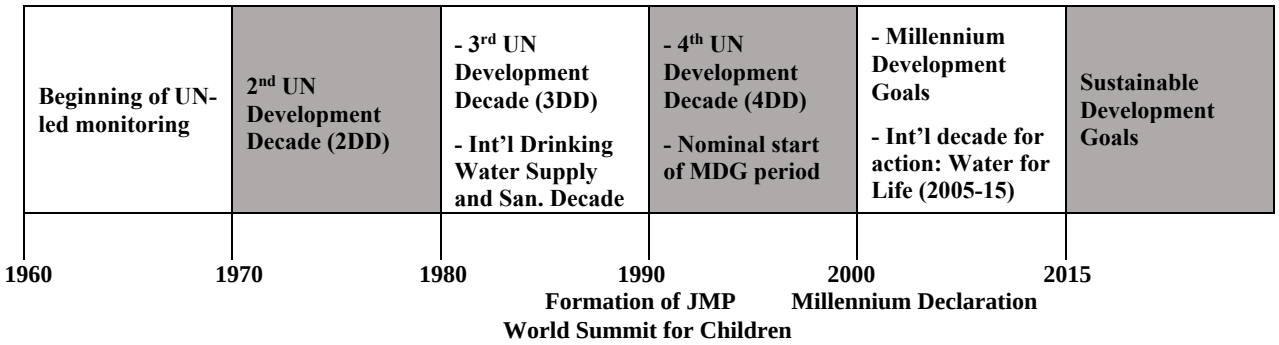

Figure 2.2: Timeline of international targets and actions related to drinking water and sanitation (Bartram et al., 2014)

2.3.1 The Millennium Development Goals (MDG)

The success and gains in access to WASH made during the Water Decade demonstrated global goals, when made on a country-by-country basis, may accelerate action (Black and White, 2003). In 2000, the United Nations unveiled the eight Millennium Development Goals (MDGs), an ambitious agenda with targets and benchmarks to alleviate poverty and improve the wellbeing of the world's population (UN, 2013). The goals were interconnected and mutually reinforcing, many of which were integral to achieving all other goals (Bisung, 2015). MDG 7 – the goal created to ensure environmental sustainability by 2015, contained four targets. One of these targets, Target 7c, aimed to halve the proportion of the population without access to water and sanitation (UN, 2013). This target acknowledged the fulfilment of a basic human right, acted as a step to reduce poverty more generally, and was part of a sustainable strategy towards integrated water resource management. It was reported that the global target for access to improved drinking water was met five years early – seeing the proportion of the population using improved sources rise from 76 per cent in 1990 to 89 per cent in 2010 (UN, 2013). For sanitation, however, the goal was not achieved, reporting 2.5 billion people still lacking access to an improved sanitation facility and one billion people continuing to practice open defecation – a major health and environmental hazard (UN, 2013).

Despite significant progress made on many of the goals, there have been critiques of the MDGs (Satterthwaite, 2016). Satterthwaite indicated the measurement and definition of terms lead to inaccurate estimates of determining access to WASH (2016). In the case of what defined "improved facilities" for services of water and sanitation – water that is protected from outside contamination and excreta that is hygienically separated from human contact – the MDGs did not go far enough to include the other, multiple dimensions of cleanliness and safety of a facility (WHO, 2012). If the MDGs were to provide estimates of the proportion of the global population without *safe* WASH, estimates could have been two-to-three times higher than reported numbers (Satterthwaite, 2016). For sanitation, the MDGs characterized pit latrines with slabs as an improved facility; however, these facilities are well-documented as being inadequate for the maintenance of good health because of concerns related to contamination of groundwater sources namely through gaps in maintenance practices for separating and disposing of waste (Satterthwaite, 2016). Scale was also not appropriately considered in the MDG 7c Target. At the community-level, habits like defecation outdoors could continue to impact resident health through contamination of a local water supply, regardless of whether incremental household-level

improvements to achieving proper separation and treatment of waste were made (Satterthwaite, 2016). Another shortcoming of the MDGs is the lack of recognition of the importance of hygiene – "the conditions and practices that help maintain health and prevent spread of disease including handwashing, menstrual hygiene management, and food hygiene" (Mara & Evans, 2017). Hygiene has long-established links with public health but was not included in any MDG targets or indicators, despite being stated as of great importance for reducing childhood mortality and the incidence of diarrhea (WHO/UNICEF, 2017, Jolly, 2003).

2.3.2 The Sustainable Development Goals (SDGs)

To continue the progress made during the era of the MDGs as well as address the gaps identified, the Sustainable Development Goals (SDGs) were adopted to achieve the long-term sustainable development of human society as a whole (Biggs et al., 2015). The SDGs marked the commitment to strengthening and increasing the comprehensiveness of a post-2015 monitoring framework to cover a range of drivers across the three main dimensions of sustainable development: economic, social, and environmental (Giné Garriga and Pérez Foguet, 2016; UNGA, 2014). This included a dedicated goal on water and sanitation, Goal 6. Goal 6 aims to ensure the availability and sustainable management of water and sanitation for all by 2030 (UNDESA, 2018) (Table 2.1). SDG 6 consists of six outcome targets (6.1–6.6), and two Means of Implementation (MoI) targets (6a and 6b) which implicitly apply to all outcome targets and to the overall goal (Bartram et al., 2018).

Table 2.1: SDG global goals, targets and indicators for drinking water, sanitation and hygiene

WASH SECTOR GOAL	SDG GLOBAL TARGET		SDG GLOBAL INDICATOR	
Ending open defecation	6.2	By 2030, achieve access to adequate and equitable sanitation and hygiene for all and **end open defecation**, paying special attention to the needs of women and girls and those in vulnerable situations	6.2.1	Population practising **open defecation**
Achieving universal access to basic services	1.4	By 2030, ensure all men and women, in particular the poor and vulnerable, have equal rights to economic resources, as well as **access to basic services**…	1.4.1	Population living in households with access to basic services (including **basic drinking water, sanitation and hygiene**)
Progress towards safely managed services	6.1	By 2030, achieve universal and equitable access to **safe and affordable drinking water** for all	6.1.1	Population using **safely managed drinking water services**
	6.2	By 2030, achieve access to **adequate and equitable sanitation and hygiene** for all and end open defecation, paying special attention to the needs of women and girls and those in vulnerable situations	6.2.1	Population using **safely managed sanitation services**
			6.2.1	Population with a basic **handwashing facility** with soap and water available on premises

SDG 6 is intended to build on the progress of the MDG Target 7c but also address the shortcomings, particularly as it relates to moving beyond the measurement of service coverage to service quality, include targets pertaining to the entire water cycle, and contain an explicit target for hygiene (WHO/UNICEF, 2017; Giné Garriga and Pérez Foguet, 2016). Service ladders are now reported to indicate whether a WASH facility is considered safely managed, basic, limited, unimproved, or a facility does not exist (Figure 2.3). "No facility" indicates a population continues to utilize untreated surface water for drinking, defecates outdoors, and lacks a handwashing station on their property. Safely managed services, the highest rung of the ladders for water and sanitation, have three dimensions: cleanliness, proximity, and availability. Water should be free from contamination, relating to the need to comply with standards for faecal contamination (*E. coli*) and priority chemical contamination (arsenic and fluoride). Supplies should also be on the premises and available and accessible when needed for at least 12 hours per day (WHO/UNICEF, 2017). For services of sanitation to be considered safely managed, there are two criteria. Excreta must either be emptied from the disposal site and the treatment of wastewater conducted off-site, ideally at wastewater treatment plants or for those without piped infrastructure, excreta is treated and disposed of in situ but is done so with appropriate leach-fields, or in latrine pits that are covered and left undisturbed when full (WHO/UNICEF, 2017). A safely managed category has not been developed for hygiene.

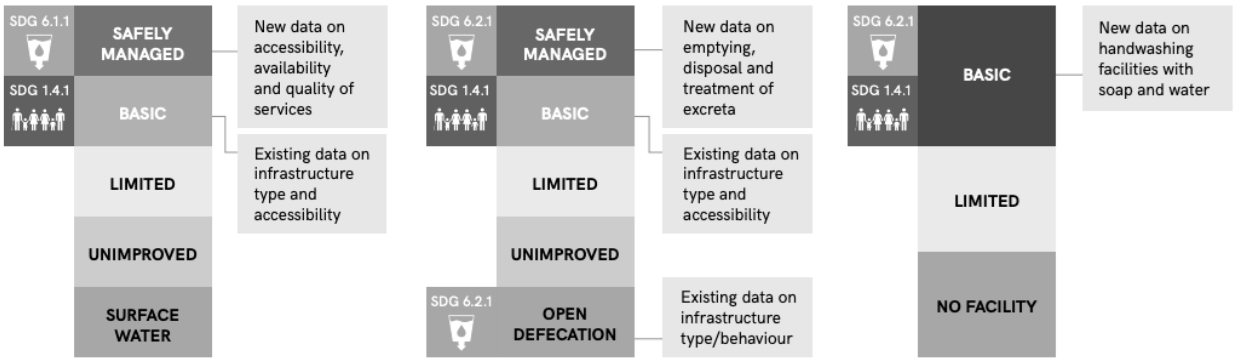

Figure 2.3: Updated service ladders per the JMP Progress Report (WHO/UNICEF, 2017)

Monitoring of the progress towards achieving the targets outlined under SDG 6 falls to the UN's custodian agencies including the inter-agency Global Expanded Monitoring Initiative (GEMI), UN-Water Global Analysis and Assessment of Sanitation and Drinking-Water (GLAAS), and the WHO/UNICEF Joint Monitoring Programme for Water Supply, Sanitation and Hygiene (JMP) ("Monitor and Report – UN Water", n.d.; Bartram et al., 2014; Cotton and Bartram, 2008). The JMP provides regular estimates and reports on progress to achieving targets 6.1 and 6.2 and

contributes to the wider UN-Water integrated monitoring initiative for SDG 6 (WHO/UNICEF, 2017).

Despite the improvements documented from the era of the MDGs to the SDGS, gaps and shortcomings of the new framework for global sustainable development have been identified including the lack of clarity around the Means of Implementation (MoI), the monitoring and reporting of targets and indicators, and the limitations of the hygiene target (Guppy, Mehta & Qadir, 2019; Bartram et al., 2018). As it relates to this thesis and in the context of targets 6.1 and 6.2 and their respective indicators, "equitable access" to WASH lacks a clear definition, particularly in inter-regional and inter-urban settings. This has implications for monitoring.

2.4 WASH in Low-Income Communities in Upper-Middle and High-Income Countries

Intra-regional variability under SDG 6 has been somewhat accounted for as part of larger monitoring efforts by the Joint Monitoring Programme (JMP); an improvement from previous practices as set out under the MDGs (Black and White, 2004; von Dach et al., 2006). While improvements have been made, monitoring the sub-national inequality in access to WASH is limited and a standardised process and set of benchmarks for tracking countries' progress to achieving targets set out under Goal 6 is somewhat lacking (Pullan et al., 2014). The JMP's 2017 Summary Report and the Special Focus on Inequalities Report indicates significant reductions in the proportion of the global population without access to WASH on an aggregated basis since the inception of the MDGs, these sub-national inequalities in WASH continue to exist (WHO/UNICEF, 2019). Where there is available data, inequalities at national and sub-national scales are particularly felt among urban slum dwellers, women and children, and rural populations (Pullan et al., 2014; Morua et al., 2014; Bisung, 2014; WHO/UNICEF, 2019). The effects of this inequitable access to services has led to a concomitant distribution of WASH-related health outcomes (Prüss-Üstün et al., 2019).

While the largest gaps in terms of access to WASH and higher reported incidence of WASH-related health outcomes are experienced by those in low-income countries (Gross National Income (GNI) per capita of $1,025 USD or less), which includes much of sub-Saharan Africa, inequities in terms of accessibility to WASH is a global phenomenon and also effects upper-middle income (GNI per capita between $3,996 and $12,375 USD) and high-income countries (GNI per capita higher than $12,376 USD) (World Bank, 2019). Research on inaccessibility to WASH in low-income countries is expansive and the majority of funding from international organizations and

non-governmental organizations (NGO) is, understandably, directed to these settings. While the JMP reports a correlation between high GNI per capita and greater access to WASH, intra-regional disparities in higher-income countries continues to be a problem. In Canada for instance, a high-income country with a GNI of $47,490 per capita, reported rates of access to WASH for Indigenous peoples is significantly lower than the rest of the population (Anderson et al., 2013; Bernier et al., 2009; Castledon et al., 2017; Hanrahan et al., 2014; Harper et al., 2015a). Similarly, along the United States' southern border, people living in unincorporated rural settlements characterized by high-levels of poverty and poor access to civil infrastructure, known as *colonias*, respiratory and skin diseases (Graham et al., 2005), high-levels of arsenic and nitrates in untreated water (Hargrove, 2015; Balazs et al., 2011), and gastrointestinal diseases (Leach et al., 2000; Rios, 2009) are prevalent. Canada and the United States, countries with significant wealth, have the resources and ability to rectify this inequity, yet it continues to be an issue for the most marginalized members of their respective populations.

This thesis focuses the subnational inequalities, particularly intra-regional, in access to WASH in an upper-middle-income country, Mexico. The subsequent physiological and psychosocial health outcomes associated with this inaccessibility is of particular interest for those members of the population living in irregular zones of ejido settlements in the peri-urban area of the City of Cancún.

2.4.1 Access to Services of WASH in Low-Income Communities in Mexico

Mexico, an upper-middle-income country (GNI/capita $9,180 USD), has made tremendous gains in improving access to basic services of water and sanitation for its population since the inception of the MDGs (World Bank, 2019; WHO/UNICEF, 2017). However, it is important to distinguish between access to basic services and safely managed. 98% of Mexico is reported as having access to basic drinking water services, and 89% for sanitation. Those figures, when contrasted with rates of access to safely managed services, decrease dramatically (World Bank, 2019). Table 2.2. demonstrates only 43% nationally have safely managed services of water and 45% for services of sanitation, with rates declining further for those living in rural locales (WHO/UNICEF, 2017).

Table 2.2: Rates of coverage in Mexico for safely managed services of water and sanitation as of 2015 (WHO/UNICEF, 2017).

	Safely Managed Services of Water						Safely Managed Services of Sanitation						
	Safely Managed Services	Accessible on premises	Available when needed	Free from contamination	Piped	Non-piped	**Safely Managed Services**	Disposed of in situ	Emptied and treated	Wastewater treated	Latrines and other	Septic Tanks	Sewer connections
National	43	94	69	43	95	4	45	8	0	37	3	13	72
Urban	-	97	72	-	98	2	46	4	0	42	1	7	83
Rural	-	82	61	-	85	10	-	-	-	16	13	36	31

Variation in access to WASH between members of the population in Quintana Roo can be traced back to the federal and state governments' substantial investment in the tourism industry and the subsequent creation of low-income neighbourhoods on the peripheries of many tourism centres, like Cancún. The growth of tourism in the Yucatán Peninsula, a region that encapsulates the states of Quintana Roo, Yucatán, and Campeche, has been encouraged and supported by the Mexican federal government since the 1960s, particularly to support the growth of the City of Cancún. The Bank of Mexico in the 1970s initiated the infrastructural projects to develop Cancún from a small settlement of 200 people to a luxurious tourist complex (Cruz, 2003). As of most recent figures, the temporary accommodation and food and beverage preparation services industry, accounts for 1.6% of gross domestic product (GDP) for the whole of Mexico (GDP) (INEGI, 2015). Following the mass migration of people in the 1970s to support the development of this international tourism emporium, the creation of migrant neighbourhoods called *areas populares* – unplanned housing areas with a lack of services, emerged (Cruz, 2003; 1996). The social dichotomy of Cancún quickly became apparent through the contrast of the residential areas of downtown versus the periphery low-income neighbourhoods of the migrants (Cruz, 1996). As the intensification of the tourism industry continued in Cancún, so did the arrival of settlers from rural Quintana Roo, other states in Mexico, and from neighbouring countries – all seeking opportunity for employment (Torres & Momsen, 2005). The Cancún Master Plan originally included a ten-kilometer by one-kilometer fringe to house migrants working in construction and low-end service jobs, but this area grew rapidly into a series of unplanned and uncontrolled squatter settlements

(Torres & Momsen, 2005). Lands from adjacent *ejidos* were expropriated to accommodate the influx of migrants. According to the Agrarian Law of 1915, ejidos are a form of collective ownership of land which designates the lands of common property to be used for harvesting or livestock activities (Alarcón, 2014). Following the financial crises in Mexico during the 1980s, the 1992 reform of Article 27 of the Mexican Constitution, the privatization of ejido lands was central to economic overhaul (Barsimantov et al, 2011). Through these reforms, the Program for Certifying Ejidal Rights (PROCEDE) was created to officially recognize individual parcels within common lands, and grant permission to legally divide, title, sell, and/or rent non-forested lands (Barsimantov et al, 2011; Salazar, 2016).

2.5 Theoretical Context

Illness and disease have been present in all societies during all times and will continue to be in the future. The salient issues are what types of health outcomes will be prevalent where, for how long, and who will be affected (Mayer, 2000). A consideration of the compositional and contextual factors that address these issues is essential to determining who gets sick and where. Compositional factors include those relating to socio-demographic characteristics of individuals who live in a certain place including age, sex, ethnicity, employment and income (Collins et al., 2017). Contextual refers to the broader social and physical opportunities in a larger container of space, such as availability and access to services (Collins et al., 2017). Exploring the intra-regional discrepancies in access to services of WASH in Mexico, an upper-middle country, and the uneven distribution of negative health outcomes makes logical sense to be positioned within health geography, a subdiscipline of human geography. Inequalities research, a subfield within health geography and increasingly popular among health geographers, employs theories and approaches to investigate the social structures in which the most influential determinants of health are rooted (Hayes, 1999). The theories selected for this research that have been utilized to further the understanding of health inequalities utilizing a place-sensitive approach and is seeking to answer the question “does living in an irregular settlement in the peri-urban zone outside the City of Cancún increase the risk of getting sick”.

The following sections provide an explanation for the orientation of this research within the subdiscipline of health geography as well as the theories and frameworks utilized to investigate this question. Using constructs found in ecosocial theory and the political ecology of health framework, WASH-related health outcomes embodied at individual, local and regional scales

influenced by the larger social structures will be explored. To conclude the section, an explanation is given on knowledge, attitudes, and practices (KAP) research and its application to this research based on its utility in other, WASH-health studies.

2.5.1 Health Geography and the WASH-Health Nexus

Health as a concept was originally placed within the biomedical sphere, and researchers largely focused on the spread, prevalence, and incidence of disease across space and time. As definitions for health changed to be more inclusive of other forms of health beyond just the presence or absence of disease, particularly those of a more psychosocial nature, so too did the methodologies and theories in health-related inquiry. Formerly, researchers engaged in the study of the spatial distribution of disease would find themselves in positivist disciplines like disease ecology, spatial epidemiology, and medical geography utilizing largely quantitative techniques (Archie et al., 2009; Ostfeld et al., 2005). The field of medical geography, thought by some to be a 'confusing sub-variety' of human geography, evolved to become the geography of health and healthcare following a call for a stronger linkage with social theory. This evolution could be a result of a 'cultural turn' whereby researchers were encouraged to consider broader social models of health and healthcare (Kearns & Moon, 2002; Dyck, 1999). Researchers who answered this call to transition to a post-medical geography now explore concepts related to the broader concept of well-being, with a particular emphasis on the theme of place (Mohan, 2000). Place has many definitions in the literature and is often positioned relative to another theme in geography: space. To contrast the two, space can be defined as an "arena for action and movement" versus place, which is about "stopping, resting, becoming, and becoming involved" (Withers, 2009; Gregory et al, 2011).

The relationship and connectivity between health and place has been well-established and provides a useful framework for acknowledging the role that social, cultural, political, and economic environments play on how health and well-being are shaped (Elliott, 1999). Indeed, some go so far as to declare risks to health cannot be considered in a context independent of time and place, and these risks are imbued with the people who are defined by these places and localities (Hayes, 1992). Journals like *Health & Place,* introduced in 1995, and the *International Journal of Health Geographics* in 2002, provided space for researchers to advocate for and document research utilizing the new place-sensitive framework, beyond the well-known *Social Science & Medicine*, although still a key journal for publication for health geographers today (Andrews & Moon, 2005).

Fields of research that utilize positivist approaches like disease ecology and even the previous iteration of health geography, medical geography, are effective for understanding the biomedical aspect of the transmission of waterborne infectious diseases. However, given the inequitable distribution of services of WASH observed in many UMIC and HICs, including Mexico, a place-sensitive approach is more appropriate to determine the underlying social determinants of WASH-based health outcomes. An interpretation of the water-health nexus is "the interface between the biophysical system of water (ecosystem), the socioeconomic and political system of water (the hydro-social cycle), and human health" (Confalonieri & Schuster-Wallace, 2011). Due to the inextricable links between safe water, adequate sanitation, and basic knowledge of hygiene and their direct implication on human health and well-being, this thesis will go beyond the water aspect of the water-health nexus to explore the *WASH*-health nexus (Jolly, 2003). Many aspects of health and well-being are underpinned by WASH, including school attendance, productivity and income generation, nutrition and stunting, cognitive impairment, and avoidable deaths (Schuster-Wallace et al., 2015). In addition, when access to safe water, functioning hand-washing facilities, latrines, hygiene and cleaning practices, and basic infection prevention and control (IPC) are prioritized, maternal, newborn and child health are drastically improved (World Health Organization, 2017). From these examples, we can see access to adequate services of WASH is both a global health and gendered issue (Lu, 2017). The exploration of the *WASH*-health nexus "provides fertile ground for synthesis of health and development issues with a focus on reducing inequalities and promoting human health and well-being" (Bisung and Elliott, 2014).

2.5.2 Ecosocial theory

In social epidemiology, population patterns of health and disease can be explained by a complex web of numerous interconnected risk and protective factors (Krieger, 1994). When Krieger initially introduced ecosocial theory in 1994, she presented it as a tool for social epidemiologists to better understand the societal patterns of health and disease by acknowledging the inextricable and ongoing interactions between the social and the biologic at all levels (Krieger, 1994; Yamada and Palmer, 2007; Bisung 2014; 2015). Ecosocial theory consists of several constructs pertaining to political ecology, ecosystems, spatiotemporal scales and embodiment (Appendix E) (Krieger, 1994; 2011). The first two constructs pertain to embodiment – how we biologically incorporate the world around us, and the multiple pathways that contribute to disease distribution (Krieger, 2001, Lu, 2017). Krieger's notion of embodiment consists of three central claims: first, "bodies tell stories about and cannot be studied divorced from – the conditions of our

existence"; second, "bodies tell stories that often – but not always – match peoples stated accounts"; and third, "bodies tell stories that people cannot or will not tell either because they are unable, they are forbidden, or they choose not to" (Krieger, 2005). These three claims were considered throughout the data collection process, particularly the second and third, as residents in irregular zones of ejido settlements can be distrustful of outsiders, including researchers and government officials. Krieger lists many potential pathways in the specific case of health inequities, such as economic and social deprivation, hazardous conditions, discrimination and other socially inflicted traumas, the targeting of harmful commodities (ranging from unhealthy food to psychoactive substances like tobacco and alcohol), inadequate healthcare, and the degradation of ecosystems including the alienation of Indigenous populations from their lands (Krieger, 2011). The third construct calls attention to the interplay of exposure, susceptibility, and resistance at multiple levels and across the life-course (Krieger, 2011). The final and fourth construct relates to concepts of accountability and agency, while still recognizing the macro-level structural phenomena that can enable or constrain the capacity and ability to act at individual and local levels (Krieger, 2011; Bisung et al., 2015; Lu, 2017).

Krieger's ecosocial theory has been used extensively by health geographers in the context of the WASH-health nexus and the inequitable distribution of WASH-related health outcomes among marginalized members of the population (Levison, 2014; Bisung et al., 2015; Lu, 2017). While much of the existing body of literature focuses on LICs, this thesis explores the WASH-health nexus in Mexico, an UMIC. The broader constructs of ecosocial theory are still applicable in this setting, however. This thesis seeks to understand the embodiment of health outcomes and their pathways, the relationships between exposure and susceptibility to WASH-related illness and disease in irregular zones of ejido settlements, and finally, the capacity of institutions and individuals to take action (agency) and claim responsibility (accountability) for inaccessibility to services of WASH in these locales.

2.5.3 Political Ecology of Health Framework

Indicated earlier in this chapter is the role of the Mexican federal government's financial investment and amendment of policies to encourage the development of tourism centres like Cancún and the subsequent creation of low-income settlements. This investment at a federal level has manifested into lack of access to basic services, including WASH, and increased exposure to health issues at regional, local, and individual levels. To better understand the impacts of these investments in the context of the WASH-health nexus, this research employs the political ecology

of health framework adapted from Mayer's (1996) treatise on the political ecology of disease. The political ecology of health framework is crucial to analysing the political economic forces that influence human-environment relations and shape local context (Grossman, 1993; Mayer 1996). This framework also appropriately considers issues with power, influence, and authority, most of which are concentrated among land developers, politicians and other groups to pursue self-interests (Grossman, 1993). The utilization of this approach is an attempt to understand the structural processes that influence the complex relationships between environment, economy, and health. Political ecology places an important emphasis on scale, as large-scale socio-economic changes, trends, and structures tend to be realized at the local scale, such as health outcomes that arise through the rapid urbanization of rural and subsistence-based economies (Mayer, 1996; Bassett, 1988; Black, 1990). This framework provides a means to consider health outcomes in a local context while examining the forces that support, constrain, and produce (ill) health – be they socioeconomic or environmental (Rishworth, 2014; Mayer, 2000).

While much of the literature utilizing a political ecology framework focuses on low-income countries (Turshen, 1977; Faranoff, 1964; Rishworth, 2014), the tools found in political ecology have been found to be of use in exploring 'first world' resource conflicts (McCarthy, 2002, Richmond et al., 2005). This framework is believed to be just as relevant and effective in its application in higher-income and more capitalistic economies, as the assumptions surrounding individual and collective identities and motivations, and the economic and historical relations in these countries have similarly led to the neglect to consider the dimensions of environmental conflicts. These decisions are particularly felt by marginalized populations who live on the periphery regions (McCarthy, 2002; Nesbitt & Weiner, 2001; Richmond et al., 2005). A salient example of decisions made at the organizational level determining access to the public water supply further marginalizing and disempowering the urban poor is found in Swyngedouw's (1995) work in Guayaquil, Ecuador. In his paper, Swyngedouw detailed how social power relations nested in city-wide structures of water governance worked to produce class and community-wide distributional inequities (1995; Truelove, 2011).

2.6 Knowledge, Attitudes, and Practices Research

Exploring the knowledge, attitudes, and practices (KAP) of individuals without access to WASH helps to reveal factors such as cultural beliefs and gaps in knowledge and understanding affecting the health of a community and identify which members are especially susceptible to

disease (WHO, 2008; Mayer, 1996). Furthermore, KAP research can illuminate potential facilitators and barriers to action and the likelihood of failure or success of a particular intervention (Bisung et al., 2014; Levison, 2014; Abate et al., 2013; WHO, 2008).

Across the disciplines, KAP research has proven useful in exploring factors relating to the WASH-health nexus. KAP has been used extensively in research pertaining to vector-borne diseases, particularly dengue (Diaz-Quijano et al., 2018; Mayxay et al., 2013) and malaria (Manana et al., 2018; Andrew et al., 2015; Hlongwana et al., 2009). These studies predominantly explore the KAP pertaining to disease transmission and household practices to mitigate potential risks including the management of stagnant water. Methodology in KAP research is predominantly quantitative (Diaz-Quijano et al., 2018; Manana et al., 2018; Mayxay et al., 2013; Hlongwana et al., 2009). These studies have larger sample sizes, typically in the hundreds, and are more oft to use surveys as the primary method. Andrew et al.'s (2015) study in Madang, Papua New Guinea employed qualitative methodology and included focus groups, in-depth interviews, and participant observation. As a result, the sample size was smaller; however, through the use of multiple methods, the findings were still significant.

In health geography and in the context of the WASH-health nexus, qualitative methodology to explore KAP has been utilized. Levison (2014) explored through focus groups, photovoice, and interviews the daily WASH and health habits at household and community-levels of the local population in a rural setting in Western Kenya. Her findings included the recommendation for interventions to increase social capital in the community, which could thereby lead to collective action and create more sustainable WASH and health interventions. Her work was foundational and was subsequently built on by Bisung, whose findings revealed the WASH-health-related KAP of the local population was shaped by ecological and broader structural factors. This meant community collective action would have limited success unless these larger forces were addressed. Ultimately, exploring KAP and delving deeper into the lived experience and stories of members of the local population informed the direction for interventions that would have the greatest impact for the community to reduce WASH-related health outcomes.

This research uses qualitative methodology to contrast the KAP between two groups: residents of irregular zones in ejido settlements without consistent access to WASH and key informants who work in the space of WASH and health service provision. While residents of these irregular zones generally would not possess the same technical knowledge or expertise on factors like water quality or disease transmission as key informants, local knowledge and lived experience

are equally important to consider. The information collected on the knowledge, attitudes, and practices of both residents and professionals in the space of service provision will guide the next phase of the CICY-WI research partnership. Ideally, the findings will be shared between these groups to facilitate the creation of sustainable and culturally appropriate interventions to reduce WASH-related health problems in these locales.

2.7 Chapter Summary

This chapter begins with an introduction to the variety and scope of WASH-related health outcomes that can arise due to inaccessibility to WASH. The proportion of the global population facing greater exposure to these outcomes tend to live in low-income and lower-middle-income countries, however, this problem is also experienced in upper-middle and high-income countries. Access to WASH and the WASH-related health issues in all countries is more prevalent among marginalized, poor, and rural communities. A summary on the international declarations made through time attempting to solve the problem of inequitable access to WASH, namely the Millennium Development Goals (MDG) and Sustainable Development Goals (SDG) frameworks, is given. To conclude this section, the rates of access to WASH in the context of the targets and indicators per SDG 6 in Mexico, the location of this research, is provided.

The chapter concludes with a discussion of the rationale for orienting this research within health geography and health inequalities research, and the theoretical frameworks employed. Utilizing ecosocial theory and the political ecology of health framework to explore the societal conditions that are expressed as biophysical realities is discussed (Krieger, 2011; Mayer 1996). Finally, a summary of the existing body of literature on knowledge, attitudes, and practices research in the space of water and health is given, followed by an explanation for the use of KAP to identify possible facilitators and barriers to achieving services of WASH.

CHAPTER THREE – METHODOLOGY

3.1 Introduction

This chapter outlines the research setting, research design, and methodology to explore the following objectives:

1. To explore the water, sanitation, hygiene and health-related knowledge, attitudes, and practices of residents living in ejido settlements
2. To explore the water, sanitation, hygiene and health-related knowledge, attitudes, and practices of key informants
3. To uncover the differences in understanding between residents and key informants with respect to the facilitators and barriers to WASH

This chapter consists of five main sections. The first provides information regarding the two ejidos in the peri-urban zone of the City of Cancún in the state of Quintana Roo, Mexico. This section also provides a brief introduction to the hydrogeologic characteristics of the Yucatán Peninsula, which is the southeastern-most point of Mexico and where Quintana Roo is located. The second section outlines the research design and methodology employed in this research as well as the data collection methods and sampling techniques. The third section outlines the process and the tools utilized to complete the analysis of the qualitative data. The next two sections, respectively, discuss the challenges associated with cross-cultural qualitative studies and how researcher reflexivity and positionality is relevant to the design of the research and interpretation of the results.

3.2 Research Setting

This research was undertaken in two ejidos outside of the urban centre of the City of Cancún in the state of Quintana Roo, Mexico. The state of Quintana Roo is located in the eastern portion of a region in Mexico known as the Yucatán Peninsula (Figure 3.1). The Peninsula is a vast limestone platform with a surface area of 165,000 km^2, comprising the Mexican federal states of Campeche, Yucatán, Quintana Roo, parts of Tabasco, as well as northern parts of Belize and Guatemala (Vieyra & Merediz-Alonso, 2011). The water resources in this region sustain rich and diverse ecosystems that include wetlands, tropical forests, and the world's second largest coral reef system (Vieyra & Merediz-Alonso, 2011). The karst geology of the Peninsula facilitates rapid infiltration and water flow through caves and large depressions in the limestone, known as *cenotes*

(Gondwe et al, 2010; Cruz, 2003). These karstic characteristics make the water sources in the Peninsula particularly vulnerable to pollution, especially as the extent and pace of economic development in the region continues to grow. The predominant economic sector in the state of Quintana Roo is tourism and contributes 1.6% of national Gross Domestic Product (GDP) (INEGI, 2015). The growth of the tourism industry year-over-year has also increased the demands on the available water resources (Gondwe et al, 2010; Vieyra & Merediz-Alonso, 2011). The state receives roughly 1,300 mm of rain yearly with a rainy season between June and October (INEGI, 2015). Quintana Roo is home to over 1.5 million inhabitants and accounts for 1.3% of the national population with the majority of residents (88%) living in urban centres (INEGI, 2015). The state is home to nearly 170,000 Indigenous peoples, a figure consistent with other southern and southeastern states similarly home to high proportions of Indigenous peoples (INEGI, 2009; 2015). Indigenous peoples with Mayan ancestry are the predominant cultural group in this region.

Figure 3.1: Map of the State of Quintana Roo within the country of Mexico (INEGI, 2015)

The Consejo Nacional de Evaluación de la Política de Desarrollo Social, or the National Council for the Evaluation of Social Development Politics (CONEVAL), generates information about the level of social development in Mexico, mainly reporting on the measurement of poverty in the country (CONEVAL, 2018). According to the report, there are six measures of social deprivation: educational lagging, access to health services, access to social security, quality and spaces of the households, basic services at home and access to food. This research focuses on members of the population classified as "vulnerable to social deprivation" or have "vulnerability

of income", meaning those people living slightly above or near the poverty line who may face one or more measures of social deprivations such as difficulty accessing WASH or health services. The most recent CONEVAL report published in 2015 states 2.59% of the population in Quintana Roo are without piped water from the public network and 2.53% are without access to the sanitation network or lack a septic tank (CONEVAL, 2018). The report classifies 18% of the population do not have access to services of healthcare.

Despite almost 20% of people in the state of Quintana Roo not having access to services of healthcare, there are a diversity of healthcare coverage options available. According to INEGI's 2017 State Statistics Report, there are five main forms of health coverage for citizens: Instituto Mexicano de Seguridad Social (IMSS), Instituto de Seguridad y Servicios Sociales de los Trabjadores del Estado (ISSSTE), PEMEX, Defensa o Marina, Seguro Popular (popular insurance), Sistema de Protección Social en Salud (SPSS), and private insurance coverage. Not included in this report is the cash transfer program for those living in extreme poverty known as PROSPERA. It is not health insurance per se, but one of its goals is to increase the level of attendance to health services (National Commission of Social Protection in Health, 2019).

WASH services in the state of Quintana Roo are jointly managed and operated through the entities Comisión Nacional del Agua (CONAGUA), Comisión de Agua Potable y Alcantarillado (CAPA), and the private concessionaire of water and sanitation infrastructure, AGUAKAN. CONAGUA is the federal entity managing water resources for all of Mexico whose mission is to preserve and sustainably administer the nation's water resources and to guarantee water security within the tiers of government (Ministry of Environment and Natural Resources, 2017). As such, CONAGUA supports the state entity for Quintana Roo, CAPA, on accomplishing their mandate of "efficiently managing the water resources by delivering drinking water, drainage, and sanitation services with equity, quantity, quality, competitiveness and sustainability to Quintana Roo (Comisión de Agua Potable y Alcantarillado, n.d.). Finally, the private concessionaire AGUAKAN is responsible for the infrastructure that provides potable water and sanitation services to the municipalities of Benito Juarez and Isla Mujeres. This infrastructure includes more than 1,580 km of pipelines used to collect residual wastewater, and 61 pumping stations to send wastewater to seven treatment plants. For the distribution of potable water, this includes over 2,400 km of pipelines collecting water from 176 wells and redirected to 51 storage and pumping stations (AGUAKAN, n.d.).

The two sites chosen were the ejidos Alfredo V. Bonfil and Rancho Viejo (officially known as Isla Mujeres), and are located to the south and north of the City of Cancún, respectively (Figure 3.2 a, b, c). These ejidos were selected on the basis that pre-existing contacts with residents of the two settlements were established by CICY and were known to be safer than other settlements for researchers to conduct fieldwork. Furthermore, each ejido exemplified different characteristics as it relates to the degree of urbanization, size of the population and total land area, and a proportion of the population living in irregular zones. The ejido Bonfil is located in the municipality of Benito Juárez, which also encompasses the City of Cancún. The ejido Rancho Viejo is located within the municipality to the north of Cancún, Isla Mujeres. Benito Juárez is significantly more populated and covers a greater area than Isla Mujeres, as the majority of residents live within the municipal seat of Cancún (National Population Council, 2016). With the majority of residents living within Cancún, those with access to services including sewage, piped water, and electricity are greater than those who live in the municipal boundaries of Isla Mujeres (Table 3.1). Residents living in the "old towns" or the *casco ejidal* areas are more likely to have access to essential services, as these properties were regularized first. Accurate figures of service coverage for all areas of these ejidos are difficult to confirm, particularly for the more rural zones as the land regularization process is controlled by the ejido office and their data is difficult to acquire.

Figure 3.2– (a) Map of two northern-most municipalities in the state of Quintana Roo; (b) map of two ejidos selected for research; (c) map from Google Maps indicating relation to City of Cancún and Hotel Zone

Table 3.1: Population Statistics as of 2015 – Municipalities of Isla Mujeres and Benito Juárez (National Population Council, 2016)

	Rachno Viejo (Isla Mujeres)	Benito Juárez
Total Population	19,495	743,626
% of population without piped water in homes	10.03	3.27
% of population without toilet or drainage	1.83	0.18
% of population without electrical service	5.43	0.75
% of Households with some level of overcrowding	46.08	32.66
% of Households with earth flooring	1.99	1.31

3.3 Research Design and Methodology

3.3.1 Data collection methods

This thesis utilizes qualitative methodology. Methods used in qualitative research allow the researcher to become involved in the work, as qualitative researchers are concerned with the dynamic nature of reality and qualitative methods attempt to achieve a holistic view of what is occurring through the use of subjective data (Dootson, 1995). Semi-structured interviews were used in this research, as they are flexible and allow the researcher to pursue emerging ideas in greater detail through the use of open-ended questions (Britten, 1995). Interviews enable respondents to recall information, expressions, and feelings regarding a specific topic, and deepens the understanding of the researcher on the individual as a social actor (Drew, 1993; Fowler & Hardesty, 1994).

Semi-structured interviews were conducted during a five-week period commencing in late-January 2019 and ending in early March 2019. During this time, 18 residents of two ejido settlements in peri-urban areas of Cancún, the ejidos Bonfil (n=9) and Rancho Viejo (n=9), were interviewed as well as 10 key informants who worked in the space of providing WASH and health services in the Yucatán Peninsula. Interview guides for both sets of interviewees were pre-tested for content and context by members of the research team and translated to Spanish by the research partner from the Centro de Investigacion Cientifica de Yucatán (CICY). Each respective interview guide contained a series of questions and probes pertaining to the central objectives of the research: exploring the knowledge, attitudes, and practices (KAP) of residents without consistent access to safely managed services of WASH and the KAP of key informants working to provide access to these services in the Peninsula. The questions were organized into the broad themes of water, sanitation, and hygiene services, health and healthcare options, and indicators of social capital

(Appendix A & B). The third theme of social capital will be addressed in subsequent publications. These questions intended to explore compositional (socio-demographic) and contextual (access and use of WASH and health services) factors. The World Health Organization's *Guide to Developing Knowledge, Attitude, and Practice Surveys* was referenced to inform the data collection process through practical, field-tested suggestions to help identify knowledge gaps, cultural beliefs, and behavioural patterns (WHO, 2008).

3.3.2 Participant Recruitment, Selection, and Sampling

Residents recruited for interview met certain eligibility criteria. Firstly, the resident must have lived in the community for longer than one year, so they could comment on changes in the settlement over one full season, particularly as it related to services of WASH during the rainy and dry seasons. Interview candidates were also to be above the age of majority, which in Mexico is 18 years of age. Preference was given to those residents who were responsible for or intimately familiar with household water management, and only one resident per household could be interviewed. Finally, as there is a variety of access to services of WASH, particularly in the "old town" of Bonfil versus personal wells that are more common in Rancho Viejo and the rural zone of Bonfil, certain residents were chosen for interview who had access to the municipally supplied system. As the majority of residents in these two ejidos tended to rely on other, less-regulated sources of water, only a small number of residents with this type of supply were interviewed. This was intended to increase the representativeness of the data and to determine whether similar patterns would emerge between resident's responses, regardless of primary water supply. The nine residents from each respective community were not intended to be representative of the larger settlement population, however, there was good variation in participant characteristics including time lived in the community, age, and occupation. There was greater participation by women in this research (n=13), as it was women who tended to be home during the day and were the parent in the household who escorted the children to school. This greater representation of women in this research is indicative of the global trend that women tend to play a larger role in household water management as well as experience risks and health burdens associated with a lack of safely managed services at a higher rate (Bisung, 2014; Silva Rodríguez de San Miguel, 2018).

Key informants were recruited based on their involvement in the provision of WASH or health services, regardless of sector or position of authority. This was intended to explore the second objective: KAP of key informants in the context of ejido settlements and the Yucatán Peninsula more generally. Introduction to potential key informants suitable for selection was

facilitated by CICY. CICY's presence on the Consejo de Cuenca de la Península de Yucatán (Basin Council) and the professional relationships with members of organizations engaged in issues pertaining to WASH facilitated provided an ample list of potential interview candidates. The purpose of this Basin Council is intended to be representative of the diversity of stakeholders involved in the provision of WASH services in the Peninsula. The research team sought to interview those from multiple levels of government who provide services of WASH, non-governmental organizations (NGO) working directly with residents in ejido settlements in the Yucatán, and the private concessionaire AGUAKAN, which is responsible for the provision of infrastructure for water and sanitation for the two municipalities where the ejidos were located – Isla Mujeres and Benito Juárez. As this research aimed to explore the WASH-health nexus, it was essential to connect with members of the health sector, particularly those who worked in the Health Secretariat. This included representatives from the Epidemiology department and a doctor in a local community clinic. While not necessarily a consideration for eligibility, variation in terms of key informant's level of interaction with residents of ejido settlements was achieved through interviewing representatives who worked both directly and indirectly with residents. To clarify, direct interaction with residents implied the key informant regularly spoke with or was in-community regularly. An indirect form of contact was coded if key informants worked on policy or frameworks that could affect resident access to services or if information and communication was relayed to the key informant by an intermediary organization.

Following the adjustment of terminology for the information and consent letters to reflect the anticipated level of knowledge of residents and key informants and the translation to Spanish, an introduction to a resident of each ejido was facilitated through the research partner, CICY. These initial residents were helpful in suggesting areas to the research team that would not represent a security risk and where residents were more likely to be home during the allotted times to conduct fieldwork. This form of recruitment is a type of non-random sampling, known as convenience or "snowball" sampling (Cresswell, 1998). Convenience sampling, while not particularly representative of the larger population, is a useful technique for recruitment in cases of "hidden" or otherwise inaccessible research populations who may either intentionally or inadvertently hide from public awareness (Cohen and Arieli, 2011). Due to the precarious nature of land ownership in these ejido settlements, certain residents were wary of government presence in the community for fear of potential eviction or the order to stop illegal connections to services, particularly electricity.

After interviewing the ninth resident, the snowball sampling method became increasingly ineffective, as the research team had exhausted all possible leads for interviews from previously interviewed residents. It was found residents were less willing to participate without the physical presence of a trusted neighbour to confirm the credentials of the research team. Certain residents believed the team were government representatives investigating illegal connections or abuse of water or electricity services under the guise of academics conducting research. To overcome this obstacle, the research team sought to establish a connection to a local organization that had regular interaction with residents, the ejido offices. This strategy achieved limited referrals for potential residents suiting our eligibility criteria, and in the case of one of the community offices, not a single referral was provided. Following the completion of an interview with a key informant who indicated their organization's programs had greater success and uptake when implemented in schools, the research team sought out local schools. Connecting with the "gatekeepers" of the schools, namely the principals and administrative staff, proved immensely productive as staff were able to vouch for the organizational affiliations of each member of the research team and validate the objectives of the research contained in the information packages. The interview length with participants recruited through schools were on average 34% longer than those recruited using the snowball method earlier in the fieldwork. While leveraging the trust imbued in the educator-student relationship as a means to achieve parental permission to study children has been well-documented in the literature, this research affirms the importance of this relationship for interviewing parents (Wanat, 2008; Namageyo-Funa et al, 2014; Sheldon et al, 2010).

The confidential interviews for residents living in the ejidos Bonfil and Rancho Viejo, respectively, were conducted in settings convenient to them. These settings were typically on their personal property, at a local school, the ejido office, and in the case of one respondent, at their place of employment. The average interview length with residents varied; the shortest interview taking just over 10 minutes to complete and the longest approaching 41 minutes. The average length of interview was 25 minutes, with a standard deviation of 12 minutes. Interviews with key informants were scheduled at the beginning of the fieldwork period based on the participant's availability and set in a location convenient to the participant. Key informants whose location was elsewhere in the Yucatán Peninsula and therefore not easily accessible by vehicle were given the option to conduct their interview over the phone or use the BlueJeans video conferencing software. The duration of interviews with key informants similarly varied in length to those with the residents with a standard deviation of 15 minutes from the average interview length of 57 minutes.

The shortest two interviews were slightly under 40 minutes, with the longest interview being over one hour and twenty minutes.

The initial plan for both residents and key informants, was to ask questions in English, followed by the translation of the question to Spanish and the response of the interviewee into English. It was discovered early in the fieldwork this process was too long, especially for residents who were wary of the research team. To ensure those who agreed to volunteer their time felt as comfortable as possible, the entire interview was conducted in Spanish. In the case of the key informants, their responses to questions were often longer than what could be reasonably synthesized by the research partner, and as such, these interviews were also conducted entirely in Spanish and transcribed following the interview.

3.4 Data analysis

A combination of deductive and inductive coding techniques was used to code the data descriptively into themes, sub-themes, and sub-sub-themes. Based on the format and organization of questions in the interview guides for residents and key informants respectively, a preliminary list of potential codes was deductively developed (Appendix C & D). Coding began by identifying broad conceptual themes like; knowledge of WASH services, beliefs about WASH-related health risks, household practices to minimize WASH-related risks. This initial code set was not exhaustive and did not incorporate the breadth of resident and key informant attitudes towards WASH and health services and the associated barriers to achieving them in ejido settlements. Therefore, new codes emerged during the collection of data, a process known as inductive coding (Miles, Huberman, & Saldaña, 2014). Finally, the code set was completed by incorporating field notes collected throughout the data collection process.

Following the completion of fieldwork and the subsequent transcription and translation of the interviews, coding manuals for one resident and key informant transcript were tested for inter-rater reliability. This process worked to ensure the codes were operationalized in a manner that multiple researchers could identify the same phenomena in the data and remove a potential element of bias (Miles, Huberman, & Saldaña, 2014; Seale, 2004). This process yielded an inter-rater reliability kappa statistic of 0.87 (key informant) and 0.81 (resident), a high interrater agreement (Seale, 2004). Remaining transcripts were coded by the lead author into the software, NVivo 12 for Mac, followed by the retrieval of relevant quotations from the transcripts. Figure 3.3 summarizes the process.

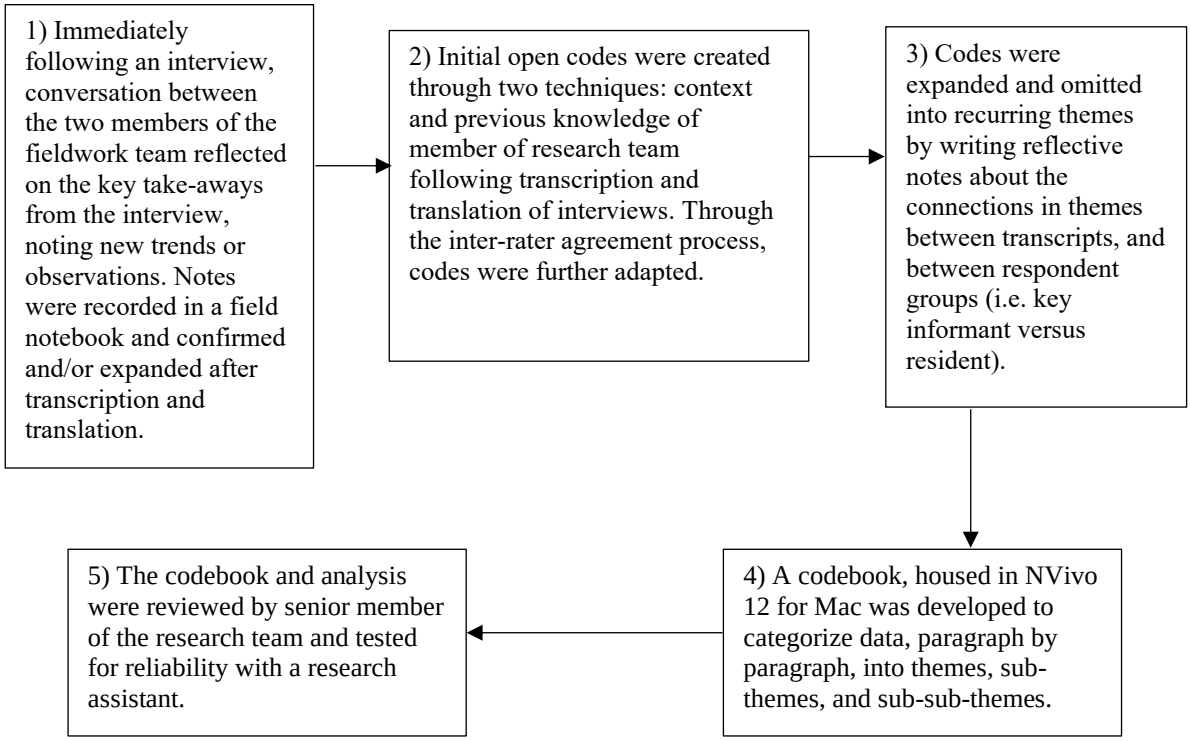

Figure 3.3: Systematic and iterative qualitative data analysis approach and technique, adapted from Harper et al., 2015

3.5 Challenges with cross-cultural qualitative studies

All interviews with residents and key informants were audio recorded with permission from the respondent. The interviews were transcribed from the source language of Spanish and translated to the target language of English with the help of Spanish-speaking individuals. This method of transcribing directly to the source language (Spanish) followed by translation to the target language (English) has been demonstrated in the literature to prevent a source of bias (Lopez et al, 2008; Pitchforth & van Teijlingen, 2005). Furthermore, as Spanish has many regional linguistic variations, the importance of a transcriber and translator who were familiar with the cultural nuances and forms of expression of a particular region ensured the respondent's intended meaning was accurately conveyed (Lopez et al, 2008). Initially, the transcription services of a Spanish-speaker from the Yucatán Peninsula were sought; however, because the process of transcription to the source language followed by translation to the target language of English is a significantly more time-consuming exercise and there were over 17 hours of interview transcripts to produce, help from other Spanish-speakers not native to the Yucatán Peninsula was necessary to complete this research within a reasonable timeline. The assembly of a "team", as discussed in Lopez et al suggests this helps with more accurate reporting of a participant's interview (2008).

While the team of translators were not all necessarily from the Yucatán, all transcripts were reviewed by two Spanish-speakers to test whether the translation had been done correctly, one of whom was either originally from the area or who had resided there for 10 or more years.

3.6 Qualitative Rigour and Reflexivity

Several strategies were employed to ensure rigour in this research. These strategies were focused on evaluating the research methodology, methods and analysis, and determining fit in the existing body of literature and theory (Baxter & Eyles, 1997). The framework proposed by Lincoln and Guba (1985) acted as a guide to determine the credibility, transferability, dependability, and confirmability of this research (Appendix F).

Credibility, referring to the accurate representation of experiences, was addressed through the respondent selection procedures, interview practise, and the strategies utilized for analysis. The research team made efforts to conduct interviews with "information-rich" cases, a strategy utilized in purposeful sampling, and attempted to avoid the pitfalls associated with snowball sampling; however, due to lack of trust on behalf of residents, certain residents may not have felt completely at ease or the ability to talk freely (Baxter & Eyles, 1997; Brown et al., 2015). Seeking out respondents through trusted members of the communities worked to source as many willing participants as possible. Further addressing credibility of the research is through the practice of being mindful of the researcher's own ethnocentricity and biases, known as 'disciplined subjectivity' (Erickson, 1973), 'bracketing' (Lincoln & Guba, 1985), or 'reflexivity' (Baxter & Eyles, 1997). By acknowledging the role of the researcher as the active instrument in qualitative research throughout the interview process and analysis, credibility is strengthened. A brief explanation on positionality and reflexivity in the context of this research is provided in Appendix H. Another common technique to enhance credibility is through triangulation, the process of employing multiple methods, theories, sources, and investigators (Lincoln & Guba, 1985; Farmer er al., 2006; Bowen, 2009). Certain aspects of triangulation were employed in this research, namely source triangulation in the use of quotations from several, different respondents in the analysis (Eyles and Donovan, 1986).

The ability to fit the results into contexts beyond the research setting, or the 'transferability' of the research, is less of a concern in the qualitative paradigm, as the experiences and meanings are assumed to be representative of a particular time and setting and bound to the people interviewed (Baxter and Eyles, 1997). However, without making sweeping generalizations about

all members of the population who live in irregular zones of ejido settlements, efforts to describe the research context in rich detail can be leveraged by other researchers and the layperson to determine similarities and contrasts between other locales.

The third construct to address rigour in this research is dependability, the element providing attention on the researcher-as-instrument and the degree to which interpretation is made in a consistent manner. Some adopt the position that strategies to improve dependability are similar to those for credibility, however, Baxter and Eyles (1997) indicate the criterion are quite different. The strategies to guard against threats to dependability are: low-inference descriptors, mechanically recorded data, multiple researchers, participant researchers and peer examination (LeCompte & Goetz, 1982). In this research, low-inference descriptors utilized include fieldnotes and audio recordings of all interviews to document the verbatim accounts. Multiple researchers were engaged in this research in the creation of the interview guides and coding manuals and the fieldwork itself. Following the completion of each interview, a discussion and review of field notes took place to identify trends in the narratives. The use of peer reviewers and auditors (the student-supervisor relationship is an implicit form of the auditee-auditor relationship) to encourage appropriate decisions throughout the research planning process, the execution of fieldwork, and data interpretation techniques.

The final element to address rigour in this research was through strategies pertaining to confirmability, which focuses attention on the investigator and the interpretations. To properly address confirmability, the data must be "reliable, factual, confirmable and so forth" (Baxter & Eyles, 1997). The use of a detailed audit process (checklist contained in Appendix G) helped to consider how decisions were made with respect to the other three constructs of credibility, transferability, and dependability.

3.7 Chapter Summary

This chapter has described the steps taken to develop a research design and methodology sufficiently rigorous for addressing the three objectives. Utilizing semi-structured interviews with both key informants and residents enabled the ability to contrast the responses in each dataset. There were challenges associated with conducting research in a foreign context, both in regard to the lack of trust by the potential participants of the researchers and with translation and transcription of data from one language to another. However, there was sufficient effort made to control for these potential sources of error including the use of key contacts at schools in the

settlements as well as several translators, including the research partner. The use of translators who possessed local knowledge and understood the nuances in expression could verify the intended meaning in the qualitative data. The importance of reflexivity throughout the research process was also discussed. Results are contained within the following chapter.

CHAPTER FOUR – RESULTS

4.1 Introduction

Results are reported first for residents followed by key informants, respectively (Tables 4.1 – 4.11), concluding with a review of resident and key informant insights into the facilitators and barriers to achieving safely managed services of WASH in ejido settlements (Table 4.12). Pseudonyms for all respondents and omission of key informant's role descriptions are used in reporting to ensure anonymity.

4.2 Resident Sociodemographic Characteristics

18 residents were interviewed from late January 2019 to early March 2019 from two ejido settlements: Rancho Viejo and Alfredo V. Bonfil. The sociodemographic profile of each resident is summarized in Table 4.1. Two thirds of respondents were women, as women tended to be at home during the hours of fieldwork. The majority of residents interviewed were not originally from the community and indicated their birthplace was outside Quintana Roo. Most residents in Rancho Viejo reported being from the Yucatán state, and the residents from Bonfil reported their birthplace as a different state in Mexico including Chiapas and Tabasco. While many residents may not have been born in Rancho Viejo or Bonfil, over two thirds of respondents indicated they had been living in the community for longer than 11 years with only one respondent from Rancho Viejo stating they had moved to the ejido within the past two years.

Those without formal connections to electricity, whereby a resident illegally connects to the municipal electrical infrastructure is known as "hanging" and is a more commonplace practice in irregular zones of ejido settlements. However, the majority of respondents interviewed had been approached by the electrical commission to regulate their electrical services and now had formal connections. The three respondents who reported they were "hanging" lived in the more rural areas of the ejido where connections are less regulated.

When residents were asked to describe the composition of their household, namely, how many children and the total number of residents in the household, most reported having four or more people in the household and either one, two, or no children. All school-aged children in the household were confirmed as attending either primary or secondary levels of education. Certain households had infants or toddlers and therefore were too young to attend school or had children who were older than the age of majority of 18 and had completed their secondary schooling. Only

two respondents indicated, without probing, they themselves had attended post-secondary schooling.

The occupations of residents interviewed reflected the fact that it is more likely to meet an unemployed person or homemaker, as they are the demographic most likely to be at home during working hours. One third of respondents indicated they were homemakers, the majority of whom did not have additional employment. We also interviewed three shop owners, all of whom lived in the same community, as well as two tradespersons whose businesses were located on the same premises as their home.

Table 4.1: Sociodemographic Profile of Residents from Rancho Viejo and Alfredo V. Bonfil Ejidos

Sex	**Number of responses**	**Rancho Viejo (n=9)**	**Bonfil (n=9)**
Female	n=12	n=5	n=7
Male	n=6	n=4	n=2
Birthplace			
Current Community	n=1	n=0	n=1
Yucatán State	n=6	n=5	n=1
Other State in Mexico	n=8	n=1	n=7
Not specified	n=3	n=3	n=0
Time Lived in Current Settlement			
1-5 years	n=1	n=1	n=0
6-10 years	n=5	n=3	n=2
11-15 years	n=4	n=4	n=0
16-20 years	n=5	n=1	n=4
21+ years	n=3	n=0	n=3
Electrical Service			
Connected formally	n=14	n=7	n=7
Connected informally (hanging)	n=3	n=1	n=2
Not specified	n=1	n=1	n=0
Number of Persons in Household			
1	n=0	n=0	n=0
2	n=0	n=0	n=0
3	n=4	n=2	n=2
4	n=6	n=4	n=2
5	n=4	n=3	n=1
6+	n=4	n=0	n=4
Number of Children (under 18) in Household			
1	n=7	n=3	n=4
2	n=6	n=3	n=3
3	n=0	n=0	n=0
4	n=0	n=0	n=0
5+	n=0	n=0	n=0
None	n=5	n=3	n=2
Level of Education of Children			
Primary	n=6	n=4	n=2
Secondary	n=9	n=4	n=5
Too young for school	n=3	n=1	n=2
Not applicable	n=6	n=3	n=3
Occupation of Respondent			
Domestic Services	n=1	n=1	n=0

Homemaker; Unemployed	n=5	n=3	n=2
Homemaker; Employed	n=1	n=0	n=1
Retail	n=3	n=2	n=1
Trade	n=2	n=2	n=0
Unemployed	n=2	n=1	n=1
Other	n=4	n=0	n=4

4.3 Resident KAP of Water

4.3.1 Resident water supply and availability

The majority of residents indicated they had water supplied from a well on their property (n=14). Three respondents had access to municipally supplied water through the concession AGUAKAN, a utility they paid for on a regular basis (Table 4.2). These three respondents were all from the central part of Bonfil, an area of the ejido that has greater rates of connections than the rural irregular zones.

Residents were also asked about the consistency of their water supply, regardless of supply source. Most who had a well on their property as the primary supply for the household reported water was always available so long as the electric pump was working. The only respondent who stated that water was not available to the household consistently was FRV16, and this was due to the well not being drilled properly and their reliance on water supplied from a private water truck company. The three Bonfil respondents with access to the municipal supply of water indicated their availability was scheduled for only a few hours per day: beginning between 6 am and 10 am and ending at approximately 3 pm every day. These respondents indicated this water was sufficient for their needs, however, if they were careless or forgetful about filling their household cistern with a reserve supply, they reported certain household tasks could not be done. For these respondents who reported having less than 12 hours per day of water available when-needed do not fit the criteria as set out by the JMP for safely managed services. However, this is only the case in times where the household neglects to fill their private water cistern and runs out of water before the end of the day.

> *F11B: No, in fact the water starts pumping at 10 o'clock in the morning and ends at 3 o'clock in the afternoon*
> *I: You have water between 10 and 3 in the afternoon every day?*
> *F11B: Sometimes, it is intermittent. Sometimes there is no water, but it always ends at 3 o'clock in the afternoon.*
> *I: Are there times that you run out of water?*
> *F11B: Yes. It has happened, if we forget to fill the water tank or sometimes just with the normal uses of the house we finish the water, we do not have even [enough] to bathe.*

4.3.2 Water quality and perceptions of water safety

Aside from a single respondent, all residents regardless of community or water supply source, believed the water was unsafe to drink and/or cook with. In particular, residents with well water would use words like "dirty", "polluted" or "contaminated". When probed as to whether they would use their primary water supply for other household purposes like cleaning or bathing, most indicated yes, they would.

> *I: Do you think the water in your well can be drunk?*
> *F20B: No, because lately the water comes out contaminated, because I understand that here in Cancún there are many cenotes and I understand that they use them, we use them for the waste of septic tanks, and the drainage, but why? Because we do not have (system of) drainage or drinking water.*

When residents were asked about the characteristics of their water supply, comments made regarding the appearance were most frequent (n=11) (Table 4.2). There were five mentions as to how the water looked "clean and transparent", but another six residents referred to the water as a yellowish colour indicating change in colour was apparent following a rain event. Nine residents also described the smell of their water. Only one of these mentions indicated their water smelled "normal". The remaining eight residents used words like "ugly", "putrid", or "stagnant". Most of the comments made about the strange or unpleasant smell of the water were reported by residents in Rancho Viejo. Two of the four mentions on taste were from the residents in the old town of Bonfil, both of whom had connections to the municipal water supply. They had two different impressions of the taste, MB9 commenting that the water had tasted of chlorine in the past but had changed over time and FB11 complained about saltiness. Some residents even noticed debris and bits of garbage floating in their water upon visual inspection. Another two respondents indicated they had observed bugs or what they interpreted to be "parasites" in their water supply.

> *F20B: Yes, in fact in my house the water lately has come out with red and black bugs – looking like parasites. And I tell you because it's in my Tinaco® (name brand of water storage tank). I since bought a filter, but it broke down. That happened just in December and we began to see some bugs in the form of parasites, similar to those that come when we get the mosquitoes and some other red ones starting to grow.*

4.3.3 Changes in water quality

All residents made some mention of changes they had observed in water quality. Nearly half of respondents indicated they saw a noticeable change in either the smell, taste, or appearance following a rain event (n=8). Only one respondent made mention of how the depth of the well was related to water quality: the deeper the well, the cleaner the water. There were other mentions of

water quality change based on a change in location (i.e. moving neighbourhoods or states), quality decreasing due to storage in unclean water cisterns, proximity to sinkholes where other residents were increasingly disposing their household and sanitary waste, and the land's natural ability to filter water. Four respondents mentioned they had seen a decrease in water quality over time, particularly as it relates to the increased urbanization of their neighbourhood.

> *I: Do you notice the smell all the time?*
> *F19B: Yes, for two years. I have lived there for seven years and when I arrived, it did not smell like that. Well when I first arrived, I did not have any neighbors, I was alone. Since more people started to live in the area, now the water is smelly.*

4.3.4 Testing and analysis of water supply

Nearly all residents from both communities reported their water was not safe for drinking and cooking (n=17). Despite this consensus, when residents were asked if they had ever tested or analyzed their water for quality, 12 residents had never formally tested their water (Table 4.2). Only one resident had their water tested shortly after their well was constructed by the company who dug the well. Two residents had done a visual inspection of their water, with one opening their water tank and looking inside and the other "just knowing by looking at it". Two residents indicated that they knew the water was poor quality through word of mouth from neighbours.

> *I: Okay, do you think well water can be drunk like that with nothing?*
> *F14RV: No, you cannot drink it, it's contaminated.*
> *I: How do you know? Have you done a study, or have you been told?*
> *F14RV: They have talked to me and just by seeing how the water comes out with a strange smell, you cannot drink it.*

Table 4.2: Resident KAP of Water

	Resident Interviews (n=18) Number of Mentions	**Rancho Viejo**	**Bonfil**
Primary Water Supply			
Well water	n=14	n=8	n=6
Water truck (pipa)	n=1	n=1	n=0
Cenote	n=0	n=0	n=0
Municipally Serviced	n=3	n=0	n=3
Purified Water (bottled)	n=0	n=0	n=0
Consistency of Access			
Always Available	n=2	n=2	n=0
Available so long as pump works	n=11	n=6	n=5
Scheduled availability	n=3	n=0	n=3
Not Available	n=1	n=1	n=0
Seasonality	n=1	n=0	n=1
Other	n=1	n=0	n=1
Observed Changes in Water Quality			
After rain event	n=8	n=5	n=3
Changes based on depth of well	n=1	n=0	n=1

Changes over time	n=4	n=1	n=3
Other	n=5	n=2	n=3
Characteristics of Water			
Appearance	n=11	n=8	n=3
Debris	n=3	n=1	n=2
Smell	n=9	n=6	n=3
Taste	n=4	n=2	n=2
Live organisms	n=2	n=1	n=1
Safety of Water Supply			
Safe for all household purposes	n=1	n=0	n=1
Unsafe for drinking and cooking	n=17	n=9	n=8
Testing and Analysis of Water			
No testing/analysis	n=12	n=6	n=7
Water samples sent to a lab	n=1	n=1	n=0
Self-inspection	n=2	n=2	n=0
Word of mouth	n=2	n=1	n=1

4.4 Resident KAP of Sanitation

4.4.1 Sanitation facilities for household and ownership of facilities

12 respondents reported their toilet facilities were connected to a septic tank or pit, an improved facility per the JMP (Table 4.3). One resident indicated his household used a bio-digester, commonly known as a composting toilet. There were five residents using a cenote or a "dry" sinkhole. Residents in Rancho Viejo reported using a sinkhole or a cenote (n=4) more frequently than those residents in Bonfil (n=1). Almost all of the residents interviewed from Bonfil used a septic tank or pit (n=8).

All residents reported having a private bathroom unique to their household and not shared with neighbours. Ten of the 18 respondents indicated they did not share a bathroom or the disposal site of their sanitary waste with neighbours. Therefore these 10 respondents had their own septic tank or pit exclusive to their property. There were five respondents who indicated they used a cenote or sinkhole for disposal of their sanitary waste and were therefore categorized as having a shared end-destination, as the aquifer system in the Yucatán is highly interconnected. The remaining residents reported having a communal septic tank that was shared between several dwellings, typically on the same property.

4.4.2 Maintenance of sanitary facilities and necessity for maintenance

Over half of residents indicated they did not maintain the disposal site for their sanitary facilities, five of whom reported never maintaining their septic tank (Table 4.3). Maintenance refers to the process of emptying the sanitary waste from a septic tank or pit or sealing the pit and

constructing a new site. Two residents did not specify the nature of the maintenance, particularly respondent MRV15, whose primary facility was a biodigester. The six residents who did report maintaining their facilities indicated their waste was removed from the septic tanks using a sanitary waste disposal truck.

Several residents reported never maintaining their septic tanks, despite many years of use. One resident who indicated they had a shared septic tank between two dwellings had not been emptied in 16 years. Nine residents believed their sanitary disposal facilities required no maintenance, six of whom were from Rancho Viejo. Five residents had a cenote as their sanitary facility and concluded it was unnecessary to maintain their waste, as the cenote was seen as a "final destination". Some residents commented there was no need for maintenance due to the construction of the tank being "deep" or "large" and therefore it had yet to reach capacity, with one resident believing that after 20 years of use, the tank still had not been filled.

> *I: What do you use?*
> *F19B: Tank*
> *I: Septic tank. Do you hire a sewage truck to empty it?*
> *F19B: In my case, no. because where I live there were a lot of cenotes. At the entrance of my house there was a huge hole with a depth I think about 5 meters down. Then it was partly filled and that's where he built the tank, because there was a lot of depth. I have lived here a little over seven years and it has never been filled.*

The six residents who reported maintaining their septic tanks had maintenance regularly scheduled. Typically, residents had their tank emptied on an interval between three and six months, depending on how quickly the disposal site filled. Two residents stated that they would maintain their facilities on an "as-needed basis" or when the tank reached its capacity. One resident, whose septic tank was shared between multiple dwellings on the same property and where more than 20 members of the same family lived, indicated the frequency of maintenance was weekly or bi-weekly.

> *I: And when do you have to maintain it? How often is that? How often do you send for this sewage truck that draws [waste] water from the septic tank?*
> *F11B: Well, like once or twice a week, that's why one has to find a better way because sewage trucks are not cheap*

Table 4.3: Resident KAP of Sanitation

SANITATION	Resident Interviews (n=18) Number of Mentions	Rancho Viejo	Bonfil
Sanitation Facilities in Household			
Cenote/sinkhole	n=5	n=4	n=1
Septic tank/pit/latrine	n=12	n=4	n=8

Other	n=1	n=1	n=0
Ownership of Facilities			
Private bathroom, private disposal site	n=10	n=4	n=6
Private bathroom, shared disposal site	n=8	n=4	n=4
Maintenance of Sanitary Facilities			
Left in cenote or sinkhole	n=5	n=3	n=2
Left in septic tank	n=5	n=3	n=2
Sewage waste removal truck	n=6	n=1	n=5
No Answer	n=2	n=2	n=0
Necessity for Maintenance			
As-needed	n=2	n=1	n=1
Regularly scheduled	n=6	n=2	n=4
Not needed	n=9	n=6	n=3

4.5 Resident KAP of Hygiene

4.5.1 Handwashing Frequency

When respondents were asked about hygiene, specifically as it relates to their handwashing practices, all respondents indicated they washed their hands after going to the washroom and before eating (Table 4.4). Residents were only asked about hygiene practices and facilities, as this is the criteria set out in SDG 6 target 6.2 and indicator 6.2.1 – "the proportion of the population using safely managed sanitation services, including a handwashing facility with soap and water" (WHO/UNICEF, 2017). 16 of the 18 residents indicated they used soap and water when asked what they used while washing their hands. One respondent commented they add a "drop of chlorine" when they wash their hands.

While most respondents indicated having a basic service of hygiene for their household, soap and water washing station on the premises, concerns regarding residents providing answers that were socially desirable arose. This was evident following an interview with a respondent who reported hygiene practices that met the Joint Monitoring Programme's designation for basic services of hygiene during her interview but handled r.w chicken and money without washing her hands in between practices. Another resident responded with a tone of indignation that the interviewers would ask questions as obvious as practices pertaining to washing their hands.

> *I: To prepare food, before eating and after going to the bathroom, do you wash your hands? With water and soap?*
> *F19B: Of course, I have to have hygiene for my family*

Table 4.4: Resident KAP of Hygiene

HYGIENE	Resident Interviews (n=18) Number of Mentions	Rancho Viejo	Bonfil
Frequency of Handwashing			
Washing hands before eating and after going to the washroom	n=18	n=9	n=9
Handwashing Facilities			
Washing hands with soap and water	n=16	n=8	n=8
Washing hands with soap, water, chlorine	n=1	n=1	n=0
No Answer	n=1	n=0	n=1

4.6 Resident KAP of Health and Healthcare

4.6.1 Predominant health issues in household and perceived causes of illness

Most residents in the two settlements mentioned at least one health issue that had affected their household at a point in time. Five residents mentioned multiple ailments that members of their household had experienced, including gastrointestinal problems and other infections, (e.g. skin, eye, ear) as well as cold and flu symptoms. When residents were asked whether they thought the sickness was potentially caused by their water supply, there were mixed responses. Some residents believed certain illnesses were correlated with the quality and treatment of their water while others did not report any illnesses in the household recently and therefore did not indicate their water supply was affiliated with sickness. There were other mentioned potential causes of illness including foodborne, as a result of heat and potentially climate change, and the lack of regular garbage pick-ups. The only "other" health issue reported was F19B disclosing her daughter having asthma, a condition she believed was exacerbated by the frequent burning of garbage in the community.

> *F19B: On the other side of where I live, there lived a teacher, primary school teacher and is in the Octavio Paz that is on the side of Kinder, look at this man, you are a teacher and you are burning trash, you are giving the bad example and talk to the patrol because my daughter is asthmatic and all the smoke is entering my house*

4.6.2 Psychosocial Health Issues

Throughout the course of interviews, residents reported several psychosocial concerns, particularly fear, despair and helplessness, worry for others in the community, and wariness and distrust (Table 4.5). These issues can manifest in ways that can affect overall health and well-being of an individual. Fear was the concern mentioned most frequently by residents, namely fear of criminal activity in the community and fear of becoming sick from potentially contaminated water.

Nine residents mentioned being afraid of criminal activity in their settlement and indicated this was mostly drug or alcohol-related activity happening during the evenings and weekends. While nine residents reported on feeling unsafe, seven residents reported feeling safe within their respective community, as the "real danger" was in Cancún and even in the hotel zone. Nearly every resident in both communities reported being afraid of drinking the water without treatment, especially well water. Many indicated they drank purified water from bottles, water trucks, or vending machines to mitigate the potential risk of illness from water.

> *F20B: Yes. In fact, in my house, the water lately has come out with red and black bugs – looking like parasites. And I tell you because my Tinaco brought it since I bought a filter, but it broke down. That happened just in December and we began to see some bugs in the form of parasites, similar to those that come when we get when the mosquitoes and some other red ones starting to grow. So, what we did, because I was afraid to bathe with that water, was to put a rag to cover the valves of the water. We wash the water tank with chlorine and put another filter so that these bugs no longer go through. The water in our case does not smell funny because the well is drilled very deep but where is my sister where the well is drilled, the water comes out very dark and smells very bad, like black, like when the water is stagnant*

The next most-commonly reported psychosocial concern was being wary of or distrustful towards "others". "Others" could include politicians and government officials, the police, and new residents migrating from elsewhere in the country to the ejidos. With regards to being distrustful of politicians, ten residents expressed they were skeptical of a candidate's ability to deliver on promises made during an election period. Several of these residents had used past experiences with politicians and government officers to justify their hesitation to trusting these officials in the future with regards to solving problems related to service provision. Three residents expressed that as the ejido grew in population, many new incomers were unknown and therefore the sense of community was "lost". This inability to trust leaders in government and their own neighbours resulted in the feeling of needing to be vigilant at all times.

> *I: What has been the biggest obstacle to getting drinking water here? Why has it not been achieved in 15 years that you has lived here?*
> *F12RV: Because no government has put an interest in it, they have sought more for their personal benefit than to engage with the community*

Another concern expressed by more than half of residents was a sense of desperation and helplessness about their situation (i.e. lack of WASH and other services). This desperation was expressed in a number of ways, including pleas to the research team to present the results of the research and to inform future awareness campaigns in the community about WASH and health.

Residents who mentioned illegal connections to services, including electricity, indicated this was done out of necessity. All three residents who were "hanging" stated this was either due to the electrical poles not being close enough to their home and therefore not meeting the CFE's requirements for legal connection or due to a lack of affordability of the services.

> *I: And in that case, have you organized to ask for electricity from the government?*
> *M15RV: No, because it is a very long process. One personally submits the application, and it takes a long time to resolve it. We need electricity, for the heat for all that. For the children. We already see by our own means how to get it.*

Half of residents reported having a sense of concern or being worried for fellow residents' well-being in the ejido. The residents interviewed acknowledged their own situation was difficult, however, some made mention of others in the ejido who had more difficulties coping and managing lack of access to WASH and other services. Many of the residents who reported this concern of being worried indicated they felt personally affected by how dire the situation was for others elsewhere in the community. One resident from Bonfil even recalled observing people selling their vote in exchange for food and money. This resident indicated she had been tempted to do the same, as the amount was 500 *pesos* (approximately $35 CAD) and understood, as a mother, how one who needed to feed their children would resort to this. She also mentioned witnessing people desperately searching for food in lots where garbage had been dumped and felt significant concern.

> *F19B: Well, I would love it if there was water and that we had electricity that we do not have until now and also the garbage because that is very worrying for me. Because where I live in front there is a wasteland and they throw a lot of garbage, there are many flies, dogs are up there to see what they find to eat, that too, there are many stray dogs, they get sick, they die there that gives me a lot of sadness because poor people walk in the trash looking for food and that hurts in my heart. I'm very worried about that also.*

Residents mentioned other psychosocial concerns like frustration, especially as it related to their experiences with gender inequities, with the process of land regularization, and securing services for their household. Three female respondents, all from Bonfil, reported how the concept of "machismo" worked to supress the views and opinions of women and affected their ability to resolve interpersonal conflicts. The respondent whose mother was an *ejidataria* (a manager of parcels of land), and therefore in a position of power in the ejido, occasionally had difficulty expressing her opinions at meetings with other ejidatarios. Another example was from a resident who out of necessity became a taxi driver to supplement her household's income after her husband fell ill reported the other taxi drivers, who were predominantly male, would cut in front of her to

"steal" her customers. The third resident reported a conflict with her male neighbour about his practice of burning garbage and the particulates aggravating her daughter's asthma and needing to call for her husband to speak to this neighbour in order for him to finally desist.

> *F11B: […] Bonfil to be a community in the north has very marked machismo, then yes, it is complicated. More than anything, being a woman and being an ejidataria are two very strong things and many times you have to take many things into account and when you do, you must be firm. It is twice as hard. Even though you are fighting for your interests and for the things that are good, it is very complicated, it is very difficult. Yes, it is also a factor that influences our community, I say being a woman and being an ejidataria.*

Frustration with the government and the ejido management was also reported by two residents. These residents reported inaction on behalf of the government to provide services and fulfill agreements promised to the ejido by previous governments. Residents also expressed frustration with the ejido system itself in presenting a barrier to resident's desires to become regularized and legal owners of their property. Finally, one resident expressed frustration at the bureaucracy she experienced when trying to make accommodations for her son who had cerebral palsy. She believed her request to secure a parking spot for a van to transport him to the front of the school was a simple request and was frustrated at the complexity and length of the process to request such an accommodation.

> *F18B: I say it's because of experiences. Because sometimes, even when you get together, in my case my son went to the primary school from there, I have a van and I had to request parking for a person with a disability, so that they gave me a space to park and it took me a lot of work to keep coming and going until I got it*
> *I: Does your child have a disability?*
> *F18B: Yes*
> *I: What disability does he have?*
> *F18B: He has spastic cerebral palsy*
> *I: Do you need a wheelchair and ramp?*
> *F18B: Yes*

4.6.2 Prevention of WASH-related Illness

Every resident interviewed reported a household practice to prevent contracting a WASH-related illness (Table 4.5). The most commonly reported practice for preventing illness in the household was to drink purified water (n=15) and avoid direct consumption of well water, which most residents believed to be unsafe for drinking (Table 4.2). Generally, residents who relied on well water for their primary water supply were in agreement this water, if treated, could be used for other household practices like washing, cleaning, and even bathing, but should be avoided as

a drinking source. The residents from Bonfil who had access to the municipal supply also drank purified water less as a safety precaution and more due to the unpleasant taste of the water.

> *M15RV: No, nobody from my house [has gotten sick from drinking well water]. In fact, even the youngest ones know that they should not drink the water*

The next most commonly reported practice to prevent WASH-related illness was to chlorinate the water supply before use for other domestic tasks like cleaning, washing, and bathing. This practice was more common in the ejido of Rancho Viejo, with six of eight mentions being from residents of this community. These residents reported adding chlorine to their water tanks prior to usage. Comments regarding the required amount of chlorine to "do something" to improve the water quality were also made: the greater the amount of chlorine, the safer the water. Certain residents also indicated that although chlorine was needed to prevent more serious gastrointestinal problems from the water, that adding too much chlorine, they believed had an adverse effect on their skin.

> *I: Okay. Now let's talk about health aspects. Has someone from your home or you gotten sick from drinking water or using water from the well?*
> *M3RV: Well, it's not that it's a disease, but how can I tell you? The water is contaminated and it's not ideal to bathe*
> *I: And how do you bathe?*
> *M3RV: We add a lot of chlorine*
> *I: Do you chlorinate it?*
> *M3RV: Yes, but you may get welts or sores or something like that*
> *I: Do you get pimples, itching?*
> *M3RV: Yes*
> *I: Okay, and is that seasonal or is it all the time?*
> *M3RV: All the time*

Two residents, both from Rancho Viejo, reported another form of water treatment to avoid illness: boiling. One resident reported boiling their water to cook, and the other reported boiling water that was used for bathing. Interestingly, the resident who indicated she now boiled the water for bathing was in response to a doctor at the clinic who stated her son's skin condition was as a result of water and her decision to boil the water was in response to the doctor's diagnoses.

The residents who reported practices related to the prevention of vector-borne diseases like zika and dengue all lived in the community of Bonfil (n=3). These residents reported having been visited by health brigades who supplied them with mosquito abatement and insecticide or provided them with helpful tips for managing potential spawning areas on their property.

I: Have you been instructed about water management and disease prevention?
F10B: No, what is very common here in Bonfil is that the inspectors pass and give you the abatement for dengue. Periodically an inspector passes, checks and explains yes and no (what to do and not do).

There were other household practices mentioned to avoid WASH-related illness including one resident's reporting of the necessity to wash the hands of her grandson after he had been playing on the floor. Another resident described, in detail, the process her household went through to secure their water tank from outside animals and debris and to manage the tank in such a way that it would not be favourable for potential bugs and parasites to breed.

F20B: Yes, in fact in my house the water lately has come out with red and black bugs – looking like parasites. And I tell you because my tinaco brought it since I bought a filter but it broke down. That happned just in December and began to bring some bugs in the form of parasites, similar to those that come when we get when the mosquito and some other red ones starting to grow. So what we did because I was afraid to bathe with that water, was to put a rag to cover the valves of the water. We wash the water tank with chlorine and put another filter so that these bugs no longer go through.
[…]
I: Are there no changes in the color of the water after it rains?
F20B: No, the water tank remains closed. In fact, we put a very heavy stone on the lid so that animals will not go there either. And where we have the well, we take care so that there is no other type of water, garbage, grass, nothing. We take care of it

4.6.3 Healthcare services and coverage in household

When respondents were asked about their access to healthcare and what form of coverage they had, most were covered under some form of insurance. The highest proportion of residents indicated they were covered by social security, otherwise known as popular insurance (n=9). Five of the 18 respondents stated they currently had no form of insurance coverage, and any health expense incurred was covered out-of-pocket.

For the residents who indicated some form of coverage for their family (n=13), when asked as to how many members of the household were covered, the majority of residents indicated all members had some form of health insurance.

I: Okay, and do you have popular insurance, ISSSTE, social security?
F1RV: Social security, I'm in social security, for my husband, he has me covered
I: And the other members of the house are insured?
F1RV: Yes

Three of the residents indicated they had previously been registered with the PROSPERA program, which is designated for low-income persons to provide a sum to access essential services,

like healthcare. Registration in this program and the amount of financial aid one person is given is dependent on the number of poverty indicators they satisfy. Each of these three residents reported having a new form of insurance and having transitioned off the PROSPERA program, which indicates an upward mobility from being designated as "marginalized" under the federal government's criteria.

When residents were asked *why* they had certain types of coverage, respondents who indicated they were covered by ISSSTE, IMSS, or had private insurance, this form of insurance is known to be provided by an employer, or it was specified by the respondent they were listed as a dependent under their spouse's policy. For those residents who indicated coverage through social security, the most commonly reported form of coverage (n=9), residents reported this coverage was available to all citizens.

Most residents indicated they sought healthcare services from a private healthcare clinic in the event they or a member of their family were ill. Respondents mentioned these private clinics were typically in Cancún, however some stated they would use private clinics within their respective community. Residents reported that their choice in healthcare services were dependent upon the severity of the illness. Three of the 11 residents stated that if it was a simple issue, they would visit a Farmacias Similares ("SIMI") clinic or a family doctor. SIMI clinics are a low-cost alternative of healthcare that typically prescribe medication that is for common ailments, such as cold, flu, and some stomach problems. For more serious afflictions, some residents mentioned visiting a private specialist. One resident indicated that the healthcare services sought by her family when someone became ill changed based on the family's financial status.

> *F20B: […] We use it (clinic) when it is something routine, like analysis, check-up, but the rest we pay privately.*
> *I: Where do you go?*
> *F20B: We used to go to a private doctor, but because of our financial situation, since I do not work now, we go to the Similares clinic (SIMI) that is here in Bonfil.*
> *I: And the private (service), you went to Cancún?*
> *F20B: No, here in Bonfil there are private (services)*

Visiting a health care centre, private or subsidized, indicates a change in routine in the household. Residents were asked to comment on the degree of severity in these changes if a member of the household became sick. Their responses were classified into one of three categories: major disruptions, minor disruptions, and no changes. If the respondent indicated they would need to miss work to tend to the sick person, or if they mentioned more than one change to the normal

routine of the household, the change was categorized as “major disruptions”. If they mentioned one change to the household and did not indicate the requirement of staying home from work, it was classified as “minor disruptions”. Finally, if the respondent indicated there were no changes in the household when a person became ill, responses were categorized as “no changes”. 12 respondents indicated that when someone in their household became sick, there were little to no changes in the household routine to accommodate the affected person. Some residents indicated that if a member of the household were sick, they would not miss work to tend to them. Four residents believed that when a person was sick in their home, there were major changes to the routine and schedule of the household.

> *I: When a member of your family gets sick does the family member’s routine change a lot?*
> *M9B: Yes, because one has to pay attention, take yourself to the doctor, ask permission at work and that causes a problem in the daily routine*
> *I: Do you miss work to care for the family?*
> *M9B: Quite so*

4.6.4 WASH and health information provided

Four residents indicated they had been supplied with information or materials for the prevention of mosquito-borne illnesses, all from brigades or an inspector from the Health Secretariat. Each of these residents stated that this was the only information they had received regarding safe water management practices and health. Resident F20B indicated in greater detail than others some of the information that was provided around the prevention of the stagnation of water as well as how to use the insecticide. More than half of the residents indicated they had never received any information from organizations such as AGUAKAN, CAPA, CONAGUA, and the Health Secretariat about safe practices or education of water, sanitation, hygiene and health.

> *I: Has AGUAKAN, CAPA, the health sector ever come to give you talks about proper water management and disease prevention? Have they given you a brochure, have they left you insecticide or something?*
> *F19B: No, never. At least until now I have never seen the interest in that, at least where I live. Why would it interest them? Never*.

Table 4.5: Resident KAP of Health and Healthcare

HEALTH AND HEALTHCARE	Resident Interviews (n=18)	Rancho Viejo (n=9)	Bonfil (n=9)
	Number of Mentions		
Predominant Health Issues in Household			
Gastrointestinal infection	n=7	n=3	n=4
Cold or Flu	n=2	n=2	n=0
Other infection (i.e. skin, eye, lung, etc.)	n=6	n=3	n=3
Asthma	n=1	n=0	n=1
No Health Issues Reported	n=6	n=4	n=2

Psychosocial Health Issues			
Fear of criminal activity	n=9	n=4	n=5
Fear of getting sick from water	n=15	n=8	n=7
Despair/Helplessness	n=10	n=5	n=5
Worry or concern for others	n=9	n=3	n=6
Wariness	n=12	n=5	n=7
Other	n=6	n=1	n=5
Perceived Cause of Illness			
Waterborne	n=7	n=5	n=2
Food-related	n=4	n=1	n=3
Garbage collection-related	n=3	n=0	n=3
Other	n=3	n=2	n=1
Unknown	n=2	n=0	n=2
Cause of illness No Answer	n=5	n=2	n=3
Prevention of WASH-related Illness			
Using purified water for direct consumption	n=15	n=7	n=8
Chlorination of water	n=8	n=6	n=2
Mosquito-related household measures	n=3	n=0	n=3
Boiling of water	n=2	n=2	n=0
Attention to hygiene practices	n=1	n=1	n=0
Other	n=2	n=0	n=2
Changes of routine in household			
Major changes to routine	n=4	n=2	n=2
Minor changes to routine	n=6	n=4	n=2
No changes in routine	n=6	n=3	n=3
No Answer	n=2	n=1	n=1
Health Coverage in Household			
IMSS	n=1	n=1	n=0
ISSST/ISSSTE	n=1	n=0	n=1
Private insurance	n=1	n=0	n=1
Social security	n=9	n=5	n=4
Combination of Coverage	n=1	n=0	n=1
No Coverage	n=5	n=3	n=2
Extent of Coverage in Household			
All Household Members Covered	n=11	n=6	n=5
Certain Household Members Covered	n=2	n=1	n=1
No one with coverage in household	n=3	n=2	n=1
No Answer	n=2	n=0	n=2
Healthcare Services Sought			
Clinic in Community	n=4	n=2	n=2
Private healthcare clinic	n=11	n=5	n=6
Farmacias Similares (SIMI)	n=5	n=3	n=2
Other	n=2	n=0	n=2
Not specified	n=2	n=1	n=1
Health-related Information Provided			
Methods for improving basic sanitation and hygiene	n=2	n=1	n=1
Mosquito-borne illness prevention information and supplies	n=5	n=0	n=5
Supplies for improving water quality	n=1	n=0	n=1
No information provided	n=7	n=5	n=2

4.7 Key Informant Profile and Organizational Attributes

10 key informants from a variety of organizations across the Yucatán Peninsula in the WASH and health spaces were interviewed (Table 4.6). These organizations included six governmental, two non-governmental (NGO), one private, and a non-profit council comprised of several organizations and members of the general public. The governmental organizations were from federal, state, and municipal levels, as well as an ejido office – a legal body under the Mexican Constitution. The two NGOs were based exclusively in the Yucatán Peninsula both working in settlements lacking WASH. The only private organization interviewed was AGUAKAN, the private concessionaire responsible for the operation of the drinking water and sanitation infrastructure for the municipalities of Benito Juarez and Isla Mujeres. A representative of the Consejo de Cuenca de la Península de Yucatán (Basin Council) was interviewed as their organization was comprised of members from all levels of government as well as private citizens and had the objective providing recommendations for policy creation and amendments. Each key informant had a different role, providing a diversity of perspectives on the facilitators and barriers to achieving services to irregular zones of ejido settlements. The individuals interviewed had a range of positions from director to research co-ordinators. To ensure the anonymity of key informants, the full list of roles is not disclosed.

Key informants were asked about their capacity working with residents who did not have access to WASH, indirect or direct. Half of the respondents indicated they worked in an indirect capacity, in that they were engaged in policy, governance, or management positions where they would not regularly interact with residents. The other half of respondents reported having a direct relationship with residents, namely their roles included a relationship with community leaders or residents on a frequent basis.

Table 4.6: Profile of Key Informants Recruited for Interview

	Number of Key Informants
Sector of Organization	
Representatives from Government Organizations	n=6
Representatives from Non-government Organizations	n=3
Representatives from Private Organizations	n=1
Organizations Represented	
CONAGUA	n=2
CAPA	n=1
AGUAKAN	n=1
Departamento de Epidemiologia (Department of Epidemiology)	n=1
Community Ejido Office	n=1
Community Health Clinic	n=1

Consejo de Cuenca de la Península de Yucatán (Basin Council of the Yucatán Peninsula)	n=1
Centinelas del Agua (Water Sentinels)	n=1
Amigos de Sian Ka'an (Friends of the Sian Ka'an)	n=1
Key Informant's Time in Current Role	
0-5 years	n=3
6-10 years	n=2
11-15 years	n=1
16-20 years	n=0
21+ years	n=4
Capacity Working with Residents in Ejido settlements	
Direct relationship with residents	n=5
Indirect relationship with residents	n=5

4.7.1 Organizational policies and guiding documents

When key informants were asked about the policies and guiding principles of their organizations, responses fell into three main categories: state or national mandates and laws, organization-specific policies and guidelines, and the Sustainable Development Goals (Table 4.7). Seven key informants stated their organization's procedures and missions were aligned with mandates set out in public policy at the federal or state levels. Two respondents indicated water was enshrined in the constitution as a right; thereby obligating their organization to provide access to citizens.

> *KI1: The access to water is constitutional, that is the right to water, we all have the right in our country, that is at the constitutional level, then it is already established.*

Three respondents indicated their work was related to the fulfillment of their own organization-specific policies and guidelines. All three respondents reported their organization adhered to other guidelines at the federal and state level as well as the SDG framework. There were seven mentions by respondents of the Sustainable Development Goals (SDG) framework. However, respondents did not voluntarily provide their work was aligned with the SDGs, rather, this was elicited through a probing question from the interviewer as to whether their organization was dedicated to accomplishing targets as set out in the SDGs.

> *I: Do you mean that all this is geared to the [Sustainable] Development Goals?*
> *KI3: Exactly, we are working mainly with the Goal 6 of water and sanitation. We have been working very much hand-in-hand with [Goal] 11, also with the Sustainable Cities, which I think is [Goal] 7. We have a project called Urban Green Spaces, which is where we have integrated the Sustainable Development Goals within the framework of this project.*

4.7.2 Organization's priorities

Over half of key informants indicated their organization's priorities were the provision of water and sanitation services (n=6). Two of these key informants, both of whom were employed at the local NGOs, stated their organization also had the priority of preserving or enhancing the state of the natural environment. Two other key informants, who both worked in the Secretariat of Health, indicated their organization's priorities were to ensure the health of residents in the region. The key informant representing the ejido office had the priority of land-related affairs, particularly the process of property regularization. Another key informant stated the priority of the Consejo de Cuenca de la Península de Yucatán (Basin Council) was to provide recommendations to governing bodies and inform policy as it pertained to water and sanitation.

When key informants were asked about their personal attitudes towards whether the need was greater for the provision of water or sanitation services, none of the key informants indicated priority for water was more important. Three key informants indicated the priority was the same to provide both water and sanitation services. Half of respondents stated the provision of sanitation services was paramount, with some key informants mentioning that due to the water availability in the Yucatán, access to water supplies was less of an issue for the population – irregular or regularized. Furthermore, it was also highlighted by respondents that the high degree of porosity in the region would make the aquifers and the subsequent water supply more susceptible to contamination from mismanaged sanitary waste therefore the necessity for sewage infrastructure was greater than that of water.

> *KI10: I think it should be sanitation for a simple reason. Usually when they defecate in the septic tanks, all that leaks into the underground rivers and directly into the wells, contaminating the water they use. Whether to brush their teeth, to bathe, it causes skin and gastrointestinal diseases. Therefore, I believe that the priority would be… both are important. But the priority would be sanitation. To come together and insist that they put sewage.*

4.7.3 Past, Current, and Future WASH-based interventions

Key informants reported interventions and initiatives their organization had undertaken in the past, were currently undertaking, or had plans to initiate in the future during the course of their interviews. All but two key informants mentioned their organization had undertaken WASH-related interventions in the past: the doctor at the local community clinic and the representative of the Consejo de Cuenca de la Península de Yucatán (Basin Council). The reported interventions were organized into distinct categories: construction of water or sanitation-related infrastructure,

educational campaigns and materials, and preservation of the natural environment. Other interventions included providing payment facilitators to residents for their water bills, "citizen science" monitoring programs, and efforts to regularize ejido lands.

Key informants reported on a variety of projects pertaining to the construction of WASH facilities. Those with knowledge on past interventions stated these projects were typically expensive and complex and included extending the water and sanitary waste pipes to the rural areas of ejidos. Comments by key informants indicated this practice of directing piped infrastructure to the peripheries of ejido settlements was cost-prohibitive due to the karst geology. Key informants acknowledged this formal infrastructure was a long-term solution that could be accomplished only if residents in irregular zones of ejidos became regularized and were therefore accounted for in urban plans. Key informants who reported their organizations as currently constructing or planning to build WASH facilities generally utilized rudimentary technology and were installed on a household-by-household basis. Key informants reported these interventions had been effective, due to their cost-effectiveness and not having the same need of land regulation to install these facilities. Examples included composting toilets and rainwater catchment systems.

> *KI6: However, there are alternatives such as the capture of rainwater, which also exists, this is a program or a component within the program called PROCAPTAR, precisely rainwater harvesting, through which, they are endowed with infrastructure for them to collect rainwater and use it for human consumption.*

The most commonly reported intervention was the production of educational materials and resources delivered through different media including in-person visits to ejido settlements, opening the doors of the water and wastewater treatment plants for tours, and curating content to be integrated into the curriculum for teachers. These interventions were implemented at a variety of scales including the regional, community, and individual level. The key informant from AGUAKAN reported a host of educational materials their organization was producing to improve awareness of the hydrologic cycle specifically geared to children in schools across both Isla Mujeres and Benito Juarez municipalities.

> *KI5: For us, it is to study and prepare these topics, and throughout the year where we go we have to touch on these topics and when we present ourselves to a school. In the school what we do is present the topics by age levels, all the themes we develop according to the guidelines of the SEP (Secretary of Public Education) and we take the textbooks that handle and analyze the topics about the environment that they have and on that we build the talks and the information, elaborated games. We present it to the teachers, and they tell us if this works or this one does not. We always present a program according to the SEP but that the teacher can mold it to their needs.*

Only a few key informants mentioned interventions aimed at the preservation and enhancement of the natural environment in the Yucatán. The two key informants who provided the greatest detail and variety of interventions were the representatives of the two NGOs. These key informants, while indicating their organizations had mandates to work with vulnerable people in settlements where WASH facilities were limited, also had within their mandate to protect the natural environment.

> *KI8: And our focus, as an organization, is dedicated to environmental conservation and sustainable development, has been much around protected areas, in rural communities, in the areas with the highest biodiversity. And also, in the communities where nobody lives.*

4.7.5 Organizational partnerships

Key informants were asked whether their organization coordinated with others for past, current, or future WASH interventions. This was to gauge the level of multi-sectoral co-operation and where there could be potential overlaps in WASH-based interventions. More than half of key informants reported partnerships across sectors, which included government and non-governmental organizations (NGO), and private corporations. Many key informants reported working with government organizations, academic institutions including primary, secondary, and post-secondary schools, and ejido commissioners. Other partnerships outside of these categories included private foundations as well as community groups, which were reported by the two key informants working for the NGOs. Several key informants mentioned the Clean Water Committee and the Consejo de Cuenca de la Península de Yucatán (Basin Council) which included several organizations all working in the WASH and health spaces. Members of either the Basin Council or Committee fulfilled different roles and contributed different assets to these groups. Furthermore, certain entities were focused on prevention of WASH-based health outbreaks while others were reactive and could help with mitigating exposure and spread of a particular health problem, like cholera.

> *KI4: We have a committee, called a Clean Water Committee, with a quarterly meeting that involves CAPA, AGUAKAN, COPREFIS and the health secretariat, during which we evaluate how each unit goes, from its point of work, information exchanges, we see if there is some problem and together with the committee we work on the tasks we are responsible for.*

4.7.4 Testing and analysis

Most key informants reported their organization had done some form of water quality testing, be it to determine bacterial, viral, or chemical characteristics of water (n=7). Only two key informants mentioned conducting surveys with members of the general population to determine the level of knowledge as it relates to water, potential WASH-related threats to health, and the hydrologic cycle in the state. The representative from the Health Secretariat indicated epidemiological studies had been conducted and also mentioned an organization that takes tissue and other samples to determine the health of the population (COFEPRIS). While the doctor from the local clinic did not indicate any testing and analysis done "in the field", they would collect the same types of samples physically in the clinic. Other forms of analysis included one key informant's systematic review of gaps in policies and budgets pertaining to environmental education and another's evaluation of a project's data to determine directions of future phases.

> *I: […] Have you done studies?*
> *KI5: We do every time a well is made, we do a study with CONAGUA, they have us to authorize then that the quality of the well is optimal. Regularly the wells of the people are clandestine*
> *I: And you do not have a control, register, or take samples of the clandestine wells of these people?*
> *KI5: No, we took samples from the water taps, yes? From the address, from outside your house we take a sample and so we know the quality of our water line to the door of your house*

Table 4.7 – Key Informant Organizational Attributes

Organizational Attributes	Key Informant Interviews (n=10) Number of Mentions
Policies and Guiding Documents	
State or National Mandates	n=7
Organization-specific	n=3
Sustainable Development Goals	n=7
Other	n=1
Organization's Priorities	
Provision of Water and Sanitation Services	n=6
Health of the Population	n=2
Preservation of Natural Environment	n=2
Other	n=2
Key Informant Attitudes towards prioritization of water and/or sanitation services	
Water and sanitation services of equal importance	n=3
Sanitation service more important	n=5
Water service more important	n=0
Not specified	n=2
WASH-related Interventions	
Past Interventions	

Conservation or rehabilitation of natural environment	n=1
Construction of water and/or sanitation facilities	n=5
Educational campaigns or materials	n=6
None	n=1
Other	n=4
Current Interventions	
Conservation or rehabilitation of natural environment	n=1
Construction of water and/or sanitation facilities	n=4
Educational campaigns or materials	n=8
Developing policy recommendations	n=3
None	n=1
Other	n=3
Inter-organizational Partnerships	
Government organizations	n=7
Non-governmental organizations (NGO)	n=6
Private organizations	n=2
None	n=2
Other	n=4
Methods of Outreach and Connecting with Residents	
Community Talks	n=6
Printed Materials	n=4
Radio	n=4
Brigades	n=2
School presentations	n=1
Other	n=8
Testing and analysis	
Water quality testing	n=7
Surveys	n=2
Health-related studies	n=2
Other	n=2
None	n=3

4.8 Key Informant KAP of Water

4.8.1 Primary water supply in ejido settlements

Most key informants indicated they had observed a variety of water supply sources used by residents in ejido settlements (Table 4.8). Nine key informants stated they knew residents used well water as their predominant household water supply. Four key informants mentioned they had observed residents being supplied by water trucks. There had been comments regarding the usage of cenotes for a water supply source, but two of the key informants indicated those who tended to rely on cenotes lived in the more rural zones of these settlements.

> *I: How do they get the water? Is it through wells, water tank trucks, rainwater?*
> *KI8: There is a bit of everything. Now there are communities that are getting their water from the rain, which is new from that project we are starting. On the coast many years ago, people were supplied with rainwater, they had their large wooden tanks. And that process, when the "progress" came, everything had to be piped and with tanks and engineering and so on, that culture was lost. We are trying to rescue a part of that*

concept. They extract water from wells, extract water from cenotes. CAPA, in the vast majority of the communities, or, here in the north, AGUAKAN, supplies them with drinking water with pumps and tanks and everything else.

4.8.2 Quality of water supply

Key informants were asked about the quality of water resources in the Peninsula and all had some level of knowledge on the topic (Table 4.7). Their comments were grouped into three main themes: the quality of the water supply used by residents in ejido settlements, quality of the water supply in the municipal system, and the declining quality of the aquifer system in the Peninsula. Those who were familiar with the quality of the water in the municipal system, namely the key informants employed at CONAGUA, CAPA, and AGUAKAN, indicated the water was tested and analyzed frequently for quality and that this data was publicly accessible, which was corroborated through a review of online resources for each agency. Not all key informants were aware of the quality of the water residents in ejido settlements had access to, particularly the quality of personal wells, but those who did have knowledge of the quality of these wells unanimously agreed the quality was poor.

KI2 […] We have taken samples of water in Bonfil, where the fecal coliforms are countless. We do not even send the chemist to measure them because they are countless. The water is highly contaminated. And the same people from Bonfil tell us, "Listen, I've already drilled my well, but it stinks". Why wouldn't it stink? It is highly contaminated.

Some key informants also commented on the quality of the aquifer system in the Yucatán Peninsula as it related to the increasing rates of sanitary waste contamination, but also how the hydrogeochemistry of the region's geology could impact water quality for human consumption. These characteristics, like high contents of calcium and sulphates as well as rapid rates of infiltration through the karstic geology, impacted the overall quality of the water supply. This water both supplies the municipal system and the personal wells of residents.

KI6: […] There is a zone consisting of gypsum, where water is scarce and when we found it, we found it contaminated. Then there are very few points where we could find water of "good quality", right? Because the water in general in the state, you must have the knowledge that it is a hard water, with high contents of sulfates, then, where we can find points in the aquifer with enough water in quantities of water, to provide water to several communities.

4.8.3 Knowledge of resident water practices

Half of key informants had seen residents consume water from a variety of sources such as bottles of purified water, cenotes, personal wells, and for those with access, water from the

municipal drinking water system (Table 4.7). Most key informants were in agreement residents living in irregular zones of ejido settlements would use purified water from bottles or large jugs ("garrafon") for drinking. The two key informants representing NGOs who had activities and programs in all regions of the Yucatán Peninsula had witnessed residents drinking water from cenotes as well as rainwater; however, these two informants recognized these practices were more common among those living in rural areas. The two key informants who indicated they had observed residents drinking from municipal supply, specified this service was only available to residents whose properties had been regularized. Residents whose properties did not have legal status, or were "irregular", would not have this opportunity.

> *I: This water that they extract from the wells, mainly for what uses? To cook, to drink, to wash?*
> *KI1: I haven't detected that about [these places] here, because, as I said before, this is no longer my function. However, well water, they do not use it to drink, normally all the people here drink water from the jug. Ok? It is rare that people drink water from the tap or well. They use it to bathe. But to drink, I don't think so.*

As it relates to water supply used for cooking by residents, not all key informants had experience or knowledge of this practice, especially those who did not work directly with residents in these settlements. The key informants who did have knowledge of cooking practices, had knowledge of residents using well water for their cooking (n=7). One key informant specified that residents they had worked with in a personal capacity had assured them they also used purified water for cooking in addition to drinking.

> *I: Let's talk about these locations that use well water, what do they use well water for? Do they use it to drink?*
> *KI4: They use it to wash the dishes, to bathe, to wash clothes*
> *I: But not to drink?*
> *KI4: Not for drinking*
> *I: Not even to cook?*
> *KI4: Neither*
> *I: But there are people who say if I boil the beans, nothing happens*
> *KI4: Yes, there are exactly such people, but fortunately when we ask about it and when we have had cases where we have visited people with their families, they tell us that they do not use it (well water) for cooking or drinking*

As most key informants indicated residents living in irregular zones of ejido settlements predominantly used well water as their primary water supply, six respondents "grouped" several household practices together, including bathing, cleaning, and washing clothes and dishes. It was

generally agreed among respondents that activities not related to directly consuming water, such as drinking and cooking, well water would be used.

> *I: Yes, the well water used by the people of the area you work in. What do they use it for?*
> *KI10: Most people use it for their personal hygiene, to wash clothes, dishes, bathe every day, wash their food*

There were two key informants who specified resident uses for their water supply beyond drinking, cooking, bathing, and washing. One key informant had observed residents using their water supply source, a cenote, as a source for recreation and tourism. A second key informant, while listing out the many possible household uses, they had seen residents use their well water for the watering of household plants.

Table 4.8: Key Informant KAP of Water

	Number of Mentions
Primary Water Supply of Residents	
Well water	n=9
Water truck (pipa)	n=4
Cenote	n=3
Municipally Serviced	n=3
Other	n=2
Unknown	n=1
Water Quality	
Hydrochemistry of aquifer leads to poor quality	n=4
Municipal water supply good quality	n=2
Residents well water supply poor quality	n=8
Other	n=1
Resident Water Practices	
Source of water for drinking	
Well water	n=2
Purified water (bottled or jug)	n=8
Municipal supply	n=2
Cenote	n=2
Other	n=2
Source of water for cooking	
Well water	n=5
Purified water (bottled or jug)	n=1
Cenote	n=1
Source of water for bathing and/or washing	
Well water	n=8
Water truck (pipa)	n=1
Cenote	n=1

4.9 Key Informant KAP of Sanitation Facilities

4.9.1 Knowledge of resident sanitation facilities

Most key informants who had experience working in irregular zones of ejido settlements reported seeing a range of facilities used by residents in these areas from septic tanks to open defecation. Five key informants reported knowing or observing residents practicing open defecation. Key informants with this knowledge stated this practice was more common in the rural areas of ejido settlements, and typically among the indigenous populations who had the practice of going "under the open sky". Four key informants also reported residents utilizing cenotes and sinkholes to dispose their waste. These geologic features are very common in the region due to the karstic geology and provide an easy, cost-effective alternative to paying for the construction of a pit latrine or septic tank. Every key informant had observed residents in ejido settlements using improved facilities, per the Joint Monitoring Program, including septic tanks and pit latrines (Table 4.9); however, provided the caveat that due to poor construction practices, these facilities could be designated more as "black holes" that residents had dug themselves rather than contract a professional to construct a proper facility.

> *KI2: No, we are aware that they need the services and for us we are not only aware, for most of their septic tanks, which are not really septic tanks, it is a hole they made or they found it there and direct their excreta or their pipes (sewage waste trucks) there. But it is not a septic tank. A well-made septic tank has its three chambers, where we say it is anaerobic and in the end the water that clarifies it receives a treatment. There the problem is bacteriological, which will not happen, but with that they add a little chlorine at the end, we already eliminate that. The problem is that they all made their septic tanks and on the one hand they drill their well and the karsticity of the land contaminates the well they make*

4.9.2 Ownership of sanitation facilities

Most key informants acknowledged residents typically had a bathroom unique to their household, but five key informants believed the disposal site was shared. Only one key informant believed both bathroom facilities and the disposal site were private to one household (Table 4.8). The key informant representing one of the ejido offices indicated the distance from the old town of the ejido was an indicator for the likelihood that a household would share their facilities. Essentially, the closer to the old town, the more likely the household would have a private disposal site and private bathroom. He had knowledge of those residents who lived in the more rural areas sharing their disposal site and bathrooms.

> *I: And what have you observed? Are the sanitary facilities shared? Are the bathrooms shared by several neighbors? Or does each house have its own bathroom?*

KI4: Sometimes they share the land, but each house has its own bathroom
I: What is observed is that many share the pit, but the bathroom is individual
KI4: Yes, that, yes

4.9.3 Resident maintenance techniques of sanitary facilities

Key informants all commented on the range of maintenance techniques of sanitary waste by residents, from "safe" disposal using a sewage truck to remove waste in constructed septic tanks (n=3) to no maintenance at all (n=4). Four key informants reported that maintenance of facilities by residents was rare and leaving their sanitary waste in the pit or septic tank was more common. These respondents indicated that the sanitary waste generated by residents was either left in a septic tank or was diverted to a cenote whereby it would eventually enter the aquifer system and pose a risk to the quality of the water supply. Another maintenance technique observed by two key informants was the digging of a new hole for their waste once their current facility had reached capacity. If the previous facility is closed and sealed properly, this practice meets the JMP's standards for a safely managed sanitation facility. Given key informant's opinions as to how quality of construction is an issue, it is likely these sealed pits have the potential to leak into the groundwater.

KI10: No, because normally sanitation I think they do with private companies, then what we have known that those individuals who come to sanitize the pits they manage, we have realized that sometimes they go and throw it in the jungle. There is not even a good plan for that. And also, not everyone has the resource to pay for their tank to be emptied. Many times, they have one filled and they make another one, then they do not all have the same level to have the sanitation of their pit

4.9.4 Impacts of mismanaged sanitary waste on water supply

Every key informant commented on the issue of improper disposal of sanitary waste as a problem for the larger water supply of the Yucatán Peninsula. Key informants spoke about the causes of this contamination and the associated risks of mismanaged sanitary waste.

Key informants identified two main causes of sanitary contamination on the water supply: the improper disposal of sanitary waste directly to the water supply and members of the population lacking connection to the formalized drainage network (Table 4.8). Proximity of a household's water supply source (i.e. a well) to their sanitary facilities was seen as a major contributing factor to the contamination of their water supply. One key informant commented that due to the lack of connection among those living in irregular areas of ejido settlements, the benefits achieved from

connecting those in the city centre were lost, as the water supply network and the aquifer was so intimately connected.

> *KI3: So we have noticed that in many of the cities no matter how much you have, such as 98% with access to water and sanitation infrastructure, but there are up to 200 thousand inhabitants for example in the conurbation (peri-urban) of Cancún that are not connected to the drainage. Then that is 400,000 who are connected but all the [benefit of the] infrastructure is lost because of those 200,000 inhabitants that are not connected to the drainage. All the investment that was made to avoid the contamination of the aquifer is not being used adequately.*

Respondents identified three main risks from mismanaged sanitary waste. These risks included contamination of the aquifer or other aspects of natural environment, impacts on the formalized water or sanitation network, and risks to human health. Many of the key informants were optimistic, however, and stated that effective treatment of sanitary waste would have benefits to both the natural environment and on human health. Most key informants mentioned the greatest risk from mismanaged waste was the contamination of the larger aquifer network. Two of the key informants indicated that if the aquifer were contaminated with sanitary waste, it would pose a problem to both the water and sanitation municipal networks. Half of key informants also stated that contamination of the water supply could also result in negative health outcomes, particularly those related to gastrointestinal issues.

> *KI5: The reason is that we carry a message of the care of water in general and part of that message is because I know that in those ejido settlements, they could take much more care of the water than those who live in the regular ones. But the issue there are the septic tanks – how they are constructed, what they do with the water, if there are cenotes nearby and what they are doing with them because these are bodies of water that are very important to us. Then it is to talk about that. That not only will this allow them to have quality water, it will allow them to have health, a better lifestyle, for many aspects that are intertwined with each other.*

Table 4.9: Key Informant KAP of Sanitation

	Number of Mentions
Resident's Sanitation Facilities	
Cenote/sinkhole	n=4
Septic tank/pit/latrine	n=10
No facility (open defecation)	n=5
Other	n=3
Resident's Ownership of Facilities	
Private bathroom, private disposal site	n=1
Private bathroom, shared disposal site	n=5
Shared bathroom, shared disposal site	n=4
Not specified	n=1
Maintenance of Sanitation Facilities	

No maintenance of facilities	n=4
Find new disposal site	n=2
Sewage waste removal truck	n=3
Unknown	n=2
Links between Sanitary Waste and Water Supply	
Causes of Contamination	
Improper disposal of sanitary waste into water supply	n=8
All of population not connected to formal drainage network	n=5
Other	n=1
Risks of Mismanaged Sanitary Waste	
Contamination of aquifer/natural environment	n=7
Impact on water/sewage infrastructure	n=2
Impacts to human health	n=5

4.10 Key Informant KAP of Resident Hygiene

Hygiene was the most underreported theme by key informants, with only four key informants explicitly referencing they had knowledge of the hygiene practices of residents in these settlements (Table 4.10). The majority of key informants often discussed the importance of safe water and basic sanitation, but hygiene was commonly excluded. Only three key informants knew their organization had current interventions related to providing information about the importance of hygiene to maintaining health. Another three key informants believed the responsibility for providing this information was the Health Secretariat. The two key informants who mentioned hygiene more frequently during the course of their interviews was the doctor from the local health clinic and the representative from the Health Secretariat. These two individuals mentioned they worked on a personal, household-by-household basis to disseminate the importance of good hygiene, namely as it related to the preparation of food. Both believed residents either did not know or did not place a high-level of importance on hygiene unless there was a problem in their household that forced them to change their habits.

> *I: In your experience, how interested is the community in these type of programs (awareness campaigns)?*
> *KI4: They are interested when they see that there is a problem, unfortunately. They know that it is better to use purified water, but they do not trust it. For example, using well water, they know, they say that the water is already very polluted, and we no longer use it. To drink or to cook, but for other activities, yes. Yes, they are interested, but are more interested when there is an outbreak, or when there are cases in the family, and it is explained to them. That is when they give it real importance.*
> *I: And when there is not an outbreak, what do you do or what do you think causes them to lose interest?*

KI4: It may be the culture, the socioeconomic conditions, but most of all it is ignorance, that they do not have the knowledge of all the consequences or benefits they would have of clean water, safe water, and hygiene practices.

Table 4.10: Key Informant KAP of Hygiene

	Number of Mentions
Hygiene Information Distributed to Residents	
Health Secretariat Responsible for Dissemination of Hygiene-related information	n=3
Organization Distributes Hygiene-related information	n=3
Information about hygiene delivered on individual scale	n=2
Hygiene Practices of Residents	
Residents using contaminated water for personal hygiene	n=4
Residents unaware of basic hygiene related to food safety	n=2
Residents lack knowledge of health risks related to hygiene	n=2

4.11 Key Informant KAP of Health and Healthcare Options of Residents

4.11.1 Predominant Health Issues

Key informants reported several health issues associated with a lack of WASH in these irregular zones (Table 4.11). Most of the health problems reported by key informants were related to inadequate or inconsistent access to safely managed services but some were influenced by other factors such as extreme heat and the common cold. Recurrent kidney stones in ejido settlements was reported by two key informants who attributed the condition to the high contents of calcium in drinking untreated water. Seven respondents indicated the most common health problem in ejido settlements were gastrointestinal infections. Four key informants also mentioned they knew residents had a higher likelihood of contracting other infections, mainly skin and respiratory due to factors such as bathing in contaminated water. Dermatological issues were reported by the doctor at the local community health clinic as a result of the close proximity of animals with scabies and poor-quality water used for bathing.

KI10: Yes, they may have dermatologic diseases. We know more dendritic cells appear, they disguise themselves, okay? For example, patients often come with scabies, which is a very frequent disease, especially in families where there are many animals. Then they come with very similar dermatological diseases, but when they are treated, the treatment does not work, because it is caused by the type of water they use to bathe.

The comments from key informants about the most common risk factors contributing to a higher incidence of certain health outcomes fell into three main sub-themes: consuming contaminated water, eating contaminated food, and living in close proximity to animals (Table 4.10). The doctor and the representative from the Health Secretariat had knowledge through

household visits and appointments at the clinic that consuming contaminated food was a common risk to health. The doctor also commented that living in close proximity to animals facilitated the transmission of certain health issues, namely certain types of skin conditions. The key informant working for one of the NGOs reiterated this and specifically mentioned the presence of dogs was a key risk factor to health. Almost every key informant recognized the contamination of the primary water supply presented the greatest risk to human health (n=9), particularly water that had been contaminated with sanitary waste.

> *KI1: I repeat if they have their septic tank in their backyard and they have their well here and they bathe with that water it is logical that they are going to have those kinds of problems. What they always try to do with the people through these associations is to sensitize them in that sense, "build your pit, do not drink that water".*

4.11.2 Resident level of knowledge of WASH-health linkages

The majority of key informants mentioned the use of a contaminated water supply was the predominant risk factor to health. Many of these key informants also had perceptions as to how aware residents were about the interconnectedness between WASH and health. Only two key informants believed residents had a good level of understanding as to how health was impacted by improperly managed sanitary waste, poor hygiene, and drinking contaminated water. These key informants mentioned that after education and outreach efforts in certain areas, they had observed residents making incremental changes in their routines so as to mitigate the potential health risks associated with using certain types of water sources. However, the majority of key informants believed residents either had limited or no knowledge at all of these linkages thereby increasing their susceptibility to WASH-related health outcomes (n=7).

> *KI5: Yes, that's what I think, there are those who do not even know the word sanitation. It will sound ugly what I say, but for them they believe that while you have a hole and your waste disappears is more than enough and you solved the problem and you are not interested in where the waste goes. It is horrible but it is the truth.*

4.11.3 Resident Access to Healthcare Services

When key informants were asked about access to healthcare in these settlements, most agreed that residents had some form of access, despite the 2017 INEGI State Statistics Report indicating nearly 20% of people in the state were without some form of health coverage. The responses were divided as to whether the healthcare options were located within residents' respective community or whether residents would be required to seek service in more populated towns or cities, such as Cancún. There was some disagreement about the role of regularization of

property on residents' ability to access healthcare. One key informant believed that if there was no recognition of property rights, services including health would not be accessible. However, the doctor in the local community contradicted this statement and indicated all those who sought treatment would be served.

> *I: In your personal opinion. Do you think that most of the people there have access (to the service of the clinic)? I think then, that everyone would have access, because you say you get patients with medical coverage and those without, right?*
> *KI10: Yes, everyone here has the right to come, whether or not they have any kind of medical assistance coverage.*

Table 4.11: Key Informant KAP of Health and Healthcare Options of Residents

	Number of Mentions
Predominant Health Issues in Ejido settlements	
Gastrointestinal infection	n=7
Other infection (i.e. skin, eye, lung, etc.)	n=4
Kidney Stones	n=2
Other health issues	n=3
Key informant does not know of health problems	n=3
Risk Factors to Health	
Using contaminated water source	n=9
Contaminated Food	n=2
Other	n=3
Attitudes of Resident's Level of Knowledge of WASH-health nexus	
Residents lack knowledge	n=5
Residents have limited knowledge	n=2
Residents have good level of knowledge	n=2
WASH and/or Health Information Provided	
Printed educational materials	n=4
Mosquito-borne illness prevention information and supplies	n=4
Supplies for improving water quality	n=1
No information provided	n=1
Resident Access to Healthcare Services	
Residents have access to healthcare services in community	n=4
Residents do not have access to healthcare services in community	n=1
Residents have access to healthcare services outside community	n=3
Other	n=2

4.12 Resident's KAP on Facilitators and Barriers to Achieving Services in Irregular Zones of Ejido Settlements

One of the research questions was to explore residents' KAP of the facilitators and barriers to achieving safely managed services of water and sanitation within their respective community, either for their household or the community in its entirety (Table 4.12). It became apparent through the interview process that residents of both communities had opinions on why there was a lack of services in general, and not solely restricted to water and sanitation infrastructure. This included services like policing, electricity, paving, and garbage collection. These were all reported on by

residents as services they had difficulty accessing or had observed gaps in quality and consistency in their provision. Facilitators and barriers were classified into five broad categories: social or cultural, economic, political or legal, technical or operational, and geographic.

Facilitators were defined as factors that residents either believed would help to grant services in their settlements as well as for their household. These facilitators also included resident perspectives as to what they had seen be successful in the past for achieving results in their neighbourhoods or settlement more generally.

Barriers were operationalized as those factors either influencing the resident's inability to acquire services in the past or what would continue to pose a problem for future efforts to acquire services for their community.

4.12.1 Economic Facilitators and Barriers

Some residents commented on facilitators and barriers of an economic nature. Residents mentioned economic barriers more frequently than they did facilitators. The facilitators they mentioned fell into two categories: co-operating with neighbours to share costs and being offered alternative payment structures by the service provider (CFE or CAPA). This is closely connected with the economic barriers, in that residents indicated the necessity to co-operate with neighbours or seek alternate payment structures due to the high cost of services or land regularization. There were certain residents who had made use of alternate payment structures, but others indicated this was never presented as an option to them. Resident F16RV's response embodies this juxtaposition of both an economic barrier and utilizing an economic facilitator to manage the issue.

> *F16RV: We had to ask for a loan, because it was that you paid it immediately or you ran out of electricity. We also had other expenses. That time we spent like 6,000 pesos, and we only managed it because we talked to the [political] candidate of that time, because if not him, who? First we do not have it, secondly the [Electricity] Commission suddenly arrives and tells us: "pay and I will put in the electricity for you, and if you do not pay, I will not give it to you, and I will also take away your illegal connection". And we need electricity. It was then, that my husband wrote a letter and sent it to a Commission representative. Then we went to speak to the Commission sub-delegation, and they gave us the opportunity to pay in three payments, and that's how they helped us.*

4.12.2 Legal and/or Political Facilitators and Barriers

Residents mentioned legal and political barriers three times as often as they did facilitators in this same category. Most residents believed if they voted strategically or enlisted the help of a government official, they would be more successful in their efforts to achieve services. However, those residents who thought these two factors may help, several other residents indicated they

believed the government to be apathetic to their situation, that politicians would break their promises even if elected, and the presence of favouritism and corruption in the political system acted as significant barriers. Seven residents also believed inaction was not just on behalf of the government, but also the ejido system and the ejiditarios (i.e. landowners). A theme that arose throughout the interview process was how the lack of regularization of property impacted the ability to receive services. The process was seen as both a facilitator and a barrier. A facilitator in the sense that by becoming regularized, one could demand services; however, regularization was seen as a barrier because of the costs associated and the bureaucracy that came along with this recognition of land title.

> *I: But in the case of the group in your neighbourhood, are you willing to pay everything that comes with being regularized - the property tax, everything?*
> *F20B: Yes, I think it's the best thing to do, because that way you can demand more, you can demand your rights as citizens. But not being that way, how can we demand this of them?*

4.12.3 Social and/or Cultural Facilitators and Barriers

Residents commented on a variety of social and cultural factors that would influence their ability to attain service provision in their settlements. The majority of residents believed the unification of residents toward a common goal (i.e. acquiring services) had been integral in success they had observed in past efforts to acquire services, particularly electricity, as well as what would be necessary having improved access to services in the future. There were, however, residents who mentioned their community and neighbourhood lacked organization and believed certain neighbours were apathetic to coming together.

> *I: Well, what do you think worked that time that they managed to get at least those 7 poles for electricity?*
> *F19B: The insistence of the people, the perseverance of being there and more than anything the solidarity. Because when there is no solidarity between the neighbors there is simply nothing, right? Then there must be solidarity, perseverance and faith so that you can achieve what you are asking for*
> *[…]*
> *I: Listen, one last question, you have lived for 20 years here in Bonfil. Why do you think that in those 20 years it has not materialized that all people have drinking water and sewage? What is lacking?*
> *F19B: I think that there is a lack of solidarity. That we have to make the the voice of the people heard. If you listen to the people. That unity of the interested parties, although we should all be interested because it is something that benefits us all. I think that is the lack of unity, because I think the government is able to support us, but if they do not see us united, then how?*

Some resident's comments fell into the sub-theme of increasing education for residents. Residents commented on the need for greater education and campaigns to promote awareness within the ejido in order for residents to understand their role in facilitating the entry of services. One resident even commented on the need for presenting the results of this particular research to share the KAP of residents and of key informants to help with the co-creation of meaningful solutions.

> *M9B: That she presents her results, that she would help with her research that would leave that legacy so that we could apply it in our community. That would be my request and my objective to participate in this interview because I really believe that a good study and a good opinion can serve to improve*

Four comments were made regarding gender imbalances within the community which were believed to act as a potential barrier to achieving services. All four comments were mentioned by women, whom indicated there were noticeable differences in terms of the level of respect each sex was afforded in decision making. One resident used the term "machismo", which is a culture of strong masculine pride, as what made a female ejidatario's role considerably more difficult. Another resident indicated that women's opinions did not have the same weight as men.

> *I: Who is more involved, men or women?*
> *F14RV: Sometimes women participate more because men work*
> *I: Do you think they are taken into account in the same way as men, in decisions?*
> *F14RV: Sometimes*
> *I: Why sometimes?*
> *F14RV: Because sometimes, the presence of the man has more pull than that of the woman*

4.12.4 Technical and/or Operational Facilitators and Barriers

Residents did not mention technical or operational facilitators or barriers with as great of frequency as other categories. There was only one resident who made mention of a potential technical facilitator to help with achieving services in the community. The resident's comment was in relation to an alternative technology a community group was exploring as a means to safely dispose of wastewater. The technical barrier mentioned was in reference to the discrepancy in quality and consistency of the services the community did have access to. Comments on quality of service provision ranged from issues with WASH-related services to health options available in the community.

> *F18B: Because it is very slow, sometimes they do not want to take care of you*
> *I: Do they not have medicines?*

F18B: They do not have medicines, although you have popular insurance, the basic medicine they don't have

4.12.5 Geographic Facilitators and Barriers

Similar to the potential technical and operational sub-theme, there were few mentions by residents of geographic facilitators and barriers. While two residents believed there was sufficient water resources in the region to supply all residents with enough water to fill their wells, when asked about their capacity to connect to the municipal supply of water, 11 residents indicated they believed they were too far from the piped infrastructure that had reached other parts of their community as well as being too far from the city centre of Cancún to receive the same level of quality and access as those who were more urbanized. One resident did mention that if the physical infrastructure were to be extended, that more residents would try to seek a connection to it.

M15RV: Well on the topic of water, as I said, it would be very good for it (the pipe) to arrive, for it to be here on the avenues. And if we could have a connection, for us it would be much better

4.13 Key Informant's KAP on Facilitators and Barriers to Achieving Services in Community

Key informants were similarly asked about their insight into the facilitators and barriers to achieving service provision in ejido settlements. Comments fell into the same categories of social or cultural, economic, political or legal, technical or operational, and geographic and facilitators and barriers were operationalized in the same manner.

4.13.1 Economic Facilitators and Barriers

Most key informants commented on economic barriers to service provision in ejido settlements, and only four key informants mentioned three types of economic facilitators. These included former programs that existed to help residents pay in installments for services, available funding to carry out their work (as was the case of one of the NGOs), and the willingness of residents to pay for the regularization of their property. Six key informants reported insufficient budget was the largest economic barrier, followed by half of key informants mentioning that costs to build formal service infrastructure, like water and sanitation pipes, was quite expensive. Two key informants mentioned other economic barriers, such as a lack of insight as to where money collected from residents is being spent within the community. This comment was in reference to the collection of taxes from residents and the potential misappropriation of funds to affecting change within their community. The second key informant mentioned something also related to accountability of funds, but rather identified the bureaucracy associated with needing to appease

board members with where funds were spent. While one key informant indicated a willingness on behalf of residents to pay to regularize, three other key informants mentioned that affordability of services was a major barrier to most residents in ejido settlements.

> *KI1: The obstacle from my point of view is the economic one. There are never resources, unfortunately for environmental education there are no resources. There are resources for the work, but not to sensitize people*

4.13.2 Political and/or Legal Facilitators and Barriers

Key informants, similar to the residents, indicated significantly more barriers of a legal and political nature than they did facilitators. Almost all key informants indicated the greatest barrier to attaining services in ejido settlements were irregular properties, in that these properties were not formally recognized and therefore could not be accounted for by urban planners to receive much-needed infrastructure. The representative from the ejido office indicated that if a property is regularized, services cannot be denied. Many of the other barriers mentioned were indirectly related to the inability to regularize land in these settlements. For instance, five key informants mentioned limitations of policy, particularly how there was not a federal program in place to simplify the process for regularization. The key informant from CAPA believed the opportunity to improve the situation would be possible if their organization had the same authority to regularize property as Comisión para la Regularización de la Tenencia de la Tierra (CORETT), the commission for the regulation of land tenure. Another barrier indirectly related to the regularization of land included four key informants who commented on the ejido system and the ejiditarios themselves.

> *KI8: The ejidos are in a transition, with this that the ejidos can be sold, even if it is illegal, but they are ejidos. They cannot be parceled. However, everyone's doing it. Then it is beginning to change. We can talk to the ejido assembly, but that ejido assembly no longer has control of the ejido territory because it is in the hands of 10 thousand more owners. So many of these ejidal assemblies, which have become more of a real estate agency than ejidal assemblies, already have a different dynamic that we are trying to learn how to address. This is a tremendous challenge that comes, I imagine, to the entire country. Right?*

While forty per cent of respondents indicated working within the ejido system and with ejiditarios as a barrier, more than fifty per cent of key informants recognized that better collaboration within and between sectors would be needed to appropriately address the problem of so many members of the population without access to safely managed services of WASH.

> *KI5: It would have to be a work of everyone, of community, where there is participatory action, where the government participates, we, and the opinion leaders of the community,*

especially here who are women, that they also participate, because they have great power. With the community and between all of them agree to cover the needs of this population.

Two key informants indicated additional barriers beyond land regularization that were also the responsibility of government agencies. Key informants mentioned sub-themes like corruption and favouritism that hindered the process, the level of bureaucracy associated with requesting services, and apathy on behalf of government officials to deal with and rectify the problem.

KI3: Mainly for political strategy, to obtain votes they offer land that is irregular, they start with a leader, attract more people, most of us have seen that they are from Chiapas, Tabasco, organize among themselves, settle in those areas and obviously acquire the votes for some political campaign and there they stay. Enter a new government, obviously they do not want to kick them out. They do not evict them because it is what they had promised, and they stay there. The next administration comes in, they do not want to fight with them because obviously getting involved with a leader or with ejido settlements generates more social problems at the town halls.

4.13.3 Social and/or Cultural Facilitators and Barriers

There were a number of social and cultural facilitators and barriers identified by key informants. Half of key informants mentioned shared ownership and accountability in projects related to service provision acted as a key facilitator to success of achieving safely managed services of WASH. Three key informants, all three of whom had direct relationships with residents in irregular zones of ejido settlements believed maintaining a strong relationship with members of the community to be an important facilitator as well. Without the trust of residents, key informants acknowledged this could act as a potential barrier to achieving their objectives.

KI3: I believe that every water and sanitation project, Quintana Roo and if I am not mistaken in the entire Yucatán Peninsula, should always be accompanied by the social part. We always focus on the technical part, quality, monitoring, supply. We do not carry the multidisciplinary part and that is the social part. I believe that if we want to ensure the success of all water and sanitation projects, yes, we have to be very involved in the social part.

Several key informants also indicated certain community norms and traditions as well as defined gender roles could inhibit the ability to gain access to services of WASH. Many of these norms and traditions presented obstacles when their organization suggested the implementation of alternative forms of managing sanitary waste. As is the case of many Mayan communities, particularly those in more rural areas of the Yucatán, open defecation or “under the open sky” is a practice that has been ongoing for several hundred years and is one that is difficult to change.

4.13.4 Technical and/or Operational Facilitators and Barriers

There was some disagreement in terms of the nature of technical and/or operational facilitators and barriers to achieving services in ejido settlements. Certain key informants believed they had access to a network of professionals with the required expertise to solve the problem, versus others who believed professionals working in the space of providing low-income communities with essential infrastructure as being difficult to find. Furthermore, the availability of comprehensive water quality data was a point of disagreement – with one key informant indicating an abundance of data on aquifer quality and another stating this baseline data still needed to be collected.

> *KI8: This has been an issue ... Well yes, the issue - having trained personnel, yes and it is also a very special work. You have to know a little bit of engineering, a little bit of construction, a little bit of environmental issues, having social sensitivity, speaking Mayan. In some cases, part of our staff speaks Maya.*

Fifty per cent of key informants did agree, however, that a lack of personnel was a barrier to working towards universal service provision. These key informants stated there were not enough people to do all the work required. Related to lacking the necessary staff, there were also key informants who commented on other operational issues including insufficient number of vehicles to reach the rural areas of ejido settlements as well as hours of operation for the community health clinic that did not extend long enough to service the volume of patients.

> *I: You mean that the problem is technical and operational, they do not have enough personnel?*
> *KI4: There is not*
> *I: Do you lack money?*
> *KI4: The staff more than anything is what we do not have*

4.13.5 Geographic Facilitators and Barriers

Only one geographic facilitator was identified by fifty per cent of key informants: availability of water in the Yucatán Peninsula. Due to the high volume of rainfall the region receives as well as the extensive network of groundwater systems, availability of fresh water was not deemed to be a problem. These key informants agreed that water quantity was not so much the issue, as it was a matter of the quality of these resources.

> *KI1: […] although it is not directly a problem of drinking water, but the problem is focused on the care and preservation of our aquifer, we have to understand, we as a Yucatán Peninsula basin, we are not threatened by the availability of water, we have enough water, however we are very vulnerable to contamination of our aquifer, if the water is not sanitary.*

There were, however, a number of geographic barriers mentioned by key informants. Sixty per cent of key informants mentioned that distance from the city centre posed a problem to the provision of services to those in ejido settlements. This barrier extended beyond just services of WASH to others including healthcare, paving, garbage collection, etc. Part of the problem related to the dispersion of residents further into rural zones is driven by the unplanned urban growth in the peripheries of these settlements. This influx of people migrating from other countries and states would not be accounted for by urban planners.

> *I: Okay. In the case of services, not only of drinking water and sewage with people who are close to home. Is there any other service that they need? Electricity, garbage collection, paving, security, education, health?*
> *KI9: Everything you just said is not something you see everywhere; in fact you have to be moving to the center of the city because there's no schools nor streets in what is called the "colonies"*

Table 4.12: Resident and Key Informant Insight on Facilitators and Barriers to Achieving Services in Irregular Zones of Ejido Settlements

Resident Facilitators	Number of Mentions	Key Informant Facilitators	Number of Mentions	Resident Barriers	Number of Mentions	Key Informant Barriers	Number of Mentions
Economic		**Economic**		**Economic**		**Economic**	
Alternative options for payments	n=3	Payment Facilitators	n=2	Land regularization expensive	n=4	Expensive to build infrastructure	n=5
Sharing costs of temporary infrastructure	n=5	Available/Accessible Funding	n=1	Cost of services expensive	n=2	Insufficient Budget	n=6
		Other	n=1	No payment facilitators available	n=2	Residents lack funds	n=3
						Other	n=2
Legal and/or Political		**Legal and/or Political**		**Legal and/or Political**		**Legal and/or Political**	
Voting strategically	n=4	Amendments to Policies and Frameworks	n=2	Ejido system or inaction by ejidatarios	n=7	Land is not regularized	n=8
Regularizing of Land	n=2	Better collaboration between sectors	n=4	Land is not regularized	n=7	Policy limitations	n=5
Help from officials	n=2			Government apathetic	n=5	Ejido system	n=4
Other	n=2	Regularizing of Land	n=1	Politicians break promises	n=5	Bureaucracy is a burden	n=3
				Political corruption	n=5	Requesting services complex	n=2
				Other	n=1	Government apathetic	n=2
						Political Corruption	n=2
						Other	n=2
Social and/or Cultural		**Social and/or Cultural**		**Social and/or Cultural**		**Social and/or Cultural**	
Unification of residents	n=13	Shared ownership of initiatives	n=5	Residents lack organization	n=5	Norms and Traditions	n=4
Increasing level of education and awareness	n=3	Strong relationship with community	n=4	Imbalance in power between men and women	n=4	Residents' lack of knowledge of how to secure services	n=4
Empowerment of Women	n=1	Traditional Knowledge	n=1	Residents are apathetic	n=2	Residents lack of organization	n=3
		Residents well-organized	n=2	Crime in community	n=2	Distrust of outsiders	n=2
		Other	n=1	Other	n=1	Defined gender roles	n=1
						Other	n=1
Technical and/or Operational		**Technical and/or Operational**		**Technical and/or Operational**		**Technical and/or Operational**	
Small-scale technologies	n=1	Small-scale technologies	n=5	Gaps in quality of services	n=7	Insufficient Personnel	n=5
		Other	n=3			Organization lacks expertise	n=1
						Limited data resources	n=1
						Other	n=4
Geographic		**Geographic**		**Geographic**		**Geographic**	

Abundance of water	n=2	Abundance of water	n=5	Distance from infrastructure	n=7	Distance from city centre	n=6
Extend infrastructure	n=1			Distance from Cancún	n=4	Unplanned urban growth	n=5
				Urban sprawl	n=3	Migration from other states	n=2
						Geological constraints	n=1
						Other	n=1

4.14 Chapter Summary

This chapter summarized the results of the research related to the three objectives set out in the introductory chapter. Resident and key informant knowledge, attitudes, and practices as it relates to the central themes of water, sanitation, hygiene, and health were reported. Almost every key informant and resident acknowledged the primary water source in ejido settlements (well water) was unsafe as a source for drinking water, with most respondents indicating this water was used for other household tasks including cooking, bathing, and washing of clothes and dishes. Many key informants believed this was due to resident's lack of awareness their water was contaminated – likely due to the poor construction of their sanitary facilities and the proximity of these facilities to their household water supply. Residents indicated well water was an easy and cost-effective option and reported several barriers to accessing to the safer municipal supply. Both key informants and residents identified having a strong community voice could be a potential facilitator to resolving inaccessibility to formal services of WASH for those living in irregular zones of ejido settlements.

Access to sanitation and the KAP surrounding the maintenance, disposal, and management of these services in ejido settlements were discussed. Most key informants had the opinion the need for safely managed services of sanitation outweighed that of water, as the geology of the area made the aquifer supplying the entire population of Quintana Roo as highly susceptible to contamination. Many residents reported diverting their household sanitary waste to a cenote or sinkhole in the area, and for those who had a septic tank on their property, only a few indicated they contracted a sewage removal company to empty their tank when it was full. Few residents expressed knowledge of the water-sanitation links, but several reported qualities of their water supply, particularly the smell, that indicated there could be potential contamination. There were several barriers to achieving safely managed services of sanitation reported, mostly by key informants who had technical knowledge of the geology of the area and the costs associated with installing this infrastructure.

Hygiene, as an element of the WASH-health nexus, was the theme with the fewest comments by both residents and key informants. Residents were asked about handwashing practices and facilities, specifically, when they washed their hands and what they used for handwashing. The key informants who were representatives of the Health Secretariat commented on the importance

of basic hygiene for maintaining good health, but other key informants either mentioned it infrequently or indicated that the onus of promoting good hygiene fell to the Health Secretariat.

Results for the final theme, health and access to healthcare options for residents in ejido settlements, were presented next. Most key informants reported WASH-related health outcomes such as diarrheal infections and skin and eye problems. Residents were less-forthcoming with disclosing the common health outcomes in their households; however, those who did report health problems mentioned some gastrointestinal problems as well as seasonal afflictions like the common cold. While many key informants believed many of these problems were WASH-related, and several residents agreed with this, many residents attributed the health issues to foodborne-related causes and issues with garbage collection in their neighbourhoods. Most residents did not believe the health issues in their household were significant enough to warrant missing work or any other major changes to their routines. Psychosocial health concerns were also identified throughout the course of interviews with residents. Emotions like fear, stress, and frustration were identified during every resident interview, with fear of getting sick from water and frustration with the lack of progress in securing WASH and other services being the most reported. Access to healthcare was seemingly not an issue for residents in ejido settlements, with almost every resident reporting have a form of health coverage for themselves and other members of their household. However, the matter of *quality* in healthcare services was discussed. Residents reported a variation in the standard of care available to them between local health clinics that were publicly funded versus private clinics closer to the City of Cancún. The distinction in when residents would use certain clinics (i.e. Farmacias Similares "SIMI" or private clinic in Cancún) was dependent on the type of ailment they had. There were few barriers identified by key informants and residents as it related to health and healthcare, as these services were seen to be readily available when-needed.

The chapter concludes with a discussion of the facilitators and barriers to achieving services of WASH in ejido settlements from the perspective of both residents and key informants. Interestingly, residents reported facilitators and barriers associated with service provision in their settlements beyond just the issue of lack of access to WASH-related services. Issues with services relating to policing and safety, garbage collection, and most frequently mentioned, electrical service were reported. The most prominent barrier identified by both residents and key informants was that of land regulation. Nearly every respondent, key informant and resident alike, reported problems with the ejido land regulation system and the government's failure to facilitate land

ownership in these settlements to properly recognize these residents in urban plans. Several key informants explicitly mentioned that until land regularization was formalized for residents in irregular zones of the ejidos, all services, WASH included, would not enter these areas.

This is a summary of the key takeaways of this research. A further discussion of the findings will follow in the next chapter, with future directions for research and potential interventions in the conclusion section.

CHAPTER FIVE – DISCUSSION AND CONCLUSION

5.1 Introduction

Research examining the knowledge, attitudes, and practices related to WASH and health of those living in low-income communities in high and upper-middle-income countries has been lacking to this point. Moreover, using qualitative methods to explore KAP in these settings is not common, per the systematic review conducted earlier in this research (Hall et al., in preparation). This thesis aimed to fill this gap and explore the facilitators and barriers to achieving safely managed services of WASH in the setting of low-income communities in an upper-middle-income country – namely, irregular zones of ejido settlements in the peri-urban zone of Cancún, Mexico. This thesis focused on achieving three main objectives:

1. To explore the water, sanitation, hygiene and health-related knowledge, attitudes, and practices of residents living in irregular zones of ejido settlements
2. To explore the water, sanitation, hygiene and health-related knowledge, attitudes, and practices of key informants
3. To uncover the differences in understanding between residents and key informants with respect to the facilitators and barriers to WASH

This thesis presents a starting point to understanding the lived experience of those without access to safely managed services of WASH and the resulting WASH-related health outcomes, and the structural and systemic factors that continue to act as a barrier to rectifying this situation. The data collected from key informants and residents sought to contextualize both group's understanding of WASH-related facilitators and barriers and identify potential opportunities for interventions.

5.2 Summary of Key Findings

5.2.1 Gaps and Overlaps in Key Informant and Resident KAP of WASH and Health

When the results for resident and key informant KAP on the theme of water were contrasted, a number of interesting findings came about. Firstly, most key informants indicated the primary water supply of residents was well water. This was confirmed by the majority of residents interviewed who stated well water was used for most household activities. When asked about the relative safety of their water for direct consumption, nearly all residents acknowledged their water was unsafe, regardless of supply source. To mitigate potential water-related health risks, nearly

every resident stated they used purified water (bottled or jug water) for drinking. Key informants with knowledge of the region's water supply quality indicated this practice was prudent, due to the high levels of contamination reported throughout the state. However, key informants with knowledge of the quality of the municipally supplied drinking water indicated this water was actually safe for consumption due to multiple levels of treatment, despite certain residents with access to this supply reporting their household also drank purified water. The two key informants who were members of the health sector and worked directly with residents of these settlements indicated they encouraged residents to use alternative sources of water to well water for drinking, cooking, and other direct contact uses, including bathing.

The majority of residents commented they did not do any formal testing or analysis of their water supply and their belief that the water was unsafe was influenced by visually inspecting their water or "just knowing". Most residents commented the water had a strange appearance, smell, or taste, and the presence of debris or bugs in their cistern. Certain residents even noticed a decreasing quality over time, especially due to factors like moving further from the centre of the ejido and following a rain event. Certain key informants specified a number of possible contaminants and water quality indicators like coliforms, E.coli, and total suspended solids (TSS) in their responses, but most stated the water in the personal wells of residents were "poor quality" and the water in the municipal supply was of "good quality". An interesting finding was uncovered with regards to the testing of personal, unregistered wells of residents in irregular zones of ejido settlements, in that none of the key informants interviewed reported their organization was responsible for the monitoring of water quality from this supply source, despite recognizing that this was the primary supply for water in irregular zones. A caveat to this statement is one key informant mentioned the organization COFEPRIS *could be* responsible for this, but a representative from this organization was not available for interview. One of the key informants from CONAGUA specified residents could request testing of their well if they believed it to be unsafe, or, in certain scenarios, when a possible health outbreak was possible. However, it was stated later in the interview that if a program monitoring these personal wells on a regular basis were instituted, this effectively could "recognize" residents who live in irregular zones.

Residents and key informants both commented on the high availability of water. Most residents agreed they had sufficient water for their household needs, but many associated access to water with a functioning electric pump, thereby indicating a dependency on services of

electricity. Those residents in Bonfil who had access to the municipal water supply indicated they too had enough water for their needs, so long as the household members prepared accordingly by filling their cisterns with water during the hours of scheduled availability. The three residents with access to the municipal supply indicated water was delivered by AGUAKAN between the hours of 10 am and 3 pm every day. Water being available for less than 12 hours per day does not meet the criteria for one of the targets for safely managed services of water (WHO/UNICEF, 2019).

The theme of sanitation saw significant gaps in understanding between residents and key informants on the potential ramifications of mismanaged sanitary waste. The similarities between resident and key informants only extended to knowledge on the types of sanitary facilities common in irregular zones of ejido settlements and the infrequent maintenance techniques of these facilities. Key informants reported observing a range of sanitary facilities including septic tanks or a dug pit, diverting sanitary waste to cenotes, and finally, open defecation in the rural areas of ejido settlements. Diverting to a cenote and defecating outdoors occupy the lowest rung on the JMP's service ladder for safely managed services of sanitation, indicating no facility is present. Not one resident reported defecating outdoors, however, this may have been attributable to the fact that residents selected for interview lived just outside the urban centres of their respective ejido and were more likely to have sanitary facilities.

When residents were asked about the ownership of their sanitary facilities, all residents reported having a bathroom facility private to their household not shared with neighbours. This indicates at least a basic level of sanitation services on a household-level, per the JMP's ladders. As for the end destination for their sanitary waste, certain residents reported sharing a communal disposal site, such as a septic tank. Residents who diverted waste to a cenote were also classified as sharing a disposal site, as these sinkholes were large enough to hold multiple household's waste. Cenotes, however, are not considered a safely managed service of sanitation, as the disposal method does not include any form of treatment offsite. Those interviewees with experience working with residents in rural zones of ejidos or the state more generally reported it was more common to observe residents sharing a bathroom facility in addition to the disposal site. This finding reaffirms the discrepancy in quality of services between urban and rural populations (Bisung, 2014).

The reported disposal and maintenance practices of sanitary waste by residents, particularly those who indicated they diverted to a cenote or had never emptied their septic tank, revealed a considerable risk to human health and the potential to contaminate the aquifer network. Almost every key informant indicated the unsafe disposal and poor construction of sanitary facilities in irregular zones posed a significant threat to the aquifer system for the entire Peninsula. Several residents reported their septic tank had yet to require maintenance due to the depth of the tank or that it had not yet reached capacity – some of whom had lived in that house for more than 20 years with several family members. This struck the research team as strange, as in some cases, the tank had not been emptied for several years – some for decades, which indicated a potential leak in their disposal site. Key informants also stated a common disposal technique was to simply seal the existing facility and construct a new one. This technically meets the standards for "safe disposal" under the category of safely-managed services so long as there is no potential for infiltration of sanitary waste; however, the caveat being many of these sites are not properly sealed and due to the high porosity and rates of infiltration common in the Peninsula, this presents a considerable risk for contamination. Most key informants agreed that safely managed services of sanitation outweighed those of water in both importance and urgency to address. Comments from several key informants on residents' lack of maintenance or the improper construction of their facilities indicated potential "victim blaming", as poor construction and awareness of the sanitation-water links are complex topics that residents may not be keenly aware of.

The theme of hygiene was not commonly discussed throughout the course of this research. Key informants referred to services of water and sanitation but typically omitted hygiene, though it is an essential component of "WASH". This could potentially be due to the fact hygiene is often seen as inextricably linked to sanitation and only recently received its own ladder by the JMP, and therefore data globally is lacking on this element (WHO/UNICEF, 2017). Those key informants who worked either within the Health Secretariat or had experience creating educational materials and awareness campaigns mentioned the importance of hygiene with the greatest frequency. While hygiene was not discussed as frequently as water and sanitation throughout the course of this research, all residents reported having basic services of hygiene – using soap and water in their household. When asked about their handwashing practices, all residents confirmed, upon probing, they washed their hands before eating and after going to the washroom. It is possible residents felt

pressured to “say the right thing” and residents *knew* hygiene practices were important for good health but did not necessarily follow this practice regularly. This was evident through the research team observing one resident, a shop owner, speak about hygiene practices while cutting raw chicken with her bare hands and handling money from customers without washing in between actions. Investigating resident KAP of hygiene in future research, beyond the JMP’s focus on handwashing facilities alone, would be valuable to understand hygiene-specific risks in irregular zones of ejido settlements.

There was consensus between key informants and residents on the predominant health issues in ejido settlements and the healthcare options available. Thirty per cent of residents and seventy per cent of key informants reported that gastrointestinal issues were the most predominant health issue in ejido settlements. Other infections, such as skin or respiratory issues were the next most-commonly reported, followed by the common cold and flu. Key informants were more likely to associate the health problems of residents in irregular zones of ejido settlements to lack of WASH and the contamination of the region’s aquifer system, whereas residents believed it was related to other pathways, like contaminated food, inconsistent garbage collection, or changing of the seasons. Psychosocial health emerged as an important theme with residents reporting feelings of despair, helplessness, and low social support. It is well-documented in the literature these feelings can lead to physical health ailments including increased inflammation, elevated heart rates and blood pressure, among others (Arcaya et al., 2015). Residents embody the lived experience of managing a lack of WASH as both psychosocial and physical health outcomes, Krieger’s first construct of ecosocial theory. Key informants with knowledge on the predominant health issues in irregular zones of ejidos reported many of these outcomes were widespread in these areas, indicating population patterns of disease.

It was reassuring, however, to discover from key informants that access to healthcare for residents in irregular zones of ejido settlements is a service that people *should not* be deprived of. Healthcare was said to be a basic right with everyone having the ability to access these services either through social security or programs like PROSPERO. However, given five of 18 residents reported having no health coverage for their family, this information needs to be circulated to those residents living further from the city centre who may be unaware they can access the services of a health clinic freely as a legal Mexican citizen. It may also be a possibility that certain residents

interviewed did not disclose their true birth country out of fear of reprisal or other, more serious consequences. A key finding in the theme of health and healthcare is the distribution of information to residents regarding potential WASH-related health risks. Key informants reported several current interventions related to improving the education and awareness of WASH-related risks; however, more than half of the residents interviewed indicated they had never received any information. For those residents who recalled receiving some material in the past, materials were mostly related to the prevention of mosquito-borne diseases. Given key informants' declaration that poor construction of sanitary facilities presented considerable risk to both human health and the health of the broader aquifer and ecosystem, perhaps targeted interventions on increasing the knowledge among residents of septic tank construction, care, and maintenance is an opportunity to achieve both outcomes: reduced risk to health for the population and preservation of the water network. This provides confirmation that continued efforts to increase the knowledge of WASH-related risk factors among residents in these settlements remains a priority.

5.2.2 Facilitators and Barriers for Improved Access to Safely Managed Services of WASH

A number of interesting findings came about from the analysis of resident and key informant insights into the facilitators and barriers to achieving safely managed services of WASH in irregular zones of ejido settlements. Many of these factors were interconnected and indicated the complexity of providing both access to services and ensuring the adequate quality of those services. This was applicable to all services in the community beyond WASH, such as garbage collection, policing, health, and electricity. Structural factors, like land ownership and urban planning, indicate how issues of power and authority are embedded and manifest in health outcomes experienced by residents at more local, regional scales.

Some key informants believed residents had the expectation services of water and sanitation should not come with any cost, as water is a national commodity and should therefore be free. Two key informants stated, paraphrased, "water is free, the infrastructure to deliver it is not". This was validated by key informant's reports of high capital expenditures for construction and the operational costs as barriers to extending infrastructure to certain parts of ejido settlements. Throughout interviews with residents and discussions on the economic-related facilitators and barriers, this expectation was not expressed, rather, residents believed that payment plans in the form of installments or even cooperation between residents to pay for a shared resource could help with gaining access over time in their respective neighbourhoods.

The legal and political factors respondents believed hindered or helped the entry of services into ejido settlements were numerous and had significantly more mentions than any other category. A major finding in this research was that lack of legal certainty in irregular zones of ejido settlements resulted in a "stand-still" on behalf of all service providers recognizing residents in formal urban plans. Key informants uniformly believed resolving this uncertainty would entitle residents of these settlements to the same rights afforded to those who were regularized. The caveat to this being services would not be delivered on an individual basis as households regularized, rather, a group of residents, potentially upwards of 500, would need to be regularized in order to warrant the costs of extending infrastructure to reach them. The region sees considerable migration of mostly low-income people from other states and countries to participate in the tourism industry, most of whom need to rent instead of purchase land outright in these irregular zones. It was reported by several key informants many of these newcomers are not financially capable of purchasing the deeds for many years and therefore must find cost-effective alternatives to obtain services of WASH like drilling their own wells and diverting their sanitary waste to a cenote. This example elucidates the complexity of service provision in these settlements and the interconnectivity between multiple types of barriers. The nature of property ownership and the imbalance between regularized and non-regularized people in this region is representative of one of Krieger's core propositions of ecosocial theory, property and power. The strong divisions in terms of property ownership and those with power to address legal uncertainty in land ownership in irregular zones is manifested in the health burdens residents experience daily.

Several social and cultural facilitators and barriers were identified. It was apparent residents recognized the importance of working with one another to achieve the common objective of improved access to services in their settlements – a key indicator of social capital. While several residents indicated a current lack of social cohesion and trust between residents in their respective settlements and neighbourhood, many residents believed coming together would result in positive outcomes. Many residents recalled instances of successful collective action on behalf of neighbours to petition government officials and cooperate to pay for services. The importance of residents having a unified voice when approaching government officials or service providers was also reiterated by key informants as a key facilitator.

Challenges with gender equity in these communities also emerged. For example, the concept of "machismo", a culture of strict masculinity, was identified by one of the female respondents as

prevalent in her ejido, particularly as it related to the difficulty women had in the governance of the ejido. Other female respondents, when probed, also identified gender-related imbalances in their communities through the retelling of specific situations they found themselves in that involved men doubting their capabilities in some manner. The very ratio of the proportion of female residents interviewed as compared to men indicated women are more likely to be home during the daytime hours managing the household tasks and taking care of the children. Interestingly, when we inquired with the key informants as to whom is most likely to participate from the community in WASH-related advocacy or awareness work, the resounding answer was women, as they are intimately familiar with these issues. Women around the world, as well as in this context, experience disproportionate burdens as a result of inadequate access to WASH in their household. The findings of this research indicate these burdens are multiple, complex and interacting (Pommels, 2013).

Key informants mentioned technological and operational facilitators and barriers more often than residents. This is not surprising, as many of the key informants selected for an interview were familiar with the infrastructural and the organizational-level challenges associated with service provision. Acknowledging the difficulties of extending infrastructure, several key informants posed alternative technologies as effective options such as composting toilets and rainwater catchment systems. These were reported as more successful in rural zones by key informants who had experience in these areas, however, residents in the peripheries of cities were less likely to be convinced. Key informants indicated that perceptions of certain technologies by residents as rudimentary or not being modern enough, led to challenges with uptake by residents to see these types of technologies as viable, sustainable solutions.

The final category responses were grouped into geographic-related facilitators and barriers. Residents and key informants both agreed those who lived further from the centre of their respective ejido and from the City of Cancún were less likely to have access to services in their households, as the more densely populated areas of the region were priority areas for the construction of formal infrastructure. Certain residents and several key informants also indicated how challenging it would be to reach residents in rural zones, particularly because of the unplanned urban sprawl into increasingly densely forested areas. However, there was no question the considerable availability of water in the Yucatán Peninsula in the aquifer system and significant

rainfall meant even those who could not connect legally to the water infrastructure would be able access sufficient quantities for their needs through constructing their own wells.

5.3 Contributions

This thesis has made substantive contributions to the existing body of literature regarding access to safely managed services of WASH in low-income communities in higher-income countries. Furthermore, the key findings of this research have parallels with other WASH-health nexus research done by health geographers in a multiplicity of settings. The revelations, particularly as it relates to the burden of access to WASH resting largely with women, reaffirms the notion that water is a women's issue around the world, and is not reserved only to women in LICs. These findings also illuminate the implications of historical decisions embedded in existing structures, like land ownership and investment in the tourism industry on the current population.

Theoretically, this thesis indicates the use of ecosocial theory, and the political ecology of health framework can help elucidate the larger structural factors and the pathways that influence health at population, regional and individual levels. Like the conclusion drawn by Yamada and Palmer (2007) in the Marshall Islands, ecosocial theory is an appropriate framework to classify the biological manifestation of WASH-based health outcomes as embodiment of the differentials in political power, economic conditions, and ecological vulnerability. Exploring the lived experience of residents who lack consistent access to safely managed services of WASH, particularly through investigating their respective knowledge, attitudes, and practices, it was possible to identify the four constructs of Krieger's ecosocial theory: embodiment, pathways, interplay of exposure across the life-course, and accountability and agency in the provision of WASH services and the preservation of the ecological integrity of the Yucatán. The embodiment of WASH-related health outcomes among residents and the data provided from both types of interviews provided a clearer understanding of these pathways – especially those rooted in inequalities such as social and economic deprivation and the degradation of local ecosystems. KAP of residents and key informants also provided clarity into the interplay of exposure, susceptibility, and resistance – especially when both groups indicated greater incidence of health outcomes during different points throughout the life-course. And the final construct, that of accountability and agency, was apparent through the lack of power and capacity among individuals to act and solve this issue of inaccessibility, although key informants almost uniformly believed the onus for

maintaining sanitary facilities fell to the residents. There also appeared to be a lack of individual ability, but also accountability to solving the problem of access to WASH expressed by key informants. Multiple respondents stated the responsibility for maintaining the health and well-being of citizens in the region and data tracking fell to the Health Secretariat, which contradicts the inextricable connection between the environment and human health.

As stated in earlier sections, the political ecology of health framework is more commonly applied in LICs, but as this thesis demonstrates, the utility of the framework in higher-income countries, especially in those where access to resources are so significantly stratified as a result of the systemic injustices created decades previous and continue to manifest in negative health consequences for the most vulnerable and peripheral members of the population. The political ecology of health framework is an effective means to provide a conceptual lens to understand the importance of political and environmental struggles and the associated costs to health and well-being (Richmond, 2005; Mayer, 1996). This framework provides an ability to explore the inequities in service provision that trickle down from a larger structural and state-level decisions to the local and regional scales, like ejido settlements in the Yucatán. This is highly relevant in this setting as imbalances in power, specifically as it relates to land ownership, dictate the ability for residents in these settlements to achieve essential services in general. Furthermore, the fieldwork constraints that led to interviewing during the daytime, and therefore a greater proportion of female residents, this research also has explored the daily practices in households that have potential to impact wider patterns of urban and social differentiation. Like Truelove's work in Delhi, India, these findings demonstrate how daily practices in spaces like the household and community can reproduce gender and other social differences within these spaces and class groups (2011).

5.4 Limitations

Due to the cross-sectional design, the research team was not able to investigate the changes in responses over time. Another limitation, and one common in studies using qualitative methodology, is the small sample size (residents n=18, key informants n=10). With smaller sample sizes, caution should be exercised when trying to extrapolate these findings beyond the two ejidos and even within individual neighbourhoods.

The chosen sampling method also presented a potential limitation. Random sampling could not be conducted due to the level of unfamiliarity of the research team with the settlements chosen

for research, therefore convenience sampling was the only viable option for completing fieldwork in the requisite time period. Despite utilizing this method to mitigate the effects of lack of trust of outsiders, it was apparent throughout the recruitment process that certain residents were distrustful of the research team's credentials and intentions, even with a neighbour's verification. For those residents who chose to participate in the research, some were reserved in their responses and could have provided more "socially desirable" answers, as exemplified in the case of residents reporting on household hygiene practices. Respondents were also subject to potential recall bias due to the self-reported KAP. Furthermore, fieldwork could only be conducted during daylight hours for personal safety reasons, which minimized the research team's ability to interview a greater diversity of residents. A limitation for both resident and key informant data were the interviews being conducted in Spanish, necessitating translation from Spanish to English. While efforts were made to control for improperly translated data, the intended meaning and cultural nuances through the transcription of the interview in Spanish followed by the translation to English with Spanish-speakers, certain phrases or expressions had the potential to be misinterpreted.

Despite the limitations mentioned, this research adds important descriptive information to the current small body of literature on the KAP of residents who live in irregular zones of ejido settlements without consistent access to safely managed services of WASH. It may also present a starting point in this setting to bridging the gap in understanding between those who work to provide services of WASH and the residents who need them.

5.5 Directions for Further Research

Important parallels can be drawn between the findings from this research context and other low-income communities, in LICs, UMICs, and HICs. In a HIC context, similarities between Canadian indigenous communities, the *colonias* between the US-Mexican border, and intra-urban settings in the United States can be observed. Further research in these settings and the continuation of the current research partnership between University of Waterloo's Water Institute and the Centro de Investigacion Cientifica de Yucatán (CICY) partnership are many.

Given the scientific capabilities of CICY's laboratory facilities, a possible next step in the partnership could be the completion of additional fieldwork to establish a baseline on water quality parameters of residents' personal wells. This will be of great importance on providing essential data to government organizations working to supply services of WASH and health in irregular

zones of ejido settlements where data may be lacking. From the findings obtained mostly from the key informant interviews in identifying technical, operational, and economic barriers to implementing formalized WASH infrastructure, further research on understanding resident's attitudes and perceptions towards alternative options for WASH facilities would be useful in identifying appropriate interventions that are both less expensive and achieve the greatest reductions in waterborne risks to health. This is consistent with findings from Bisung et al. (2014) suggesting incremental improvements are an effective strategy to accessing water and sanitation services in low-resource settings. Also essential to the uptake and sustainability of WASH and health-based interventions, community members must come together willingly to create a unified voice as to the goals and steps needed to obtain safely managed services of WASH (Levison, 2010). Past examples of successful collective action reported by respondents in this research are suggestive of social capital in these settlements and this should be explored further. Certain questions pertaining to social capital were asked during the course of this research, while not reported in this thesis, and included inquiring about neighbourhood and interpersonal trust, willingness to participate in civic duties, and norms within the community. Utilizing an established framework to assess social capital like that of Putnam's or Coleman's could be a next step in the research project. The most commonly reported barrier to achieving safely managed services of WASH for residents in irregular zones by key informants and residents pertained to the issue of land regularization and indicates the need to further investigate the legality around land ownership in ejido settlements. The process of facilitating land ownership and formally recognizing those in ejido settlements not currently included in city planning would be worth pursuing as a long-term and sustainable solution to inaccessibility to services in these communities. As it pertains to data collection methods, particularly the recruitment and selection of residents to participate in future research in these locales, the importance of establishing trust in these settlements is paramount. Based on the experience as a foreign researcher in these settlements, making contact with the local schools to facilitate introductions and validate the credentials of future researchers to residents, more responsive and receptive participants would be recruited. Furthermore, a researcher who is a Spanish-speaker, preferably from Mexico, would also be recommended. As a non-native Spanish-speaker it was difficult to capture the nuance in expression of the residents during interviews, and this could only be revealed following transcription and translation, after which the opportunities to recall the subtleties of the interview were limited. The ability of CICY to facilitate interviews

with other members on the Consejo de Cuenca (Basin Council) will be of use for future research in these locales.

5.6 Conclusion

This thesis provides a substantive contribution for the exploration of facilitators and barriers to achieving safely managed services of WASH in low-income communities in higher-income countries. Understanding knowledge, attitudes, and practices of residents of these communities and the key informants working to provide these services with proper consideration for compositional and contextual factors will help to develop sustainable solutions. As much as political decisions about the investment in the built, natural, human, and social systems can result in negative outcomes, like lack of access to services, if decisions are made in a balanced way, opportunities for people to fulfill their needs can be accomplished (Kangmennaang & Elliott, 2018). Residents of ejido settlements have important insight into the issues with service provision and are an effective resource for key informants to leverage in order to continue furthering the efforts to bring formalized infrastructure into these locales. Ultimately, amendments to policy to facilitate the regularization of these settlements and thereby the entry of permanent WASH infrastructure is of significant importance, but to reduce WASH-related health outcomes being experienced currently, efforts must be made on behalf of organizations to increase the knowledge and awareness among residents for more immediate technological solutions like composting toilets, rainwater catchment, and the proper construction of sanitary facilities. Further investigation of social capital in irregular zones and the potential for collective action to be an effective, interim solution to reducing WASH-based health outcomes is also needed. Involvement of women will be crucial to the success of both short and long-term solutions, as it is women who disproportionately face the burden of water management in the household and who are already actively engaged in community-based advocacy work to improve access to WASH in their communities.

Many of the Sustainable Development Goals are mutually enforcing and cannot be achieved without improvements to targets and indicators across each of the 17 goals. Goal 3, ensuring healthy lives and promoting well-being for all at all ages cannot be accomplished without improvements to WASH and the reduction of waterborne illnesses, Target 3.9. This target is expressed in the dedicated SDG for ensuring the availability and sustainable management for all to water and sanitation, Goal 6. One of SDG 6's targets call for special attention to improving sanitation and hygiene particularly for women and girls who are in vulnerable positions. As observed in this research, water management in

the household is predominantly a women's issue. Achievements in improving health and well-being and reducing WASH-based health outcomes through sustainable and appropriate solutions cannot be made without understanding women's lived experience with lack of access to safely managed WASH. Women must be included in the conversation and decision-making process for these solutions at both the household and community levels. Improving equity and empowering women in this context, and all others, is SDG 5. Without this essential component of sustainable development, other goals will cease to be achieved.

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APPENDIX A – INTERVIEW GUIDE FOR RESIDENT INTERVIEWS

Construct	Question	Probes & Notes
Socio-Economic Status - Current economic standing - Household Characteristics/ Dynamic	*I am going to begin with a few questions about your home and daily life, just to get to know more about you.*	
	How long have you lived in this settlement?	Did you live somewhere else before moving to this settlement? Where are you originally from?
	How many people live in your house? How are they related to you?	
	How old are your children? Are they attending school?	
	What do you do on a normal day?	What do you do for work (if applicable)?
Water, Sanitation, and Hygiene Services - Availability and access to water and sanitation services - Usage and practices of water and sanitation services	*Thank you for answering those questions. I would like to know a bit about water, sanitation, and hygiene services in your home and in the settlement.*	
	Where do you get your water?	Are you connected to a well or the local municipal system? Do you know who manages the water you use? How much time does it take you to collect water? (only ask if no access to a personal well) How do you store your water?
	Do you have water available to you at certain times per day? Is it consistent/inconsistent? (only ask if NOT using a well)	Why do you think that is (if irregular)?
	Are there times when you do not have enough water?	If no, why not? Dry season? The water truck did not drop it off? Is water expensive?
	Do you think the well water is safe for drinking?	Why or why not?

Construct	Question	Probes & Notes
	Thanks for your feedback. Now I am going to start asking you questions about your sanitation facilities.	
	Are you connected to the local system for sewage?	If no, do you have a septic tank or a latrine?
	Do you maintain the septic tank? If not you, who? How often?	
	Do you share the bathroom with your neighbours?	
	Do you wash your hands?	Do you use soap and water?
Health of Family Members and Health of Settlement - Perceptions of sickness - Facilities available for treating sickness - Dealing with sickness	*I am going to move on to talking about health among your family members and health in the settlement.*	
	Has anyone in your household experienced sickness that you think might have been caused by water?	When was that? What type of sickness? Who was affected? What do you do to get better?
	What do you do to avoid getting sick?	
	How does your routine change when you or a family member is sick?	Will you miss work to stay home with your child if they are sick?
	Do you have access to medical assistance?	Where do you usually go when you or a family member gets sick?
	Do you have information on proper water management and disease prevention?	What kind? Where do you get it from?
Indicators of Social Capital - Organizational Density and Characteristics - Networks and Mutual Support	*This is the final section of our interview. We are going to move onto talking about how your settlement functions, both normally and when trying to solve problems.*	
	Are you or is someone in your household a member of any groups, organizations, or associations? If applicable, which are most important to your household?	Who in the household belongs to which group?

Construct	Question	Probes & Notes
- Exclusion - Solidarity and Belonging - Specific and General Trust	Who in your settlement participates to solve problems?	Who is the leader?
	Have you ever come together as a settlement to address an issue?	Have they organized to ask the government for help? How often?
	Was it successful?	What do you think worked/did not work? Why?
	Who would you turn to for help in a difficult situation (e.g. sick children, job loss)?	Friends, neighbours, family?
	If you needed to leave the settlement for a while, who would take care of your house while you are gone?	
	There can be differences between the people who live in the same settlement…	
	Do you think there are some social problems that divide people in your neighbourhood?	Money? Crime? Cultural? Gender?
	Are there any services that you or members of your household are occasionally denied service or have only limited opportunity to use?	Are there other households that similarly do not have access to these services? Do you think there are some people who do not have access to healthcare services? Why do you think this is the case?
	I would now like to ask you some questions about trust and co-operation.	
	Do you think that in this settlement people generally trust one another?	Why do you think this?
	Would you say most people in this settlement are willing to help if you need it?	For example, if you lost something of importance and needed help finding it.

Construct	Question	Probes & Notes
	In your opinion do you think residents are likely to participate?	
	Are there any times when you feel unsafe here?	When? How often? Why? What do you do when that happens?
	Would you say you feel accepted as a member of this settlement?	
Thank you very much for your time. Is there anything else you would like to add that we have not already talked about?		

APPENDIX B – INTERVIEW GUIDE FOR KEY INFORMANT INTERVIEWS

Construct	Question	Probes & Notes
Background Information - Scope of Organization - Individual Role and Responsibilities	I will begin this interview by asking you some questions about your role in this organization and what you do regarding water and sanitation.	
	1. What is your role here at (x) organization?	How long have you been working at organization (x)?
	2. In what capacity do you work with those who do not have water and sanitation services?	What are the projects or initiatives you are working on to improve water and sanitation in these zones?
	3. What do you think the top priority is when it comes to improving access to water and sanitation?	Does your organization's top priority differ from the residents' top priority?
	4. Do you have specific guiding policies your organization adheres to?	I.e. the SDGs?
Water, Sanitation, and Hygiene Services - Uses of water and sanitation services - Priorities of settlement members	*Thank you for answering those questions. I would like to ask you about water and sanitation services more generally within irregular zones.*	
	5. Does everyone have the same level of access to water and sanitation services?	Why do you think this is the case?
	6. Does everyone have the same barriers to water and sanitation services?	
	7. What are the residents' top priority for water and sanitation?	Is it consistent access? Quality of resources? Connection to their homes?
	8. How have you observed the residents using water in their homes?	Cooking? Cleaning? Washing?
	9. What do you believe are the predominant uses of water in irregular zones?	Cooking? Washing and/or cleaning? Watering plants?

Construct	Question	Probes & Notes
	10. How do residents collect their water?	Jerry cans? Delivered to the home?
	11. Do you think the water is safe to use or of good quality?	How do you know the quality?
	12. What are the predominant sanitation practices the settlement?	Open defecation? Use of latrines? In-home washrooms?
	13. Are sanitation facilities shared among neighbours or are they individually owned/managed by one household?	
	14. Where does waste from sanitation facilities go?	Does it remain in the septic beds? Is it burned?
	15. Are there any other service gaps experienced in this community?	What are those? Education? Transportation? Security/police services? Etc. What about health services? Will some residents have more access to certain services than others in the same settlement?
Co-operation - Consultation and collaboration with informal settlements - Means of communication	*I would like to now ask you some questions about the nature of your organization's relationship with residents in irregular zones of ejido settlements*	
	16. Do you know what groups or organizations residents can join in their settlement?	In general? Any related to water and sanitation?
	17. In the context of water and sanitation services, how successful are the actions of these groups in achieving results?	How do you think success affects residents' likelihood to join together to address this issue?
	18. Do you receive updates or complaints from settlement members on water and sanitation projects? How often?	How will you receive complaints from residents?

Construct	Question	Probes & Notes
		*This may depend on particular KI - take note on who you are asking this question to
	19. When you are working on water and sanitation projects, who is your main contact in the settlement?	Who do you prefer to work with? Why?
	20. Do you conduct meetings with the residents to determine what their water and sanitation needs are?	Where will you conduct these meetings? Who typically attends with you (within/outside your organization)?
	21. How interested do you think residents are when you talk about progress in water and sanitation projects in their settlement?	Do you think they trust/believe you?
	22. What do you do to build trust with residents of the settlement?	What are examples of these techniques?
	23. Is there a difference between men and women in terms of participation in water and sanitation projects?	In problem solving, in identifying the issue?
	24. What information do you provide residents to increase their knowledge around accessing services of water, sanitation, and hygiene?	
	25. What strategies have you used to distribute information about safe practices around water, sanitation, and hygiene to settlement residents? How effective have they been?	What obstacles might you face distributing this information?

Construct	Question	Probes & Notes
Health in the settlement - Health status of residents - Health and healthcare seeking behaviours	*I will now ask you some questions about your perceptions of the health of the residents in the settlement.*	
	26. What do you think are the top health problems for those in irregular zones of ejido settlements?	Gastrointestinal? Infection? Injury?
	27. What resources does your organization develop/create for residents to learn about WASH and health?	Where do they go to get this information?
Progress of organization - Challenges and future directions - Partnerships and collaborations	*I would like to now ask you some questions about the progress that is being made for improving access to water and sanitation in informal settlements.*	
	28. What challenges do you experience working in these settlements to achieve access to water and sanitation?	Which of these challenges do you think poses the greatest obstacle?
	29. What help does your organization need to achieve its goals?	Additional Funding? More staff?
	30. Have you partnered with other organizations to improve access to water and sanitation for these settlements?	What are these organizations?
	31. What have you observed over your career that was successful in improving access to WASH?	Why do you think they were successful?
Thank you very much for your time. Is there anything else you would like to add that we have not already talked about?		

APPENDIX C – RESIDENT CODING MANUAL

Key theme	Sub-theme	Sub-Sub-theme	
1. Socioeconomic and Demographic Information of Respondent	**1.1** Birthplace	- Current community - Elsewhere in Quintana Roo - Yucatán State - Other State in Mexico - Other country	
	1.2 Time lived in settlement	- 1-5 years - 6-10 years - 11-15 years - 16-20 years - 21+ years	
	1.3 Electrical Service	- Connected formally - Connected informally (hanging)	
	1.4 Number of People in Household	- 1 - 2 - 3 - 4 - 5+	
	1.5 Children in Household	- 1 - 2 - 3 - 4 - 5+ - None	
	1.6 Level of education of children	- Primary - Secondary - Post-secondary - Not school-age	
	1.7 Occupation of respondent	- Unemployed; Homemaker - Employed; homemaker - Domestic services - Retail - Other - Unemployed	
2. Knowledge	**2.1** Water	**2.1.1** Primary Water Supply Source for Household	- Well water - Cenote - Purified water (garrafon) - Water truck (pipa) - Vending machine - Municipally serviced - Other

		2.1.2 Ownership of water resource	- Self (i.e. property owner) - Community - Government
		2.1.3 Consistency of Access	- Always available - Available so long as pump works - Seasonal variability - Inconsistent - Not available
	2.2 Sanitation	**2.2.1** Facilities used	- Septic tank - Cenote/sinkhole - Municipal system - None (open defecation) - Other
		2.2.2 Ownership of facilities	- Private bathroom and private disposal - Shared bathroom and disposal site - Private Bathroom, shared end-destination
	2.3 Health	**2.3.1** Health Coverage	- Private coverage - Social security - PROSPERA - ISSSTE/ISSST - IMSS - None - Does not specify - Other
		2.3.2 Extent of Coverage for household	- All members of household covered - Some members covered - None with insurance
		2.3.3 Predominant health issues in household	- Gastrointestinal - Cold or Flu - Other Infection (skin, eye, lung) - Other
		2.3.4 Vulnerable Members of Community to Sickness	- Children - Elderly - Members in periphery of community

			- All members of community
		2.3.5 Generators of Health-related resources	- CONAGUA/CAPA/AGUAKAN - Health secretariat (brigades) - PROSPERA - Other - None provided
		2.3.6 Nature of Health Resources Provided	- Chlorine (tablets or powder) - Mosquito-borne illnesses - Methods of improving basic sanitation and hygiene - Other - None provided
		2.3.7 Information Distribution Mediums	- Talks - Printed materials - Community meetings - Radio - None provided
	2.4 Groups in Settlements	**2.4.1** Types of Organizations and Associations Respondent Belongs to	- Church group - Neighbourhood council - School council - Other - None
		2.4.2 Leadership	- Leadership is shared - Another specific community member - Self - Other
		2.4.3 Issues Group Addresses	- Access to water/sanitation services - Access to electrical service - Increased policing - Other
		2.4.4 Outcomes of Cooperation	- Achieved electrical service

			- Achieved water and sanitation services - Ongoing - Other
3. Attitudes	**3.1** Water	**3.1.1** Safety	- Unsafe for drinking - Safe for other household purposes (excl. drinking) - Safe for all household purposes - Unsafe for all household purposes
		3.1.2 Effectiveness of Treatment	- Very effective - Somewhat effective - Ineffective
		3.1.3 Observations of Quality	- Colour - Smell - Taste - Debris - Other
		3.1.4 Changes in Water Quality	- Seasonal - After rain event - Depth of well - Changes over time
		3.1.5 Sufficient Quantity for Household Needs	- Sufficient - Insufficient - Other
	3.2 Sanitation	**3.2.1** Necessity for maintenance	- Only when tank or pit is full - Not needed - Could be needed in the future
		3.2.2 Potential impacts of waste on water	- Unknown - Contamination of Water - Aquifer contamination
	3.3 Health	**3.3.1** Healthcare barriers	- Cost - Wait times - Hours of operation - Insufficient supplies - Other
		3.3.2 Perceived causes of illness	- Garbage/Waste - Water Source - Food - Other

			- Unknown
	3.4 Affordability	**3.4.1** Water and Sanitation Services	- Expensive - About right - Inexpensive
		3.4.2 Electrical Services	- Expensive - About right - Inexpensive
		3.4.3 Healthcare Services	- Expensive - About right - Inexpensive
		3.4.4 Regularizing Land	- Expensive - About right - Inexpensive
		3.4.5 Of Life in General	- Expensive - About right - Inexpensive
	3.5 Settlement Dynamics	**3.5.1** Priorities in settlement	- Access to water/sanitation services - Access to electrical service - Better policing - Other
		3.5.2 Problems in Settlement	- Access to Water and Sanitation services - Health services - Formal Connection to electricity - Inconsistent or unavailable collection of garbage - Poor education - Criminal activity - Other
		3.5.3 Inequalities	- Gender inequality - Economic disparity - Cultural differences - Geographic differences - Political favourtism - Other - None
		3.5.4 Safety and Security	- Feels safe in community at all times

			- Feels unsafe in community at all times - Feels unsafe during evening and weekends in community
		3.5.5 Perceptions of Acceptance	- Accepted - Somewhat accepted - An outsider
	3.6 Cooperation	**3.6.1** Likelihood of Settlement Participating in Groups	- Likely - Not likely - Unknown - Other
		3.6.2 Participation in Groups	- Men - Women - Children - Equal - Other
		3.6.3 Personal Motivations to Cooperate	- Religious values - Accountability to the natural environment - Accountability to other people - Sense of justice - Other
	3.7 Trust	**3.7.1** Trust of Government	- Do not trust government - Some trust of government - Full trust in government
		3.7.2 Trust of Family	- Trust to care of assets - Do not trust to take care of assets - Trust to help out if in need - Do not trust to help out if in need - Trust of family in general - No trust of family in general - Other
		3.7.3 Trust of Neighbours	- Trust to care of assets

			- Do not trust to take care of assets - Trust to help out if in need - Do not trust to help out if in need - Trust of neighbours in general - No trust of neighbours in general - Other
	3.8 Facilitators to achieving services in settlement	**3.8.1** Economic	- Alternative payment structures
		3.8.2 Legal and Political	- Land regulation - Voting strategically - Help of political candidates
		3.8.3 Social and Cultural	- Unifying of residents - Empowerment of women - Increasing education
		3.8.4 Technical or Operational	- Alternative sources of water
		3.8.5 Geographic	- Water availability in area
	3.9 Barriers to achieving services in settlement	**3.9.1** Economic	- Expensive or cost-prohibitive
		3.9.2 Legal and Political	- Government apathetic - Bureaucracy of Land regularization - Government ineffective - Broken promises from politicians
		3.9.3 Social and Cultural	- Resident apathy - Lack of power of residents - Division in colony - Urban Sprawl
		3.9.4 Technical	- Problems with drilling of well - Treatment problems
		3.9.5 Geographic	- Distance from piped infrastructure

			- Distance from city centre
4. Practices of Residents	**4.1** Household Water Management	**4.1.1** Storage	- Cistern (Tinaco) - Jugs (garrafon) - Other
		4.1.2 Treatment	- Chlorine - Boiling - Colloidal silver - Insecticide - Other - None
		4.1.3 Testing and Analysis	- Self-inspection - Water samples sent to lab - Water tested by government - None - Other
	4.2 Sources of Water for Common Household Uses	**4.2.1** Source of Water for Drinking	- Cenote - Municipally Serviced - Purified Water (Bottled or Garrafon) - Water truck - Water vending machine - Well water - Other
		4.2.2 Source of Water for Cooking	- Cenote - Municipally Serviced - Purified Water (Bottled or Garrafon) - Water truck - Water vending machine - Well water - Other
		4.2.3 Source of Water for Bathing	- Cenote - Municipally Serviced - Purified Water (Bottled or Garrafon) - Water truck - Water vending machine

			- Well water - Other
		4.2.4 Source of Water for Washing	- Cenote - Municipally Serviced - Purified Water (Bottled or Garrafon) - Water truck - Water vending machine - Well water - Other
	4.3 Sanitation	**4.3.1** Disposal of sanitary waste	- Sewage truck (pipa) - Left in septic tank - Left in cenote/sinkhole - Burned - Other
		4.3.2 Maintenance schedule of sanitation facilities	- Never - Often - As-needed
		4.3.3 Disposal of Household Waste	- Burned - Garbage Collection - Thrown in Lot - Other
	4.4 Hygiene	**4.4.1** Facilities for handwashing	- Soap and water - None
		4.4.2 Frequency of handwashing	- Before eating - After washroom - Both before eating and after the washroom
	4.5 Health	**4.5.1** Healthcare services sought	- Clinic in community - Private clinic - Farmacias Similares (SIMI) - Hospital - Other - None
		4.5.2 Treatment of illness	- Antibiotics - Behind-the-counter medication - Home remedy - Other
		4.5.3 Prevention of illness	- Change water source - Eat different food

			- Change in basic hygiene practices
		4.5.4 Household routine changes	- Major disruptions - Minor disruptions - No changes
	4.6 Household-level Efforts to Obtain Services	**4.6.1** Water or Sanitation Services	- Drilling own well - Securing water from private companies - Buying purified water - Other
		4.6.2 Electrical Services	- Connecting illegally (hanging) - Cooperating with neighbours on a transformer - Other
		4.6.3 Health Services	- Going to second choice health service centre - ?? - Other
		4.6.4 Other Services	
		4.6.5 Help Sought from	- Government Organization - Private companies - Neighbours - Political Candidate - Other - Reliance on self (or immediate family)
	4.7 Settlement Organization and Dynamics	**4.7.1** Role in Organization	- Leadership - Administrative - General Member - Not a member - Other
		4.7.2 Frequency of Assembly	- Monthly - As needed/as issues arise - Never
		4.7.3 Help sought from	- Ejido office - Political candidate - Government agency - Other - Unknown

APPENDIX D – KEY INFORMANT CODING MANUAL

	Theme	Sub-theme	Sub-sub-theme
1. Knowledge	**1.1** Organizational Attributes	**1.1.1** Policies and Guiding Documents	- Sustainable Development Goals - State or National mandates - Organization-specific - Other
		1.1.2 Organization's Priorities	- Provision of Water - Provision of sanitation - Water quality - Other
		1.1.3 Past Interventions	- Research - Programs - Laws - Other
		1.1.4 Scale of Past Interventions	- Community-based - Population-level - Individual - Other
		1.1.5 Outcomes of Past Interventions	- Success - Failure - Other
	1.2 Service Provision-related Interventions conducted outside organization	**1.2.1** Type of Intervention	- Educational Campaigns/Materials - Construction of water and sanitation facilities - Conservation or rehabilitation of natural environment - Policy or Law - Other
		1.2.2 Sector of Organization	- Government - Non-government organization - Private Corporation - Other
		1.2.3 Scale of Intervention	- Population-based - Community-based - Individual - Other
	1.3 Current Water Services for Residents	**1.3.1** Household Water Supply Source	- Well - Water Truck - Cenote - Water Jugs (Garrafon) or bottled

			- Other
		1.3.2 Water Quality	- Poor - Good - Excellent
		1.3.3 Water Availability	- Close (distance) to household - Far (distance) from household - In household - Not available - Other
		1.3.4 Residents' Storage Methods	- Tinaco - Cistern - Jugs - Other
		1.3.5 Residents' Methods of Water Treatment	- Chlorine - Insecticide - Boiling - Colloidal Silver - None - Other
	1.4 Resident Water Uses	**1.4.1** Source of Water for Drinking	- Purified Water (bottled or water jugs) - Well water - Water trucks - Cenote water - Other
		1.4.2 Source of Water for Cooking	- Purified Water (bottled or water jugs) - Well water - Water trucks - Cenote water - Other
		1.4.3 Source of Water for Bathing	- Purified Water (bottled or water jugs) - Well water - Water trucks - Cenote water - Other
		1.4.4 Source of Water for Washing	- Purified Water (bottled or water jugs) - Well water - Water trucks - Cenote water - Other

		1.4.5 Other Water Uses	- Tourism - Other
	1.5 Key Informant Knowledge of Water-Sanitation Links	**1.5.1** Sanitation-related Causes of Contamination to water	- End destination of sanitary waste - Resident habits - Proximity of disposal site to source of water - Other
		1.5.2 Risks Derived from sanitation-related contamination of water	- Contamination of aquifer - Infection and Disease - Impact on larger water network - Other
	1.6 Residents' Current Sanitation Services	**1.6.1** Types of Sanitation Facilities	- Latrine - Septic Tank - Cenote - None (open defecation) - Other
		1.6.2 Maintenance Techniques	- Sewage truck (pipas) - Find new disposal site - Other - None - Unknown
		1.6.3 Ownership of Sanitation Facilities	- Private bathroom, shared end destination - Private bathroom, private end destination - Shared bathroom, shared end destination - Other
		1.6.4 Household waste disposal	- Burning - Garbage collection - Thrown in empty lot - Allocated to cenote - Other
	1.7 Gaps in Services in Community	**1.7.1** Types of Services	- Water - Sanitation - Education - Paving - Health - Electricity - Garbage - Other
		1.7.2 Nature of Gaps	- Geographical

			- Social or Cultural - Technological - Economic - Legal or Political - Other
	1.8 Healthcare Options and Health of Residents	**1.8.1** Predominant Health Problems	- Gastrointestinal - Skin - Respiratory - Water Security - Psychosocial - Other
		1.8.2 Healthcare options	- Clinics - Hospitals - Home remedies - Farmacias Similares (SIMI) - Not specified - Other
		1.8.3 Vulnerable members of population	- Children - Elderly - Pregnant
		1.8.4 Seasonality to health issues	- Rainy season - Dry season - None
		1.8.5 Potential Risk Factors	- Eating contaminated food - Consuming contaminated water - Other
	1.9 Community-based Groups	**1.9.1** Type of Group	- Church - Neighbourhood Council - School - Other - None
		1.9.2 Issues Group Seeks to Solve	- Water/sanitation services - Land regularization - Electricity coverage - Not water and sanitation-specific - Other
		1.9.3 Presence of Leadership	- Visible - Shared - Not visible

2. Attitudes	**2.1** Governance	**2.1.1** Accountability for Service Provision	- Municipal Government - State Government - Federal Government - Unknown - Other
		2.1.2 Co-operation between Stakeholders	- Not functioning - Functioning well - Other
	2.2 Community Dynamics	**2.2.1** Resident Trust in Organization	- Full trust - Trust with conditions - No trust - Other
		2.2.2 Inequalities between residents	- Social - Gender - Economic - Political Favour - Geographic - Service provision - All equal - Other
		2.2.3 Resident Priorities	- Water services - Sanitation services - Not sanitation services - Safety and security services - Health services - Education services - Other - Unknown
	2.3 Co-operation in Community	**2.3.1** Outcomes of Community-led organizations	- LIST
		2.3.2 Importance of Leadership	- Very important - Somewhat important - Not important - Other
		2.3.3 Participation	- Women - Children - Men - Not men - Equal - Other
		2.3.4 Willingness to Participate	- Willing - Unwilling

			- Residents participate as issues arise
	2.4 Key Informant's Perspectives on Water and Sanitation linkages	**2.4.1** Prioritization of Water and Sanitation Services	- Provision of water services - Provision of sanitation services - Equal provision of water and sanitation services - Other
		2.4.2 Awareness of Water and Sanitation-linkages	- Fully aware - Somewhat aware - Unaware - Other
		2.4.3 Degree of contamination from sanitation on water resources	- Severe - Common - Uncommon - Other
	2.5 Residents' Water and Sanitation Knowledge	**2.5.1** Water quality	- Proficient - Limited - None
		2.5.2 Potential for sanitation to contaminate water supply	- Proficient - Limited - None
		2.5.3 Known threats to health	- Water - Food - Sanitation - Other
	2.6 Facilitators to achieve services in community	**2.6.1** Economic	- Incentives - Payment Facilitators
		2.6.2 Legal and Political	- Land regulation - Communication between levels of government - Amendments to policies and frameworks
		2.6.3 Social and Cultural	- Shared ownership - Traditional Knowledge - Relationship with community leaders
		2.6.4 Technical	- Small-scale water/sanitation projects

		2.6.5 Geographic	- Water Availability
	2.7 Barriers to achieving service provision in community	**2.7.1.** Economic	- Residents lack funds - Expensive to build infrastructure - Insufficient Budget
		2.7.2 Legal and Political	- Land regulation - Political disengagement - Political disorganization - Ejido system - Lack of effective communication with residents
		2.7.3 Social and Cultural	- Cultural traditions and taboos - Distrust of outsiders - Defined Gender roles
		2.7.4 Technical and Operational	- Technology Limitations - Insufficient personnel - Operational Limitations (i.e. insufficient vehicles)
		2.7.5 Geographical	- Inaccessible communities - Geological constraints - Distance from urban centre - Urban population growth - Migration
3. Practices	**3.1** Role and Responsibility within Organization	**3.1.1** Role Description	*No code*
		3.1.2 Time in current role	- 0-5 years - 6-10 years - 11-15 years - 16-20 years - 21+ years
		3.1.3 Key Responsibilities	- Provision of water - Provision of sanitation - Provision of Water and sanitation - Water Quality - Other

		3.1.4 Capacity Working with Residents in Irregular Settlements	- Direct - Indirect
	3.2 Organization's Current Interventions	**3.2.1** Type of Intervention	- Educational Campaigns/Materials - Construction of water and sanitation facilities - Conservation or rehabilitation of natural environment - No intervention regarding -health linkages - Other
		3.2.2 Scale of Intervention	- Population-level - Community-based - Individual - Other
		3.2.3 Responsiveness of Interventions	- Preventative - Reactive - Both - Other
	3.3 Organization's Future or Potential Interventions	**3.3.1** Type of Intervention	- Educational Campaigns/Materials - Construction of water and sanitation facilities - Conservation or rehabilitation of natural environment - No intervention regarding -health linkages - Other
		3.3.2 Responsiveness of Interventions	- Preventative - Reactive - Both - Other
	3.4 Testing and Analysis	**3.4.1** Water Quality Testing	- Bacteria or viruses - Chemicals - Other - None
		3.4.2 Surveys	- Resident knowledge on water and sanitation - Conservation and sustainability practices - Other

			- None
		3.4.3 Emerging Health Threats	- Epidemiological studies - Blood and tissue samples
	3.5 Community Engagement and Partnerships	**3.5.1** Methods for Building Trust	- Talking one-on-one - Continued presence in community - Positioning organization as non-government affiliated - Other
		3.5.2 Mechanisms for Distributing Information	- Brigades - Radio - Social Media - Printed Materials - In-person - Community Meetings - Schools
		3.5.3 Inbound communication with residents	- Complaints received directly by organization - Through other organizations - OTHER
	3.6 Inter-Organizational Partnerships	**3.6.1** Organizations Partnered with	- Non-governmental organizations - Private organizations - Government Organizations - Other - None
		3.6.2 Purpose of Partnerships	- Establish connection to communities - Prevention of aquifer contamination - Funding - Other

APPENDIX E – ECOSOCIAL THEORY: CORE CONSTRUCTS AND CORE PROPOSITIONS

Core constructs

1. Embodiment: referring to how we literally incorporate, biologically, in societal and ecological context, the material and social world in which we live.
2. Pathways of embodiment: via diverse, concurrent, and interacting pathways, involving adverse exposure to social and economic deprivation, exogenous hazards (e.g., toxic substances, pathogens, and hazardous conditions), social trauma (e.g., discrimination and other forms of mental, physical, and sexual trauma), targeted marketing of harmful commodities (e.g., tobacco, alcohol, other licit and illicit drugs), inadequate or degrading health care; and degradation of ecosystems, including as linked to alienation of Indigenous populations from their lands.
3. Cumulative interplay of exposure, susceptibility, and resistance across the life course: referring to the importance of timing and accumulation of, plus responses to, embodied exposures, involving gene expression, not simply gene frequency.
4. Accountability and agency: both for social disparities in health and research to explain these inequities.

Core propositions

1. People literally embody, biologically, their lived experience, in societal and ecologic context, thereby creating population patterns of health and disease.
2. Societies' epidemiological profiles are shaped by the ways of living afforded by their current and changing societal arrangements of power, property, and the production and reproduction of both social and biological life, involving people, other species, and the biophysical world in which we live.
3. Determinants of current and changing societal patterns of disease distribution, including health inequities, are (a) exogenous to people's bodies, and (b) manifest at different levels and involve different spatiotemporal scales, with macro-level phenomena are more likely to drive and constrain meso- and microlevel phenomena than vice versa; to the extent genes are relevant to societal distributions of disease, at issue is gene expression, not gene frequency.
4. In societies exhibiting social divisions based on property and power, and in which those with the most power and resources constitute a small percentage of the population, the more prevalent the health outcome, the greater the absolute burden (and potentially the relative burden) on those with less power and fewer resources, because they constitute the majority of the population; a corollary is that for more rare or infrequent (nonendemic) diseases, it cannot be presumed, in advance, whether social inequalities in the outcome exist, and, if they do, the direction of the gradient.
5. Explanations of disease distribution cannot be reduced solely to explanations of disease mechanisms, because the latter do not account for why rates and patterns change, in complex ways, over time and place.
6. Practice of a reflexive epidemiology that situates in broader societal context an investigation's motivating theories, hypotheses, methods of analysis, and interpretation of findings will improve the likelihood of epidemiologists being better positioned to understand and convey the meanings and limitation of our study results and explanations for population patterns of health, disease, and well-being

Source: (Krieger, 2011**)**

APPENDIX F – CRITERIA FOR EVALUATING QUALITATIVE RESEARCH

Criteria	Definition	Assumptions	Strategies/Practices to satisfy criteria
Credibility	Authentic representations of experience	- Multiple realities - Causes not distinguishable from effects - Empathetic researcher - Researcher as instrument - Emphasis of the research endeavour	- Purposeful sampling - Disciplined subjectivity/bracketing - Prolonged engagement - Persistent observation - Triangulation - Peer debriefing - Negative case analysis - Referential adequacy - Member checking
Transferability	Fit within contexts outside the study situation	- Time and context-bound experiences - Not responsibility of 'sending' researcher - Provision of information for 'receiving' researcher	- Purposeful sampling - Thick description
Dependability	Minimization of idiosyncrasies in interpretation Variability tracked to identifiable sources	- Researcher as instrument - Consistency in interpretation (same phenomena always matched with the same constructs) - Multiple realities - Idiosyncrasy of behaviour and context	- Low-inference descriptors, mechanically recorded data - Multiple researchers - Participant researchers - Peer examination - Triangulation, inquiry audit
Confirmability	Extent to which biases, motivations, interests or perspectives of the inquirer influence interpretations	- Biases, motivations, interests or perspectives of the inquirer can influence interpretation - Focus on investigator and interpretations	- Audit trail products - Thick description of the audit process - Autobiography - Journal/notebook

Source: (Lincoln & Guba, 1985)

APPENDIX G – CHECKLIST FOR EVALUATING QUALITATIVE INTERVIEW RESEARCH

Question	Elaboration/Examples
1. What was the natural history of the research?	- Original purpose(s) of the research - Rationale for methodology - How research developed over time - Fieldwork relations
2. What data were collected and by what methods?	- Method of note-keeping; - Method of tape-recording
3. How was the sampling done?	- Explicit delineation of sample frame (working universe) - Random or purposeful? Purposeful – opportunistic - Rationale for type of sampling used
4. How was the data analysis done?	- Procedures for summarizing and presenting data - How data were selected for presentation
5. What results are presented?	- Description of researcher's objective for results presentation (e.g. theory-building or description) - Differentiation of data-derived as opposed to pre-existing constructs - Differentiation of participant concepts as opposed to theoretical (researcher-derived) constructs
6. How credible and dependable are the data–construct links?	- Details of the relationship(s) between the data and constructs/concepts derived from data (e.g. member checking)
7. How credible is the theory/hypothesis?	- Specification of the relationship between constructs/concepts and theory/hypotheses
8. How transferable are the findings?	- Recognition of the limits imposed by the sampling strategy

Source: Baxter and Eyles, 1997

APPENDIX H – RESEARCHER POSITIONALITY AND REFLEXIVITY

There have been two distinct moments in my life thus far that have guided and shaped my personal worldviews and have therefore informed my approach and interpretation of this research. The first was as a 10-year old visiting family in Walkerton, Ontario in the year 2000, unknowingly, during the Walkerton Water Crisis. This crisis is still the most significant water-related tragedy in Canada's history, where seven people died, and countless others became infected by *E. coli*-contaminated water, including members of my own family. I luckily did not fall ill, as I stubbornly insisted on drinking only Coca cola during our stay. While I may not have known at the time that this tragedy exemplifies the WASH-health nexus, it informed my understanding about the importance of clean water for human health from an early age. The Walkerton Water Crisis of 2000 also indicated what an appropriate response from a community and government-level should look like – the immediate launch of a formal investigation, with arrests and charges laid, the introduction of province-wide legislation mandating effective monitoring and testing of all water supplies, and the creation of a state-of-the-art education and training centre to inform operators and members of the general public about the intricacies and complexities of water treatment.

The second moment, later in life as a high-school student, was learning about the residential school crisis and the long-lasting impacts of colonialism on Indigenous Peoples in this country. Along with the numerous social and cultural damages this system has inflicted on generations of Indigenous Peoples, perhaps the one that has caught my attention because of my experience in Walkerton is the lack of clean and safe drinking water in many Indigenous communities nation-wide. I have since spent my life trying to understand and unpack how the injustices and systemic racism embedded in our political structures persist to this day and manifest in ways such as decades-long boil water advisories. Canada, where we have an abundance of water and have the capability to respond to and rectify water-related tragedies *should not* also be a place where 56 long-term boil water advisories (a drinking water advisory in effect for more than 12 months) effecting over 2,100 households and 124 community buildings exist (Indigenous Services Canada, 2019).

Continuous reflection on these pivotal moments, both independently and in the company of other researchers and peers, I am engaging with concepts of positionality and reflexivity. The concept of positionality, a reflective process to examine one's social, cultural, and subject positions, and how the intersection of these may influence the types of questions asked and how

they are framed, the theories chosen, access to data, institutions and outlets for information, etc. is important to consider throughout the research process (Gregory et al., 2011). The purpose of discussing positionality, while carefully trying to avoid introducing too many details about myself thereby shifting the focus from the research participants to the researcher, provides a platform to consider what it means to occupy a position of power and how relationships with participants impacts perceptions of positionality in the research process (Kohl and McCutcheon, 2015). This process is important for critical geographers who conduct qualitative research and engage directly with how positionalities impact research participants, and how power relations impact the research process (Kohl and McCutcheon, 2015).

Through the partnership of the University of Waterloo and the Centro de Investigacion Cientifica de Yucatán (CICY), it was possible to engage with these concepts regularly throughout the research planning stages, data collection, and the interpretation of said data. For example, during the formulation of the interview guides for both residents and key informants, discussing cultural sensitivities of with a representative who was equipped with local knowledge and awareness of potential sensitivities of the local population through continued conversation with the research partner to examine specific and definitive moments during the data collection process.

APPENDIX I – RESEARCH ETHICS APPROVAL

UNIVERSITY OF WATERLOO

Notification of Ethics Clearance to Conduct Research with Human Participants

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Principal Investigator: Susan Elliott (Geography and Environmental Management)

Student investigator: Margaret Hall (Geography and Environmental Management)

File #: 40441

Title: Determining local-level facilitators and barriers to access to water, sanitation, and hygiene (WaSH) in two settlements in Cancun, Mexico

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The Human Research Ethics Committee is pleased to inform you this study has been reviewed and given ethics clearance.

Initial Approval Date: 01/15/19 (m/d/y)

University of Waterloo Research Ethics Committees are composed in accordance with, and carry out their functions and operate in a manner consistent with, the institution's guidelines for research with human participants, the Tri-Council Policy Statement for the Ethical Conduct for Research Involving Humans (TCPS, 2nd edition), International Conference on Harmonization: Good Clinical Practice (ICH-GCP), the Ontario Personal Health Information Protection Act (PHIPA), the applicable laws and regulations of the province of Ontario. Both Committees are registered with the U.S. Department of Health and Human Services under the Federal Wide Assurance, FWA00021410, and IRB registration number IRB00002419 (HREC) and IRB00007409 (CREC).

This study is to be conducted in accordance with the submitted application and the most recently approved versions of all supporting materials.

Expiry Date: 01/16/20 (m/d/y)

Multi-year research must be renewed at least once every 12 months unless a more frequent review has otherwise been specified. Studies will only be renewed if the renewal report is received and approved before the expiry date. Failure to submit renewal reports will result in the investigators being notified ethics clearance has been suspended and Research Finance being notified the ethics clearance is no longer valid.

Level of review: Delegated Review

Signed on behalf of the Human Research Ethics Committee

Karen Pieters, Manager, Research Ethics, karen.pieters@uwaterloo.ca, 519-888-4567, ext. 30495

This above named study is to be conducted in accordance with the submitted application and the most recently approved versions of all supporting materials.

Documents reviewed and received ethics clearance for use in the study and/or received for information:

file: Confidentiality Agreement - Mexico Research.docx

file: Data Management Plan - Margaret Hall.pdf

file: In-depth Interview Schedule - Residents - revisions.docx

file: Key Informant Interview Schedule.docx

file: Information and Consent Letter - Residents - revisions.docx

file: Information and Consent Letter - Key Informants - revisions.docx

file: Appreciation Letter - Residents - revisions.docx

file: Appreciation Letter - Key Informants - revisions.docx

file: Door-to-Door Recruitment Verbal Script - Residents - revisions - January 14, 2019.docx

file: Email Recruitment Letter - Key Informants - revisions.docx

Approved Protocol Version 3 in Research Ethics System

This is an official document. Retain for your files.

You are responsible for obtaining any additional institutional approvals that might be required to complete this study.