FOOD INSECURITY AND CLIMATE CHANGE ADAPTATION AMONG PERUVIAN INDIGENOUS SHAWI

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ABSTRACT

Indigenous peoples are among the most vulnerable populations to climate change. This doctoral thesis assesses the vulnerability of Shawi Indigenous people living in the Peruvian Amazon to food insecurity and identifies entry-points and opportunities for adaptation interventions to reduce the population's vulnerability to climate change. This thesis uses mixed methods and community-based participatory fieldwork to investigate how climatic and non-climatic processes ─ and their interactions ─ shape the Shawi food system and its vulnerability to climate change. The participating Shawi communities are located along a river in the Balsapuerto district of the Loreto region in the Peruvian Amazon.

The thesis has three main objectives. The first objective is to characterize the baseline nutritional and food security status of Shawi Indigenous Amazonian children and adults. I measured the nutritional status of Shawi children ≤ 5 y and their parents. This was complimented by an assessment of household food security using a locally-adapted food security questionnaire. My results highlight very low food security across Shawi households ─ among the lowest documented globally ─ and high prevalence of anemia among children and adults. In addition, the presence of cases of overweight adults signals the potential for an emerging trend of double burden of malnutrition in Shawi communities.

The second objective is to characterize the diet, food sources, and food preferences of Shawi households. Drawing upon a mixed method approach, I documented self-reported diet, food sources, and perspectives of new food types among households in eleven communities. My results point to Shawi preferences for traditional food sources embedded in Indigenous cultural traditions, as well as strong food sharing networks and food substitution as important determinants of household food security.

The third objective is to characterize the Shawi food system and the interacting climatic and non-climatic determinants of food security within Shawi Indigenous communities. For this objective, I employed participatory qualitative methods in two communities and built upon a contextual vulnerability approach to investigate the drivers of the Shawi food system's vulnerability to climate change. My findings indicate that the contemporary Shawi food system relies on three main sub-systems (forest, farming and externally-sourced). Participants reported a rapidly expanding population, changing settlement patterns, and natural resource degradation as the proximal non-climatic drivers of food insecurity. Distal drivers of vulnerability included population recovery and the negligible value attributed nationally to traditional Indigenous food systems. Adaptive capacity was characterized by the high dependence of Shawi food security on the wild food sub-system, traditional knowledge to respond to climatic stresses, and a desire for education to help diversify livelihoods in a context of limited economic opportunities. These thesis findings provide an evidence base to inform food- and nutrition-related adaptation policies that decrease the vulnerability of Shawi peoples to adverse climate change impacts.

RÉSUMÉ

Les populations autochtones sont parmi les populations les plus vulnérables aux changements climatiques. Cette thèse évalue la vulnérabilité de populations autochtones Shawi de l'Amazonie péruvienne à l'insécurité alimentaire et identifie des points d'entrée et des opportunités d'intervention en adaptation pour réduire la vulnérabilité de la population aux changements climatiques. Cette thèse utilise des méthodes mixtes et un travail de terrain communautaire participatif pour évaluer les processus climatiques et non climatiques – ainsi que leurs interactions – formant le système alimentaire Shawi et sa vulnérabilité aux changements climatiques. Les communautés participantes Shawi sont situées le long d'une rivière dans le district de Balsapuerto, dans la région de Loreto, en Amazonie péruvienne.

La thèse a trois objectifs principaux. Le premier objectif est de caractériser le statut nutritionnel et de sécurité alimentaire de référence des enfants et des adultes autochtones Shawi de l'Amazonie. J'ai mesuré l'état nutritionnel d'enfants Shawi âgés de 5 ans ou moins ainsi que de leurs parents. Ceci est agrémenté d'une évaluation de la sécurité alimentaire des ménages utilisant un questionnaire de sécurité alimentaire adapté au contexte local. Mes résultats mettent en évidence une très faible sécurité alimentaire dans les ménages Shawi - parmi les taux les plus bas documentés globalement - et une forte prévalence d'anémie chez les enfants et les adultes. De plus, l'existence de cas de surpoids chez les adultes témoigne de la possibilité d'une tendance émergente au double fardeau morbide en raison de malnutrition dans les communautés Shawi.

Le deuxième objectif est de caractériser l'alimentation, les sources de nourriture et les préférences alimentaires de ménages Shawi. M'appuyant sur une approche de méthodes mixtes, j'ai documenté des régimes alimentaires auto-déclarés, les sources de nourriture et les perspectives pour de nouveaux types de nourriture parmi les ménages dans onze communautés.

Mes résultats indiquent des préférences Shawi envers les sources de nourriture traditionnelles faisant partie des traditions culturelles autochtones, ainsi que des réseaux de partage d'aliments et de substitution de nourriture comme d'importants déterminants de la sécurité alimentaire des ménages.

Le troisième objectif fut de caractériser le système alimentaire Shawi et les facteurs climatiques et non climatiques qui ont un impact sur la sécurité alimentaire dans les communautés autochtones Shawi. Pour cet objectif, j'ai utilisé des méthodes qualitatives participatives dans deux communautés et me suis basée sur une approche de vulnérabilité contextuelle pour enquêter sur les facteurs qui ont un impact sur sur la vulnérabilité aux changements climatiques de la sécurité alimentaire des Shawi. Mes résultats indiquent que le système alimentaire contemporain Shawi repose sur trois sous-systèmes principaux (forêt, agriculture, de provenance externe). Les participants ont signalé une population en pleine expansion, l'évolution des styles d'occupation du territoire et la dégradation des ressources naturelles comme principaux moteurs non climatiques de l'insécurité alimentaire. Les déterminants distaux de la vulnérabilité comprennent le rétablissement des populations et la valeur négligeable attribuée à l'échelle nationale aux systèmes alimentaires traditionnels autochtones. La capacité d'adaptation a été décrite par la grande dépendance de la sécurité alimentaire des Shawi envers le sous-système d'aliments sauvages, les connaissances traditionnelles pour répondre aux évènements climatiques extrêmes et le désir d'éducation pour aider à diversifier les moyens de subsistance dans un contexte d'opportunités économiques limitées. Ces résultats de thèse fournissent une base factuelle pour les politiques d'adaptation liées à l'alimentation et à la nutrition afin de réduire la vulnérabilité des populations Shawi aux impacts des changements climatiques.

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AUTHORS CONTRIBUTIONS

This dissertation is a manuscript-based style thesis and consists of three empirical research chapters. These empirical chapters were completed under the supervision of my committee: Prof Lea Berrang-Ford (LBF), Prof Nancy Ross (NR), Prof James Ford (JF) and Prof Duncan Pedersen (DP). Prof Grace Marquis (GM) kindly accepted to be part of my committee when Prof Pedersen passed away. My supervisor Prof Lea Berrang-Ford guided me to conceptualize the goal of my thesis research, to identify specific objectives, to select methodologies. She has reviewed, edited and provided comments on each of the manuscripts. Prof Ross's ideas gave me a global perspective about the food security and nutrition transition, enabling me to better understand the social determinants of health, and also provided assistance in editing this thesis. Prof. James Ford advised me on the application of the climate change vulnerability framework in the Indigenous Shawi food security context. Prof. Marquis provided me with insights on the nutrition aspects, including the use of indicators and classification of food types. Prof. Pedersen mentored me on the social, economic and political context of Peru and how these factors relate to the health of Indigenous populations in Peru and globally.

My dissertation has been built upon the Indigenous Health and Adaptation to Climate Change (IHACC) program where Dr. Alejandro Llanos (AL) and Dr. César Cárcamo (CC) were the Peruvian principal investigators. They gave me valuable academic feedback on health in Peru and national epidemiological trends. There are other international researchers who also contributed to the development of my empirical chapters, including Prof Sheri Lee Harper (SLH), Kaitlin Patterson (KP) from the University of Guelph and Peruvian Masters student Rosa Silvera (RS). Also, before I started this PhD at McGill, I (CZ) was part of the IHACC research

team and I wrote the original IHACC protocol in Peru, contacted Indigenous partner organizations and communities, piloted questionnaires and collected preliminary data.

The following table lists the specific independent contributions that each co-author made to the three empirical manuscripts contained in this thesis:

Independent contribution	**Chapter Three:** "*Malnutrition and food insecurity among Shawi children and their parents in the Peruvian Amazon*"	**Chapter Four:** *"Indigenous Shawi communities and national food security support: right direction, but not enough"*	**Chapter Five:** *"Indigenous food systems and climate change adaptation among the Shawi of the Peruvian Amazon"*
Obtaining funding	CZ, LBF, JF, AL, CC, SLH	CZ, LBF, JF, AL, CC, SLH	CZ, LBF, JF, AL, CC, SLH
Conceptualizing the manuscript	CZ, LBF	CZ, LBF	CZ, LBF, JF. NR
Collecting data	CZ, RS	CZ, RS	CZ
Entering the data	KP, CZ	KP, CZ	CZ
Performing statistical analysis	CZ	CZ	
Performing qualitative analysis		CZ	CZ
Assistance with data analysis	KP		
Interpretation of results	CZ, LBF, GM, NR	CZ, LBF, GM	CZ, LBF, JF
Writing	CZ	CZ	CZ
Editing	LBF, GM, NR, KP, SLH, JF	LBF, GM, SHL, JF, KP, RS, CC, AL	LBF, JF, SLH, CC, AL, RS, NR
Providing intellectual comments for discussion	GM, JF, NR, CC, AL	LBF, JF, GM, CC, AL	LBF, JF, NR
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1 CHAPTER 1: INTRODUCTION

1.1 OVERVIEW

Climate change represents one of the main threats to human health this century, particularly for populations who already have high food insecurity and experience socioeconomic marginalization (Costello et al., 2009). The objective of this thesis is to characterize food systems and food security among Indigenous Amazonian Shawi communities and their vulnerability to climate change. In doing so, this thesis aims to offer insights for the development of adaptation strategies. In this research, I worked with the Amazonian Shawi people in Peru to investigate their food security status, as well as the food systems that underpin their adaptive capacity to respond to future climate change impacts. This dissertation uses mixed methods to investigate the diet, food preferences, and key elements of the Shawi food system in order to identify climatic and non-climatic drivers of climate change vulnerability. This research provides place-based evidence to inform food-related and nutritional interventions that are oriented to increasing the adaptive capacity of Shawi peoples and to preventing the exacerbation of current health problems among the Shawi living in the Peruvian Amazon. In addition, this dissertation contributes to a research gap on food systems and their interactions with the climatic, cultural, demographic, economic and environmental changes that are currently challenging multiple Indigenous Amazonian populations.

1.2 Research rationale

Malnutrition is one of the major health risks expected to be exacerbated by global climatic change, especially in places where people already face high food insecurity (McMichael, 2013; Woodward et al., 2014; Costello et al., 2009). For Indigenous peoples in the Amazon, where

nutrition is already poor and food systems are highly reliant on the physical environment (Horta et al., 2013; Smith et al., 2014), climate change is expected to further increase the prevalence and severity of food insecurity (Ford, 2012; Kuhnlein, 2014). However, there is still limited understanding of food security and food systems among Indigenous Amazonian populations (Ortiz et al., 2013; Kronik, 2010; Keleman Saxena, 2016). Our knowledge of how long-term alterations in climate systems will affect malnutrition in these populations is even more limited.

Lack of information about climate change and climatic variability at a local scale represents an important constraint to planning for and responding to the potential health impacts of climatic change. Increased temperatures and changes in annual hydrological cycles have already been documented in the Amazon region (Malhi and Wright, 2004; Marengo et al., 2016), and regional models project that the magnitude of local ecosystem change could reach a point of significant vegetation loss (Olivares et al., 2015; Cook et al., 2012). Over the past two decades, the increased frequency of extreme drought and flooding has already adversely impacted food security among Amazonian communities (Ovando et al., 2016; Brondízio et al., 2016). Though global climatic models are increasingly robust, regional-, country- or community-level information regarding climatic indicators remains scarce; this issue is particularly acute in the Amazon. There is negligible capacity to develop quantitative climate change models that would be able to predict impacts on human health and malnutrition at the community level in the Amazon. Although hydro-meteorological stations in the Peruvian Amazon increased from 782 to 890 between 2010 and 2016, the region still does not have a sufficient number of stations to properly register, monitor and project climatic conditions in the Amazon (Ministerio del Ambiente, 2016; Ministerio del Ambiente, 2010b). There is thus a high level of uncertainty regarding climatic risk in the Amazon compared to other areas in Peru.

Poor climate data and limited down-scaled —or locally relevant —projection capacity in the Amazon intersect with limited information on socially marginalized and excluded populations in the region to create a double research challenge. Data on basic health status and documentation of local responses to environmental change, weather extremes, and climate variability in Indigenous Amazonian communities are still limited (Ford, 2012; Kronik and Verner, 2010). Additionally, Peru's geography is highly diverse, with more than thirty types of microclimates (Ministerio del Ambiente, 2016), implying that generalized or coarse regional climate models cannot reliably be extrapolated across the country or across the Amazon region. This creates immense challenges for research and evidence-based interventions to protect the health of Indigenous Amazonian populations.

Researchers have consistently documented poorer health outcomes affecting Indigenous populations compared to non-Indigenous populations living in the same territory, with Indigenous health disparities observed in both developed and developing contexts (Montenegro and Stephens, 2006). These health disparities reflect poorer access to healthcare and other basic public services (Anderson et al., 2016). A critical analysis of the social and health trajectories of Indigenous populations also indicates that dominant societies have contributed to the exclusion and invisibility of Indigenous livelihoods and identities (Kirmayer and Brass, 2016; Paradies, 2016; Stephens et al., 2005). One result of this marginalization has been the relatively poorer documentation of the health status and profiles of Indigenous populations compared to non-Indigenous populations within dominant societies (Stephens et al., 2006; Kirmayer and Brass, 2016). This gap further constrains our ability to understand and characterize the ways in which climate change will affect Indigenous health and our ability to design effective adaptation policies targeted at Indigenous populations (Daniels, 2017).

Furthermore, the ways weather and climate variability might affect food security has only started to be examined in contemporary Indigenous Amazonian populations. If Amazonian communities and governments are to implement and evaluate adaptation programs targeted at reducing food insecurity in the context of climate change, it will be critical to establish baseline data and characterize the current vulnerability of food systems to changing climatic conditions (McMichael, 2001). To support climate change adaptation in Indigenous Amazonian communities, we first need baseline data on the current food systems and the prevalence of food security and malnutrition, as well as information on how these populations cope with periods of food insecurity. Yet this information is limited for populations in the Peruvian Amazon. Some national data have been generated about Indigenous health (Ormaeche and Barclay, 2008; MINSA, 2013), however information about food security and how it is affected by climatic or weather factors are scarce (Sherman et al., 2015; Hofmeijer et al., 2013).

Literature on the human dimensions of climate change have pointed to the importance of non-climatic drivers of vulnerability, including the social, political and cultural factors that shape the ability of local populations to adapt, respond to, and manage risks and damages associated with climatic events (Füssel and Klein, 2006; O'Brien et al., 2007; Adger, 2006). In some contexts, such as Indigenous populations, researchers have emphasized the comparatively strong influence that non-climatic variables play in determining the food system vulnerability of human populations to climate change (Ford, 2009; Beaumier and Ford, 2010; Sherman et al., 2015). Two key reasons explain the importance of investigating non-climatic factors influencing food-related vulnerability. Firstly, a focus on non-climatic drivers provides the opportunity to focus on modifiable factors to identify short or long-term strategies to decrease the vulnerability to

climate change impacts. Second, this approach allows us to distinguish non-climatic conditions that have the potential to increase health risks associated with alterations in the climate system.

In this dissertation, I provide a baseline of evidence documenting food security and food systems among Shawi Indigenous communities in the Peruvian Amazon and characterize current vulnerability of the Shawi food system to social and ecological changes. By characterizing the current vulnerability of Shawi food security, I am informing the development and implementation of strategies that can be used to both enhance adaptation to future climate scenarios and reduce the likelihood of negative health consequences among some of Peru's most vulnerable populations (Ministerio del Ambiente, 2016).

1.3 Research objectives

The goal of my doctoral thesis is to assess the vulnerability of Shawi Indigenous people living in the Peruvian Amazon to food insecurity and to identify entry-points and opportunities for adaptation interventions to reduce the vulnerability of Indigenous peoples to climate change. In the context of this goal, this thesis is not hypothesis-driven, but rather hypothesis-generating, reflecting a characterization and critical appraisal of Shawi food security vulnerability. To achieve this goal, my dissertation has the following specific objectives:

1. To characterize the nutritional and food security status of Shawi Indigenous Amazonian children ≤ 5y and their parents;
2. To characterize the diet, food sources, and food preferences of Shawi households;
3. To characterize the Shawi food system and interactions between climatic and non-climatic determinants of Shawi food security.

1.4 Thesis structure and overview of chapters

This is a manuscript-style thesis with six chapters (including three empirical manuscripts). The first chapter is the introduction, where I explain my research rational and propose the overarching dissertation goal and three specific research objectives. I conclude this introductory chapter by describing my positionality and my own personal learning process that occurred through the development of this research work. The second chapter presents the relevant academic literature that underpins the research question, methodologies, and interpretation of results. Chapters three, four, and five present the core empirical manuscripts within this thesis, presenting research conducted with Shawi communities located in Balsapuerto, a district in the Loreto region in the northern Peruvian Amazon. These three chapters draw on cross-sectional quantitative research in eleven communities, and community-based qualitative research in two of those communities. Chapter three examines data on children (≤5y) and both of their parents in eleven Shawi communities. This chapter characterizes the nutritional status of each participant using anthropometry and hemoglobin and also determines the food security level of Shawi households. This manuscript also investigates individual and household factors associated with the nutritional status of Shawi children. Chapter four, the second manuscript, is a mixed methods study characterizing the traditional Shawi diet and household coping mechanisms. The manuscript also analyzes Shawi perceptions of governmental food and income assistance. A mixed methods approach integrates both quantitative and qualitative methods in the design, collection, analysis and interpretation of research data (Creswell J.W., 2011). This manuscript addresses the challenge of integrating traditional perspectives within the context of Peruvian national health interventions. Chapter five is the last empirical manuscript in this dissertation and draws on purely qualitative methods. This work characterizes the key elements of the Shawi food

system within households and the community. Using a vulnerability contextual approach, this manuscript examines the exposure of Shawi to flash flooding events and landslides, analyzes the sensitivity of the food system in terms of demographic, socioeconomic, and environmental factors, and identifies the main adaptive strategies that community members have used to respond to previous weather risks. Chapter five also addresses the overarching goal of this dissertation by organizing the discussion around proximal and distal drivers of Shawi food security vulnerability, and, in doing so, identifies entry points for adaptation interventions. This dissertation concludes in Chapter six with key findings, research contributions, and opportunities for future research.

1.5 My place in the research and policy landscape

This dissertation represents a journey of transformation for me in terms of my research approach, methodologies, and priorities. My background is in human medicine and my masters degree was equivalent to a Masters in Public Health, focusing on infectious disease control. I am finishing my PhD studies with a stronger understanding of the role that social and environmental factors play in influencing human health. My interest in researching health among Indigenous Amazonian peoples was inspired by my initial medical practice attending Indigenous Amazonian patients, mostly affected by HIV, malaria, and hepatitis B, as well as by my readings of other researchers' work on Indigenous health disparities in other countries (Schulz et al., 2006, Gracey and King, 2009, Couzos and Murray, 2008). For me, it did not make sense that Indigenous peoples in developing countries had poorer health indicators compared to national averages. I expected that in wealthier countries Indigenous peoples would not face similar gradients, yet discovered that both infectious disease and chronic conditions were also frequently higher among Indigenous peoples in Canada, the United States, New Zealand, and Australia. These disparities

challenged my professional convictions that the availability of technology, medication, and modern health services represented the greatest pathway to improving Indigenous health. I have learned that multiple proximal and distal factors, as well as historical processes act at the interface of health policy, services, and care of vulnerable populations. Culture and beliefs, but also power dynamics, and national or regional governmental priorities are among other forces shaping Indigenous health.

My thesis research also has provided me with the opportunity to train in qualitative methods. I was previously a predominantly medical and quantitative investigator, using primarily a positivist approach. I now appreciate that the balance between qualitative and quantitative methods is critical to producing both depth and breadth of evidence to inform policies and to contribute respectfully and ethically to Indigenous Amazonian health research. I hope that I might influence a similar reflective process among other researchers as well as national and regional authorities in Peru, with the goal of highlighting the urgency of improving health and nutrition among Indigenous Amazonian peoples. Strategies designed for Indigenous Amazonian peoples in Peru require consideration of local perceptions and traditional knowledge as valid pillars that parallel external and scientific knowledge. A lack of recognition of culturally and socially appropriate relationship-building and respect within health research involving Indigenous peoples in Peru represents a fundamental social inequity. In this way, Peruvian educational institutions are 'normalizing' the historical process of Amazonian colonization and social power dynamics occurring across generations, with implications for Amazons Indigenous peoples' health at present.

2 CHAPTER 2: RESEARCH APPROACH, BACKGROUND, AND STUDY POPULATION

2.1 OVERVIEW

This chapter describes my theoretical approach to investigating food security and its relationship with climatic and non-climatic drivers in the context of Indigenous Amazonian populations. I have divided this chapter in two sub-sections. The first sub-section presents theories and general concepts that support my methodology and provide the tools to interpret my results. This first sub-section includes a review of how impacts of climate change on health have been investigated in the scientific literature and introduces the vulnerability approach as a conceptual lens within climate change research. The second sub-section develops a synthesis of key thematic literature, moving from a general to a more specific perspective. Firstly, I synthesize literature on climate change impacts on health and food security in general, as well as existing literature on changing weather patterns in Amazonia. Next, I focus on Indigenous Amazonian health and food security, ending with a summary of current knowledge on weather and climate variability impacts on food security specifically among Amazonian ethnic groups. The last sub-section introduces my study population. In this section, I briefly describe the contemporary Shawi people of the Peruvian Amazon and their main health and ongoing socioeconomic challenges.

2.2 Research approach: theories and key concepts

2.2.1 Health geography and social determinants of health

Health geography is a sub-discipline of human geography whose main research interest goes beyond heath and illness to encompass the well-being of people in places (Kearns, 1993; Kearns

and Moon, 2002). Health geography focuses on the social, economic, cultural, political, environmental and other tangible (e.g. distance to health centers) and less-tangible (e.g. social networks) factors influencing humans and their experience of health in place (Andrews and Moon, 2005; Harrington et al., 2016). Contemporary health geography includes in particular a focus on addressing complex health questions, developing social theories, and the utilization of mixed-methodologies (Andrews et al., 2012; Curtis and Riva, 2010; Kearns and Moon, 2002). Critical health geography has adopted concepts of equity and social justice to inform policies oriented to improving the health of different human populations (Labonte et al., 2005; Kearns and Moon, 2002; Gatrell, 2005). Some of the main non-climatic determinants of health synthesized and articulated through key health geography theories and concepts are summarized in Figure 2-1 (Meade and Emch, 2010; King, 2010; May, 1977; Cutchin, 2007; Brown and Moon, 2012; Rosenberg, 2016). I include 'colonial history' in the fourth level to highlight the role of social determinants of health in the context of Indigenous peoples as it includes the historical political and economic process of encounters between different societies and cultures.

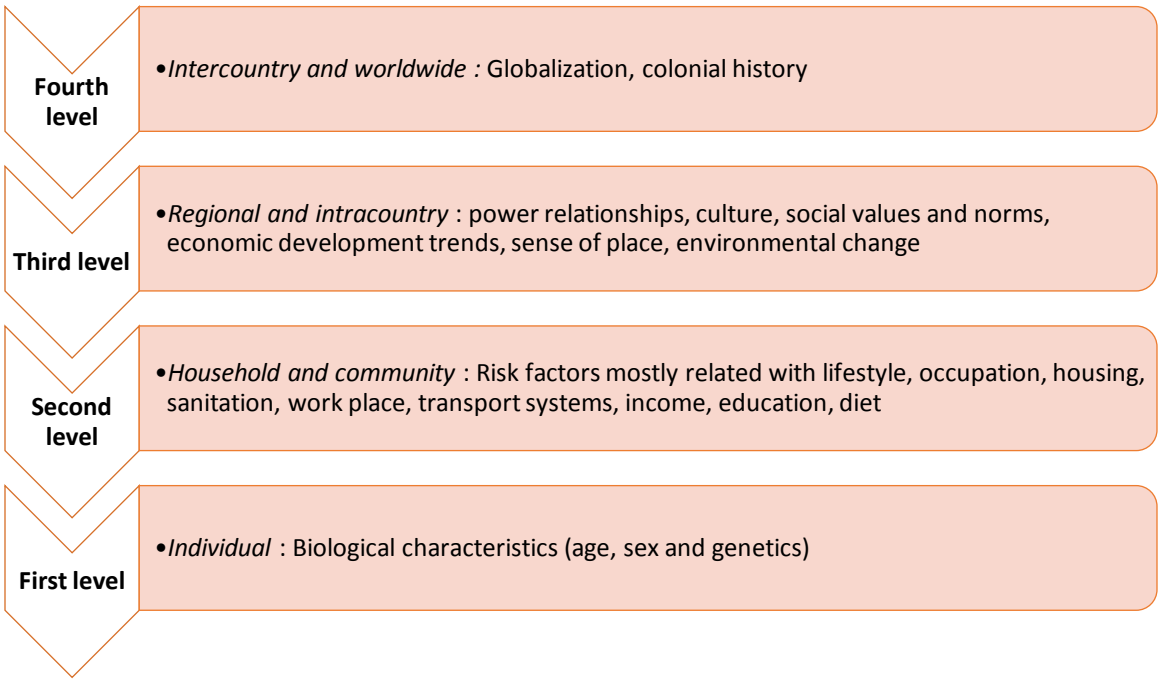

Figure 2-1 Non-climatic determinants of health synthesized and articulated through key health geography theories and concepts. Note: Adapted from the works of Meade and Emch (2010) King (2010), May (1977), Cutchin (2007), Brown and Moon (2012) and Rosenberg (2016)

Health geography draws on diverse theory to make sense of health in place, to understand the distribution of health outcomes, and to inform policy development to protect human health (Dummer, 2008; Andrews et al., 2012). Human ecology and disease theory are recognized as early theoretical constructs to explain processes of ill-health and remain a component of health geography research. These approaches, however, primarily conceptualize health as conditions that expose people to hazards (Meade, 1977), and focused on individual and biological determinants (e.g. sex, age and genetics), human behaviors that are typically shaped by culture (e.g. habits, beliefs, strategies to cope with, diet) and the physical (e.g. housing, workplaces, schools) and social environment (e.g. socioeconomic status, values) which influence where and how people can be exposed to dangerous stimuli (Meade and Emch, 2010). One main contribution of this to the climate change literature is the recognition of climate as a

fundamentally *geographical* variable (May, 1977). Climate has long been recognized as a direct modifier of human physiology (May, 1977), but also as an indirect physical factor affecting crop production, and consequently the nutrition of populations; these insights emerged from multiple countries in the period after the second War (May, 1963; May, 1961). Human ecology and disease theory continue to be relevant to informing our understanding of how climate directly or proximally affects health outcomes in place (Meade and Emch, 2010).

Ecological theory has, however, been criticized for its conceptualization of health as no more than the patterning or distributions of disease, neglecting an interrogation of the deeper drivers of health across multiple places and spaces (Kearns, 1993; Kearns and Joseph, 1993; Macintyre et al., 2002). Cultural, social and political forces and processes occuring at different times and spatial scales have been highlighted as part of the important context where health outcomes are situated (Jones and Moon, 1993; Mayer, 2000; Andrews et al., 2012; Curtis and Rees Jones, 1998). Social theories have particularly provided insight into cultural perceptions of people in places and their implications for health and well-being (Kearns and Joseph, 1993). These theoretical constructs drawing on social theory are particularly pertinent in the study of Indigenous populations, where social determinants of health provide deep contextual insight into understanding how health is constructed, and in exposing and contrasting dominant western concepts and local traditional epistemologies associated with local realities, perceptions, and health priorities (Kearns, 1991; Cunsolo Willox et al., 2012; Wilson, 2003; Kearns and Joseph, 1993; Richmond and Ross, 2008). Researchers drawing from a sociocultural approach, for example, have demonstrated the importance of land, land perceptions, environmental changes and collective social behaviors as important determinants of Indigenous health (Durkalec et al., 2015; Richmond and Ross, 2008).

Health geography has also drawn insights from political ecology by seeking to understand and characterize the more distal causes of local emergent disease. As such, health geographers often research larger global processes, such as migration, economic development and power relations (Mayer, 2000), which particularly influences the administration of and access to natural resources and their social and economic benefits (Meade and Emch, 2010). This approach, for example, has led to the observation that among Indigenous populations, local perceptions of health and the prioritization of economic activities are not necessarily aligned with broader hegemonic interests (Richmond et al., 2005).

An interest in understanding the variation in health outcomes between and within populations ─ also referred to as gradients in heath ─ has articulated the conceptualization of place based on compositional and contextual factors (Andrews et al., 2012; Macintyre et al., 2002). Compositional factors include age, sex, genetics and others proximal risk factors, for example income, education, and risk behavior. However, these compositional factors are insufficient to explain why some health outcomes vary substantially between populations, regardless of individual or compositional status (Rose, 2001). Contextual factors are understood as the social, economic, cultural drivers, and even values and norms that affect groups of peoples, thus reflecting the characteristics of places (rather than people) where individuals are located. Contextual factors have the potential to influence access to health services and even the biological process underpinning physiological and psychological process that mediate health outcomes (Andrews and Moon, 2005; Gatrell, 2005; Andrews et al., 2012; Macintyre et al., 2002).

Health geographers have analyzed social determinants of health to promote the development of policies (which are not necessarily restricted to the health sector) in order to modify social,

cultural and political structures that underpin social gradients of health (Cummins et al., 2007; Macintyre, 1997). Social determinants of health represent the major non-climatic variables, factors or conditions associated with current health risks that have the potential to be modified to decrease or increase climate change impacts on health.

2.2.2 Weather, climate change and health research

The terms weather, climate, and climate variability ─ while sometimes used interchangeably in academic or popular writing ─ have important definitional distinctions, and these have implications for the ways in which we research climate and health. Weather refers to directly observable conditions on a daily or weekly basis in focal locations (Council 2001). Weather variables include temperature, wind, humidity, and precipitation (Council, 2001). Climate refers to long-term changes in the atmosphere, and average conditions of weather over days, months, decades, or longer (Council, 2001). Climate naturally varies across space and time, and scientists refer to normal climate variability by statistically comparing climate conditions with historic data. It is very likely that warmer temperatures and extreme climatic events will increase in frequency and intensity as consequence of global climate change over the next decades (Stocker et al., 2013). This implies that climate change will affect local populations by alteration of natural climate variability or normal weather patterns (Smith et al., 2014; Patz et al., 2005).

Direct observation of statistical associations between climate (documented over the long-term and averaged over large areas) and health (observed in shorter time periods, and often at the individual level) ─ particularly in the context of several other social and economic factors including individual, social, community or national response ─ is difficult (McMichael, 2013). With some exceptions where data availability has allowed assessment of the association between climatic changes and long-term datasets of disease distributions (Descloux et al., 2012), research

on climate change effects on health have followed one of three main research directions: 1) current associations between weather and disease, 2) investigating recent climatic or meteorological events (e.g. floods, heatwaves, storms), and 3) creating an evidence base for future climate change impacts (Haines et al., 2006). These directions recognise the importance of past climatic events, longitudinal epidemiological studies, and modelling future scenarios by incorporating other non-climatic factors such as demographic and economic trends. For example, in a 2015 systematic review identifying pathways by which climate change could impact child nutrition, the authors identified a series of intermediate factors and indirect pathways linking meteorological conditions to crops yields to explain child undernutrition (Phalkey et al., 2015). Individual and household characteristics were reported as important modifiers of the interaction between weather and nutrition. One key finding of this work — with implications for the field of climate and health more broadly — is the importance of local non-climatic conditions as modifiers of the impact of weather/climate on nutrition (Phalkey et al., 2015)

It has been argued that the current vulnerability of individuals, communities, or other human systems are essential determinants and proxies of future vulnerability to climate change (Kelly and Adger, 2000). In other words, to decrease vulnerability to the health impacts of climate change, it is fundamental to characterize the socioeconomic, cultural, and political determinants of climate- or weather-sensitive health outcomes or health risks in the present (Ford, 2012). A comparative assessment of past climate and how societies have responded starts with a deep understanding of the human system of interest, the production of data to understand previous climate impacts, and the analysis of non-climatic factors interacting with climatic factors to inform future adaptive strategies (Smit et al., 2000); these three steps — which begin with a focus on current relationships between peoples and their environments as a prerequisite to

analyses of future change —are the central components of the contextual vulnerability approach taken in this dissertation.

2.2.3 Contextual vulnerability approach to examining climate change impacts on health

For my dissertation, I use the vulnerability approach of Ford and Smit (2004), consistent with the broader vulnerability and climate change adaptation scholarship (Turner et al., 2003, Smit and Wandel, 2006; Field et al., 2014). There is a long tradition of using vulnerability assessment to research the interactions between human and environmental risks (Watts and Bohle, 1993). Over recent years, however, the vulnerability approach has evolved from a central focus on physical hazard events to investigate the social, economic, political, and environmental contexts within which people are or will be exposed (Bohle et al., 1994; Smit et al., 2000; Cutter, 1996; Hewitt, 1983). In the context of climate change, characterizing vulnerability has emerged as an approach with policy relevance for addressing global climatic impacts among vulnerable populations (Smit et al., 2000; Ford and Smit, 2004; Füssel and Klein, 2006). The climate change vulnerability approach characterizes the magnitude, frequency, and intensity of climate-related impacts and their interactions with multiple non-climatic determinants to underlying causes of current vulnerability. The approach then projects vulnerability trajectories based on climatic manifestations of changes in the global climate system (Füssel and Klein, 2006). The approach implies that links and associations between climatic and non-climatic determinants are critical for understanding future climate change impacts on human systems (Ford et al., 2013; Ford et al., 2010).

For my dissertation, I conceptualized vulnerability as a result of exposure, sensitivity and adaptive capacity to climate change. It has been described by (Ford and Smit, 2004) in the following way:

$$V = f\,(E, S, A)$$

Vulnerability can be defined as a function of: a) exposure (E) to the climate-related event or variability which affects the system (directly or indirectly); b) sensitivity (S) which refers to the characteristics of the system including social, cultural, economic, and demographic factors which affect how the exposure is experienced and the extent to which a population is impacted, and; c) adaptive capacity (A), representing the ability of the system to respond to, plan for, and reduce the impact of climate effects – on food security in the case of my thesis − and take advantage of new opportunities (Ebi et al., 2006a; Berrang-Ford et al., 2012). According to the framework's conceptualization of "contextual vulnerability", the researcher is to maintain a focus on the properties of the system and not on the climatic event itself (O'Brien et al., 2007). The vulnerability approach recognizes the importance of sensitivity in driving the vulnerability of populations to climate change, thus highlighting the importance of non-climatic factors; many of these are typically discussed as social determinants of health in other fields and are significant for understanding climate vulnerability. Non-climatic factors are understood as key physical and social determinants of human health acting across dynamic geographical and temporal scales (Füssel and Klein, 2006; Ford et al., 2010). For example, social deprivation (Krieger et al., 2016), cultural awareness (Lee et al., 2015) and ecosystems impairment (Graham and White, 2016) within vulnerable populations have been observed to exacerbate present and future health vulnerability to weather variability and extremes. For example, communities will be affected differently by identical flooding events (exposure) depending on the socioeconomic conditions of each community and their support networks, the availability of backup support for resources, social and physical infrastructure, and a range of other non-climatic factors (sensitivity and adaptive capacity). In this sense, adaptive capacity is the *space* where non-climatic determinants interact with climatic risks, creating opportunities for adaptation or favoring maladaptation pathways

(Fazey et al., 2011). 'Maladaptation pathways' (Magnan et al., 2016) refer to processes or conditions that exacerbate the susceptibility of human populations (e.g., social exclusion) or reduce options (e.g. erosion of knowledge about environmental risks) to respond to future climatic events.

The vulnerability approach has been used to inform climate change adaptation and health research at the national, regional, and community levels (Ebi et al., 2006a; Furgal and Seguin, 2006). By using past data from climatic records, future climate projections, and by analyzing social, environmental and climatic factors, vulnerability findings have been use to characterize potential future health burden (e.g. changes on diseases patterns or frequencies) and susceptibility of the health systems to handle climatic impacts associated with projected consequences of long-term climate change (Ebi et al., 2006b). The vulnerability framework has been used extensively in the Arctic with Indigenous populations (Ford and Smit, 2004; Ford, 2009; Ford et al., 2010), and also underpins early research among Indigenous people living in the Peruvian Amazon and in Uganda (Berrang-Ford et al., 2012; Sherman et al., 2015). The IPCC (2007:138) states, "the assessing of vulnerability offers a framework for policy measures" which is particularly in order to develop sustainable solutions for Indigenous people living in ecosystems that are already threatened, such as the Peruvian Amazon (Finer et al., 2008). Climate change vulnerability of Indigenous food systems has been studied mainly among Artic Indigenous people where researchers have found that traditional practices and knowledge for producing and accessing food were key pathways of climate change risk on food security (Ford and Beaumier, 2011; Beaumier and Ford, 2010).

The vulnerability approach is generally applied using community-based participatory research (CBPR) methods. CBPR prioritizes the importance of community participation and perspectives in the research process, and emphasizes the coproduction of knowledge, continuous self-reflection, and the generation of *meaningful* data for participants (Ford et al., 2016; Kindon, 2010). In the

case of this thesis, CBPR methods informed the *a priori* decision to focus on food security as this topic was identified by community members and leaders as one of three key health priorities during a preliminary pilot study (Hofmeijer et al., 2013). This thesis focuses on assessment of *current* vulnerability as a starting point for future vulnerability assessment. In doing so, I do not use future climate change scenario models, but — consistent with the vulnerability approach — contribute to the characterization of the ways in which food systems in the past and present interact with climatic and non-climatic determinants. This in-depth characterization is a starting point for assessing the impact of climate projections or scenarios of future changes in climate.

2.2.4 Measuring food security

Food security is defined as complete physical and economic access to sufficient, safe and nutritious food that meets a person´s dietary needs and food preferences for an active and healthy life (Pinstrup-Andersen, 2009). This definition considers four major components: food availability, food access, food utilization and food stability (FAO, 2008b; Webb et al., 2006). The availability component refers to the ability to have or produce sufficient quantities of food; the access component encompasses the ability to have sufficient resources (physical and economical) to attain a nutritious diet in a cultural and socially acceptable way. The utilization component is understood to describe how the body manages the consumed food in order to achieve a healthy nutritional status (Webb et al., 2006; Melgar-Quinonez and Hackett, 2008). Food stability refers to the possibility of achieving the three previous food security dimensions over a constant period over time. There is a dynamic and interacting relationship among these components. For example, food availability is necessary but not sufficient for access, and access is necessary but not sufficient for utilization (Webb et al., 2006). Moreover, nutritional status is

determined by food security, which is defined as the quality and quantity of food that each person consumes, as well as each person's access to good health and sanitation services (FAO, 2013).

There is no direct or gold-standard method to measure food security (Webb et al., 2006). One qualitative method that has been used consistently among the developed and developing world is the United States Department of Agriculture (USDA) Household Food Security Survey Module (HFSSM) (Melgar-Quinonez and Hackett, 2008). The survey uses 18 questions to assess perceptions of food quantity and quality and includes questions concerning participant's anxiety about household supplies and behavioral responses to a reduction of food intake by children and adults. Anthropometric indices are another way to assess food security and are based on individual-level data (Jones et al., 2013). The main benefit of using anthropometric indices is that they allow identification of vulnerable groups to food insecurity and also permit the monitoring of food and nutritional interventions over time (FAO, 2002). There are two main criticisms of anthropometric indices as measures of food security, however. The first is that food security components (availability, access and utilization) represent only one condition for nutritional status. Non-food determinants, such as infectious diseases, may be particularly important in influencing nutrition, especially for populations in the developing world (FAO, 2002). The second criticism is related to the cut-off values used to establish the levels of undernutrition. Research indicates that genetics and environment could affect the growing patterns of a population in ways that remain poorly understood. This has, for example, resulted in an overestimation of undernutrition levels in South Asia (Klasen, 2000). Despite these uncertainties, the WHO values have been generally well accepted for investigating nutritional status within different populations, including Indigenous Amazonian peoples in Peru (Huamán-

Espino and Valladares, 2006) and in other parts of South America (Houck et al., 2013; Horta et al., 2013).

While anthropometric indices are often used to measure undernutrition, malnutrition has also been measured using micronutrient deficiency, or "hidden hunger" (FAO, 2012), meaning a lack of fundamental vitamins and minerals necessary for physiological processes such as blood synthesis, immunological function, and growth and cognitive development. Biochemical assessments are recommended as a better measurement of the quality of the food that has been absorbed and metabolized by the body and also to facilitate standardized monitoring of change over time (Mason, 2001). Additionally, diminishing micronutrient deficiency is one of the goals of food security policies in Peru and globally (FAO, 2013; Jones et al., 2013). Iron-deficiency anemia is the most prevalent worldwide micronutrient deficiency and is thus an important indicator for malnutrition research. I thus chose to use a hemoglobin test, a biochemical measure, to assess iron-deficiency to evaluate anemia, a micronutrient condition related to food insecurity (Lemos et al., 2013; Osei et al., 2010).

2.3 Background: climate change impacts on health, food security and the Amazon region

2.3.1 Climate change impacts on human health and food security

Climate change influences human health through direct and indirect pathways acting at different temporal and spaces scales (McMichael, 2013; Costello et al., 2009). Direct impacts include changes in mortality and morbidity associated with extreme events (heat waves, drought, intense precipitation) while indirect climate health impacts are associated with the transformation of natural and human systems due to climate (Smith et al., 2014). Climate change is projected to impact health through effects on natural ecosystems, including altered distributions of vector-

borne, foodborne, and waterborne diseases (e.g. dengue, cholera), as well as diseases associated with air quality (e.g. allergies) (Smith et al., 2014; Haines et al., 2006). Climate change can also affect human health through the deterioration of socioeconomic activities and institutions via interactions that are complex and often difficult to predict (McMichael, 2013; Smith et al., 2014). Nutrition, occupational risk, mental illness, violence, and conflict have all been identified as among the principal health outcomes associated with the disruptions of human systems by climate change (Smith et al., 2014; Haines et al., 2006; Costello et al., 2009). It is estimated that by 2050, there will be 38,000 excess deaths ─ associated with climate change ─ due to heat shock among the elderly (WHO, 2014), and by that same year, severe stunting in children will rise between 20% and 60% compared to a non-climate change scenario in South Asia and sub-Saharan Africa respectively (Lloyd et al., 2011). There is consensus that greater health consequences from climate change will occur among populations living in the poorest socioeconomic conditions (Patz et al., 2005; Smith et al., 2014; Costello et al., 2009). Therefore, in addition to direct and indirect effects on disease distribution and incidence, climate change also represents a barrier to global efforts to achieve and build a more equitable world and combat health inequality (Friel et al., 2008; McMichael, 2013).

Food security represents one pathway by which climate change will affect human health (Porter et al., 2014). Climate change affects all components of food security (availability, access, utilization and stability), particularly in the southern hemisphere and in developing countries (II-AR5, 2014, Wiley and Gostin, 2009). For both agriculture and fisheries production, climate change projections generally indicate that the alteration of the physical environment will negatively affect tropical countries more than northern areas (II-AR5, 2014). In addition, people who depend on natural resources for their diet and cash incomes (e.g. fisheries in developing

countries) and those populations who already suffer of high levels of malnutrition will experience less availability of food and fewer options to purchase food during difficult times (Allison et al., 2009, Watts et al., 2015). This implies that climate change impacts on food security will potentially exacerbate current nutrition and socioeconomic disparities (Nelson et al., 2009; Parry et al., 2004).

Climate change is projected to directly impact food production by reducing crop yields and indirectly by increasing food prices and making human activities in outdoor places for growing plants difficult (II-AR5 2014). The majority of studies have been conducted at global scale, however, and typically focus on assessing climate impacts on agriculture and food productive systems (Brown and Funk, 2008; Rosenzweig et al., 2014; Schmidhuber and Tubiello, 2007) rather than local experiences of food security in-place in specific populations (Thornton et al., 2014). Warming temperatures and increasing levels of CO_2, for example, have been associated with mixed, positive and negative effects on crop yield/production and nutrient content (Sinclair, 1992; Schafleitner et al., 2011). For the case of cassava, a crop originally domesticated in the Amazon region, for example, some studies have demonstrated its high tolerance to prolonged water stress and poor soil quality with high photosynthetic activity during high temperature (>25°C); these results imply that cassava may be a suitable crop (in terms of yield and energy availability) under warming conditions (El-Sharkawy, 2012, Jarvis et al., 2012). On other hand, other studies have found that because of water stress and warming temperatures, toxicity will likely increase in some types of cassava, increasing the importance of local knowledge and expertise about different species and processes to avoid acute poisoning (Brown et al., 2016).

Warming temperatures and changes in precipitation might also impact the availability of fish in Amazon region (Sorribas et al., 2016). Given that fish are the main source of animal protein among poor households in Amazonia (Ortiz et al., 2013), climate change implications on fisheries represent an emergent food security challenge (Frederico et al., 2016). This implies that not only crops, but also animal food sources could be affected by climate change, representing a food security risk in particular for populations who currently have restricted access to wild protein sources and/or low socioeconomic status (Isanaka, 2007)

2.3.2 Climate change in the Amazon region

Over the past decades, alteration of normal precipitations regimens, warming temperatures and more frequent extreme climatic events have been reported in the Amazon region. The Amazon region experiences high temperatures and rainfall throughout the year; a seasonal pattern is observed at certain periods, although this pattern varies by location. The average length of the dry season and average temperature, for example, vary from 0.6 months and 25.9 ^{o}C in the northwest to 4.5 months and 25.5^{o}C in the Southeast (Malhi and Wright, 2004). The mean precipitation in Amazonia is also variable, from 2000-3000mm/year, although there are some places where average rainfall is less than 300mm/year (UNEP, 2009). A positive trend in temperature has been observed, with an increase of 0.09 to 0.4ºC per decade since 1970 (Jiménez-Muñoz et al., 2013; Malhi and Wright, 2004), a decrease in mean rainfall since 1990 (Lavado Casimiro et al., 2012), and documentation of extreme droughts and floods across many Amazonian countries simultaneously (Marengo et al., 2016).

Alteration of the Amazonian climate system is reflected in two major droughts in 2005 and 2010. Those extreme climatic events negatively affected local human populations and their interactions with natural systems, including river transportation, crop productions, food prices, and damage to key food trees (Lewis et al., 2011; Marengo et al., 2008b). In addition, a major flood in 2012 affected housing, roads, and tourism activities. The combination of these two hydrological regimens in such a short period of time (~20 months) is perceived locally to be an indication of the intensification of extreme climatic events in the Amazon region. (Marengo et al., 2013; Espinoza et al., 2014). Extreme climatic events have been related to regional climatic variation, such as the El Niño Southern Oscillation (ENSO), the variability of the tropical Atlantic sea surface temperature (SST), or a combination of both (Marengo et al., 2016), implying that global climate change might affect the Amazon's climatic system by altering Pacific or Atlantic sea surface temperatures (Gloor et al., 2015).

Climate change projections for the Amazon region favor a significant decrease in average annual precipitation, although wetter conditions will likely persist in the western Amazon region (Cox et al., 2004) (where Peru is located) compared to the eastern and central regions. For Peru, using a high emission scenario (A2), there is a projected increase in the maximum temperature by 1.6°C by the year 2030, while the minimum temperature is expected to increase by 1.4°C (Ministerio del Ambiente, 2010a). As a result, it is anticipated that the maximum temperature of the Peruvian Amazon will increase, particularly during the period of September, October, and November in the Northern region. Rainfall is expected to decrease by about 20% in the Peruvian Amazon, especially during December, January, and February (Ministerio del Ambiente, 2010a). These findings indicate that climate change will likely impact local ecosystems heterogeneously,

highlighting the importance of developing place-based research to better inform regional and global model projections.

Uncertainty about future climate change still persists, especially in a context where multiple non-climatic environmental changes are ongoing (Malhi et al., 2008). Other environmental changes are occurring in the Amazon region, with the potential for impacts to further exacerbate ongoing climate change through positive feedback loops in the climate system (Nobre et al., 2016). Deforestation is the main environmental change affecting the Amazon region, driven mainly by road construction, agricultural activities, and a growing population (Davidson et al., 2012, Perz et al., 2005). Deforestation directly affects the local and regional climate by altering evapotranspiration (ability of vegetation to transpire water to the atmosphere) and reflectivity/albedo (crops and pasture tend to reflect more solar radiation). Furthermore, researchers have found that intense drought, particularly those associated with ENSO, in the last ten years has led to a decline of vegetation, highlighting the fragility of the Amazon ecosystem and its potential to exacerbate global climate change (Hilker et al., 2014)

2.3.3 Indigenous Amazonian health and food security

In South America, Indigenous Amazonian peoples face significant health inequities and social disparities compared to non-Indigenous populations in the same countries. Contrary to more developed countries (Stephens et al., 2005), few studies have been conducted in the Amazon region to specifically investigate the differences in social and health status between Indigenous and non-Indigenous peoples and within Indigenous peoples living in the same country (Weigel and Sanchez, 2013). However, available data indicate that generally Indigenous Amazonian

peoples experience relatively poorer socioeconomic conditions, lower access to health services, and a lower life expectancy compared to non-Indigenous peoples. One study conducted in the northern Peruvian Amazon found that Indigenous households were considered more likely to be poor (99% vs 76%) and extremely poor (76% vs 31%) compared with non-Indigenous households in the same region (Díaz et al., 2015). In northeastern Ecuador, researchers observed that both mortality and morbidity were higher among Indigenous people than in colonists located in the same geographical region, pointing to limitations in access and utilization of health services (Pan et al., 2010). Less is known about how social determinants of health drive health disparities among Indigenous Amazonian peoples (Nettleton, 2007; King, 2009). For example, data from Peru have shown that the infant mortality rate among Indigenous Amazonian peoples has improved over previous years (Ramirez et al., 2009), yet important inequalities persist when compared to Peruvian national data (Table 2-1). This reflects the social disadvantage that Indigenous Amazonian people face throughout the lifespan.

Table 2-1. Indigenous Amazonian infant mortality rate per 1000 boys/girls born alive

	Country	Rural	Urban	Indigenous
Peru (2007)[1]	18.5	28.3	14.4	49.2
Brazil (2010)[2]	15.3	n.i.	n.i.	40.6
Venezuela (2001)[2]	19.6	n.i.	n.i.	44.1

[1] Ramirez et al. (2009), [2] Anderson et al.(2016), no information available (n.i.)

After many decades of declining population rates, Indigenous Amazonian populations are increasing markedly. Researchers have documented rapid population growth likely associated with decreasing infant mortality and high fertility rates (McSweeney and Arps, 2005). Indigenous populations in South America historically experienced multiple periods of catastrophic depopulation (Montenegro and Stephens, 2006). Epidemic mortality rates of 1% to

97% have been documented and associated with the introduction of measles, malaria, influenza, hepatitis B, tuberculosis, small pox, and chicken pox between 1875 and 2008 (Walker 2015). Recent reports document a total fertility rate among Indigenous Amazonian women in Peru and Ecuador >7, more than double the values for non-Indigenous women (Dirección Técnica de Demografía e Indicadores Sociales, 2010, Bremner et al., 2009). In Peru, the population growth rate in 2010 was substantially higher among Indigenous Amazonian peoples (2.7 per 100 annually) compared to the Peruvian general population (1.6) (Dirección Técnica de Demografía e Indicadores Sociales, 2010). However, this demographic recovery has occurred within the context of the extinction of several Indigenous groups, limited availability and accessibility to education and health services, degraded natural resources, and poor land access and political Indigenous representation (McSweeney and Arps, 2005).

Absence of health information on Indigenous peoples has been identified as a political act of discrimination as it constrains the identification of disease burden, reporting and response to national health inequities, and restricts the unpacking of colonial impacts and Indigenous perspectives on health and its determinants (Gianella et al., 2016; Kirmayer and Brass, 2016). For Indigenous peoples, the logic behind health is more complex and wider than the most common biomedical concepts (King et al., 2009). Indigenous peoples in the Amazon, as elsewhere (King et al., 2009), conceptualize health as not only a physical condition, but also emotional, spiritual, and mental conditions as part of a whole status of wellbeing; individual wellbeing is also linked to community wellbeing (Ormaeche and Valdez 2003). In this context, past and current experiences, including rubber, oil, and mineral exploitation, loss of land, religious activities, and legal and illegal logging represent distal factors that contextualize the contemporary health of Indigenous Amazonian peoples (Nettleton et al., 2007). One study using

a longitudinal and ethnographic approach found for example, that despite of improvements in typical health indicators, Indigenous people in the *Camisea* region of Peru considered their health to be "not good," and that the presence of extractive industry and imposed religious practices strongly affected their wellbeing (Izquierdo, 2005). This work also found that, after a period of twenty years, hemoglobin levels increased and intestinal parasites decreased among children and adults; however interpersonal conflicts, loss of autonomy, anxiety, alcoholism, and sorcery were perceived by participants as more frequent (Izquierdo, 2005).

Even when researchers have systematically reported poor health outcomes among Indigenous peoples, national public health responses have struggled or failed to consider Indigenous perspectives and meet Indigenous health needs (Stephens et al., 2005). In Brazil, multiple reports suggest that high biological and social vulnerability to tuberculosis persist among Indigenous peoples, with prevalence of this disease ten times the national values (Sousa et al., 1997; Coimbra Jr and Basta, 2007; Gava et al., 2013). In the Peruvian context, the Indigenous environment has been historically influenced by frequent and extensive contamination of food and water resources (Anticona et al., 2011; Finer et al., 2008; Finer and Orta-Martínez, 2010; Yusta-García et al., 2017; Martínez et al., 2007; Webb et al., 2016; Defensoría del Pueblo, 2015). For example, in 2010, over 80% of the active hydrocarbon concessions in Peru lay in titled Indigenous lands, representing a risk to Indigenous livelihoods (Finer and Orta-Martínez, 2010). Thus, in addition to limited health data and poor access to health services, Indigenous peoples in the Amazon region face ongoing inequities that remain poorly understood (Nettleton et al., 2007).

Indigenous Amazonian peoples rely on local environmental resources for food. They engage in traditional subsistence practices (farming, fishing, hunting, and food gathering). Recent studies have revisited constructs, typically described during the past century, that conceptualize the physical environment as central to Amazon food systems and food security (Cotta, 2017; Coimbra Jr et al., 2004; Dufour, 1987; Flowers et al., 1983, Roche et al., 2008; Berlin and Berlin, 1977). In addition, researchers point to the importance of wild and cultivated plants, and wild animal food sources, not only for diet and nutrition, but also for medicine, rituals, and social reciprocity practices (Welch, 2014; Cotta, 2017). In this context, food security among Indigenous Amazonian peoples is a manifestation of more than just physical nutritional status, but also embedded with socio-cultural traditions.

Food security among Indigenous Amazonian populations has mainly been studied by analyzing individual nutritional indicators, with few studies reporting on food security at the household level, or on experiences of food security at community level (Fávaro et al., 2007; Benefice et al., 2006). Nutritional deficiencies are one of the major health problems affecting Indigenous Amazonian societies currently, with documented rates of stunting of 20% in Brazil and 78% in Peru (Huamán-Espino and Valladares, 2006; Anticona and San Sebastian, 2014; Horta et al., 2013; Borges et al., 2016; Restrepo et al., 2006; Tarqui-Mamani et al., 2009). Despite the limited information about nutritional composition of Amazonian foods types (Dufour et al., 2016), two main diet conditions have been reported as associated with high levels of malnutrition and food insecurity: limited access to animal sources of food and low diet diversity (Rosique et al., 2010; Benefice et al., 2006). For example, high levels of stunting among the Shuar of Ecuador and the Tukunoans of Colombia were reported to be associated with low access to bushmeat on a daily base and likely substitution of animal food proteins with staples, including tubers, rice, and other

non-rich protein foods (Orr et al., 2001; Blackwell et al., 2009). In the Bolivian Amazon, one study reported that fewer than 30% of households with young children had access to the recommended combination of food products, including animal proteins (fish, meat or milk), cereals, fruits, and tubers or plantain (Benefice et al., 2006). This implies that low diet quality associated with food utilization may represent an important component of contemporary Indigenous Amazonian food (in)security.

At the same time, an emerging nutritional transition is evolving among Indigenous Amazonian populations. Research from Brazil, Colombia, Venezuela, and Bolivia reports that even when nutritional deficiencies are present, overweight and obesity are also prevalent or emerging among Indigenous peoples (Welch, 2014; Hidalgo et al., 2014; Restrepo et al., 2006; Bénéfice et al., 2007). In the case of Peruvian Indigenous populations, nutritional profiles suggest that an initial transition is emerging, with obesity affecting only adults, while children are still typified by nutritional deficiency profiles; however, data for adults are available for only a few ethnic groups (Huamán-Espino and Valladares, 2006; Romero et al., 2014; Tarqui-Mamani et al., 2009). The nutritional transition is characterized by increasing obesity rates where nutritional deficiencies are still prevalent (Hidalgo et al., 2014; Benefice et al., 2006; Gimeno et al., 2009). This double burden of malnutrition ─ the coincidence of under- and over-nutrition at the same time and even within the same household ─ has implications for increasing susceptibility to chronic health conditions, currently and in future generations (Victora and Rivera, 2014; Gimeno et al., 2009).

Researchers have suggested that socioeconomic changes, such as market integration, are shifting the type of diet among Amazonian populations in Ecuador, Brazil and Colombia, from

consumption of locally produced food to a preference for purchased/processed food, with negative nutritional consequences (Piperata et al., 2011b; Houck et al., 2013; van Vliet et al., 2015). This shift in diet may be in part responsible for the nutrition transitional previously described. It also may affect the food security of these Indigenous groups. One recent report from Brazil found no evidence that children participating in an economic-social cash transfer program showed improved nutritional status (Piperata et al., 2016). Such results and trends underscore the urgency of improving our understanding of the social, economic, and cultural determinants of Indigenous Amazonian food security, particularly in the context of a changing climate.

2.3.4 Weather, climate variability and food among Indigenous Amazonian peoples

The role of weather and climate variability in affecting food security has not been widely explored among Indigenous Amazonian populations. The diet of Indigenous peoples in the Amazon is likely to vary throughout the year, and this is believed to be especially true for animal sources of protein (Dufour, 1992). For example, Dufour et al (1991) reported that for the Tukánanuan in Colombia, cassava sources did not show much seasonal variation, however animal foods, including insects and wild vegetables did (Dufour, 1991). More recently in 2007, researchers found that nutritional status, measured through anthropometric surveys for one Warí community in the Brazilian Amazon, was generally better during the dry season, when crops like cassava and grains were more productive and fishing more accessible, compared to the rainy season when fishing was restricted (Leite, Santos et al. 2007). These differences in the availability of different sources of food indicate the potential for food security of communities in the Amazon to be influenced by weather.

For Indigenous peoples in the Amazon, where nutritional indicators are already poor and food systems are highly reliant on the physical environment, climate change is expected to further increase prevalence and severity of food insecurity (Ford, 2012, Kuhnlein, 2014). Initial information indicated that Indigenous Amazonian peoples in Peru have started to perceive warming temperatures and alterations of normal rainfall precipitation (Fundación MJ Bustamante De La Fuente, 2010). For example, in 2006, the year after a major drought in the Amazon (Marengo et al., 2008a), Indigenous peoples reported difficulty accessing fish in their local rivers; following the flood, water was too low to favor seasonal fish migration during a critical period when large numbers of fish are typically available (Fundación MJ Bustamante De La Fuente, 2010). Furthermore, in the same year, multiple cash crops (e.g. rice, maize, coffee) and palm fruits had lower than usual production (Fundación MJ Bustamante De La Fuente, 2010). Intensification of flooding had been reported by Shipibo participants in one study conducted in Peruvian Amazon, with adverse consequences for developing agricultural activities and increasing risk of soil erosion (Sherman, 2015). In the context of high food insecurity, an increase in extreme hydrological events under climate change will impact local animal and vegetable species, with implications for the nutrition, health, and well-being of Indigenous Amazonian peoples in Peru (Magrin, 2015).

2.4 Study Population: the Indigenous Shawi of the Peruvian Amazon

The Shawi people are located in the Loreto and San Martin regions of Northern Peru along the rivers Cahuapanas, Paranapura and their tributaries (Sillay, Sapuyacu and Shanusi). (Figure 2-2). They are among the five largest Indigenous groups in Peru, with approximately 21,000 members, representing ~6% of the Peruvian Indigenous population (INEI, 2009). Since 1538, the Shawi have been in contact with western society through relationships with Spanish explorers, Jesuit

missionaries, and Peruvian post-colonial traders and landlords. Since the last quarter of the last century, after a national law that legalized for the very first time Peruvian Indigenous communities (D.L. 20653, 1975), they have acquired greater independence and emphasized retention of traditional beliefs and social organization (Fuentes, 1988).

The Shawi are a young population; half of all Shawi are under 15 years old, compared to only a third of the Peruvian overall population (INEI, 2009). During the past decade, the Shawi population has increased at an annual rate (3.1%) twice that of the Peruvian general population (1.6%) (Dirección Técnica de Demografía e Indicadores Sociales, 2010) (Table 2-2). Thirty years ago, Shawi Indigenous groups were described as a society with two main production systems. The first and most predominant referred to the traditional or native subsistence system that consists of shifting cultivation, hunting of small mammals, and fishing. The second is related to trade and the market, but not necessarily through monetary transactions. Instead, some domestic animals or crops are bartered for goods that are used for traditional livelihoods, such as fabrics to make blouses, batteries for radios, and munitions for hunting (Fuentes, 1988).

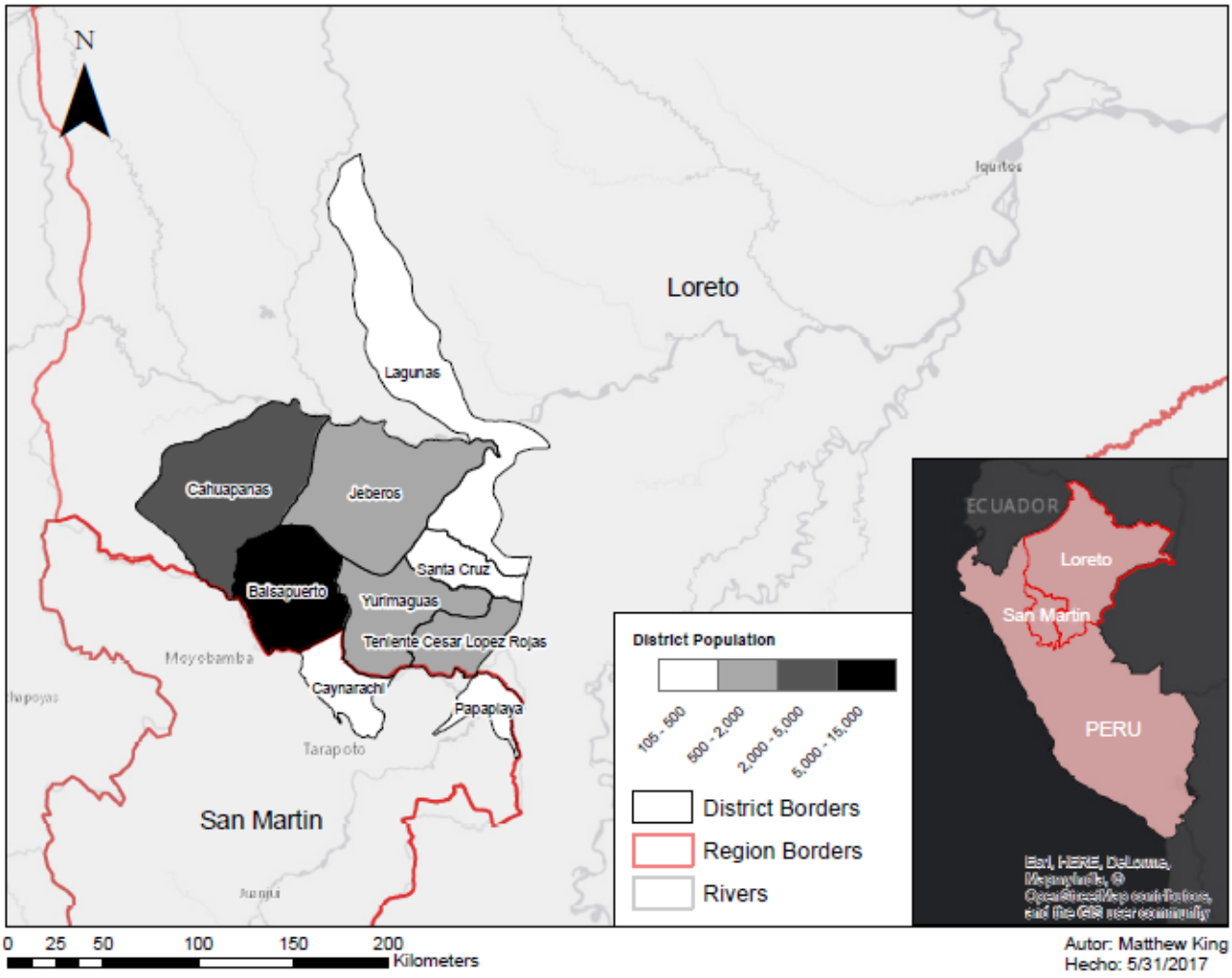

Figure 2-2 Peruvian districts and regions where Shawi people are located. Information about population obtained from INEI (2009)

Table 2-2. Sociodemographic characteristics of Shawi people compared with the Peruvian general population

Social characteristics	Shawi	Peru
Total population	21,424	27,412,157
Annual growth rate (1993-2007) (%)	3.17	1.6
Population <15 years old (%)	50.7	30
Population >65 years old (%)	0.9	6
Average of children per women of 15 to 49 years old	3.3	1.7
Individuals >15 years old without any school level (%)	31	11
Individuals with more than secondary school level (%)	3.1	23

Note: Information from INEI (2009)

According to the Shawi belief systems, health is a condition that results from interactions with pathogens, but also social and environmental factors, including climate. A Peruvian Ministry of Health (MoH) study conducted among multiple Shawi communities reported, for example, that participants recognized categories of diseases like “air disease” and “people diseases”, both conditions associated with natural environmental and social forces (Ormaeche Macassi 2008). The same MoH study, found that Shawi health has been negatively affected by social, economic and environmental factors (Ormaeche Macassi 2008). The Shawi population has grown substantially in recent years, yet this growth has not been paralleled by associated updates in land tenure rights. Increasing human density and unclear land tenure are considered among the major drivers of lack of resources among Shawi, including insufficient access to and availability of animals and land for hunting, fishing and farming (Ormaeche and Barclay, 2008). In addition, illegal deforestation and threats associated with oil exploration and the expansion of palm oil production within or close to Shawi lands represent contemporary determinants of Shawi health and well-being (Ormaeche and Barclay, 2008).

Historically, Shawi communities were not easily connected to urban centers, although this has begun to shift since a new road crossing the Shawi territory began construction in 2010. This new road now connects Yurimaguas with the Balsapuerto district where most Shawi live. Up until 2010, travel from Balsapuerto from the closest regional centre — Yurimaguas — was a two-day walk; by car, Balsapuerto is now accessible in only few hours from Yurimaguas. River transportation is also limited in Shawi territory, except during the wet season when river levels increase and water access is possible via small boats through the main rivers to certain locations (e.g. Varadero in Balsapuerto district). The Shawi typically use canoes or an extensive system of small foot paths for local transport (Gonzáles, 2013, Fuentes, 1988). Despite the potential benefits of a road for improved access to public services and employment opportunities, there have been reports by Indigenous authorities, the Ministry of Health, and communities themselves of the road's negative impacts on natural resources since the road facilitates deforestation and increases sand erosion into the river, which have implications for water and food security (SPDA-Actualidad Ambiental, 2017, Hofmeijer et al., 2013, Ormaeche and Barclay, 2008).

Currently, demographic, social and environmental changes are affecting the contemporary Shawi Indigenous population, most of those changes might have impacts on the household and community food security, and even affect the nutrition status of Shawi people. Given that climate regional system is changing in the Amazon (see section 2.3.2), a better understanding of the nutrition and food security status and a deeply characterization of coping mechanism to handle food insecurity could provide insights to inform future climate change adaptation policies.

3 CHAPTER 3: MALNUTRITION AND FOOD INSECURITY AMONG SHAWI CHILDREN AND THEIR PARENTS IN THE PERUVIAN AMAZON

3.1 OVERVIEW

In this chapter, I characterize the nutritional (individual level) and food security (household level) status of Shawi children (≤ 5y) and their parents in the Peruvian Amazon. This chapter highlights the magnitude of food insecurity affecting the Shawi people, focusing on the individual and household levels using standardized methods for assessment of nutrition and food security. Given that research on food security among Indigenous Amazonian peoples has been largely reported using nutritional indicators, I describe nutritional gaps in terms of stunting, wasting, and anemia in order to facilitate comparison to other studies and inform local and national policies. However, the climate change vulnerability literature typically investigates food security dimensions in terms of availability, access, utilization and stability at the household level (Porter et al., 2014); I have thus used a standardized and locally validated instrument to measure these dimensions of household food security in addition to measuring individual nutritional status. This chapter addresses Objective 1 of my thesis: *to characterize the nutritional and food security status of Shawi Indigenous Amazonian children (≤ 5y) and their parents.* In doing so, I provide an evidence base for baseline health risks associated with food security. This chapter also explores household-level variation in nutrition and discusses the health implications of an emerging Shawi nutritional transition (e.g. overweight parents and underweight children in the same household). Coauthors: Carol Zavaleta, Lea Berrang-Ford, Grace S Marquis, James Ford, Kaitlin Patterson, Cesar Cárcamo, Elmer-Alejandro Llanos Cuentas, Rosa Silvera, Nancy Ross, Sherilee L. Harper. Carol Zavaleta was the primary author of the manuscript. She

conducted statistical analyses, interpreted results, and wrote the manuscript. Profs. Berrang-Ford, Grace Marquis, Nancy Ross, James Ford and Sherilee Harper contributed intellectually and provided comments and edits to the manuscript. Kaitlin Patterson collaborated on data entry and survival analysis, and provided edits. Rosa Silvera participated on the data collection and provided intellectual comments to the final manuscript. Cesar Cárcamo and Elmer-Alejandro Llanos Cuentas contributed to the conception of the study and provided comments on the manuscript.

3.2 Abstract

Despite persistent nutritional deficiencies affecting Indigenous Amazonian children, the prevalence of overweight individuals is rapidly increasing in the region, particularly among adults, highlighting the need to evaluate population-level and intra-household nutritional profiles. This paper characterizes the nutrition profiles of Indigenous Amazonian children and their parents and measures food security at the household level in eleven Shawi communities in Peru. Associations between pediatric nutritional outcomes and parental/household characteristics are also investigated. This cross-sectional study was conducted in Indigenous Shawi communities on a tributary of the Huallaga river in the Peruvian Amazon. Households (N=177) were recruited to participate in the survey if they had at least one child ≤ 5 y and both biological parents (or grandparents if the parents were absent). Each participant was evaluated for weight, height, and hemoglobin level. World Health Organization (WHO) recommendations were used to calculate nutritional indicators, and food security was evaluated according to the United States Department of Agriculture (USDA) Household Food Security Survey Module (HFSSM). Unadjusted and adjusted (multivariable) logistic regressions were applied to identify factors associated with stunting, wasting, and anemia. Households were overwhelmingly food insecure (98%). Nutritional deficiencies were highly prevalent among children (stunting=43.6%, wasting=4.0% and anemia=65.7%). Parents presented with anemia (35.0%) and some were also overweight (12.0%). Thirteen percent of stunted children and 18.9% of anemic children had an overweight parent. The height of both parents, maternal BMI, household food security levels for children in the home, and access to *masato* (fermented cassava beverage) were significantly associated with stunting when adjusting for covariates. Our results indicate that

Shawi households experience one of the highest reported rates of food insecurity worldwide. In addition, an important nutritional deficiency gap exists among Shawi children compared to non-Indigenous Peruvian children, although some Shawi adult participants were also overweight. Characterization of changing nutritional profiles among remote Indigenous households and individuals is a priority to ensure effective food programing and nutritional policy.

3.3 Introduction

Malnutrition represents an important public health burden for Indigenous populations in the Peruvian Amazon (Anticona and San Sebastian, 2014). The prevalence of stunting, being underweight, wasting, and anemia among Indigenous communities varies, with documented rates of stunting at 78% among Indigenous children under 5 years old (Tarqui-Mamani et al., 2009; Anticona and San Sebastian, 2014; Huamán-Espino and Valladares, 2006). The occurrence of child malnourishment is influenced by social conditions. Consistent with research in other Amazonian countries and globally, malnourishment among Indigenous children in Peru is substantially higher than among non-Indigenous children living in the same territory (Díaz et al., 2015; Coimbra et al., 2013; Anderson et al., 2016). This Indigenous health gradient has persisted and represents an important health and equity mandate for nutritional policy in Peru.

There is initial evidence that Indigenous communities in the Amazon are experiencing an emerging nutritional transition similar to what has been documented in Latin America more broadly (Rivera et al., 2014; Port Lourenço et al., 2008; Hidalgo et al., 2014). This transition is typified by a *double burden* — or concurrence — of under- and over-nutrition (Doak et al., 2005), with important implications for the design of public health interventions (Doak et al., 2005). For example, among Indigenous Amazonian populations, high levels of stunting and

anemia have been reported to coincide with elevated rates of overweight and obesity among children (Houck et al., 2013; Orellana et al., 2006; Rosique et al., 2010), anemia and overweight among adults (Coimbra et al., 2013) and even stunting and overweight coinciding within individual households (Bénéfice et al., 2007). Emerging research points to the Peruvian Amazon as being in the early stages of a nutritional transition (Popkin, 1994); obesity is still negligible among children (Díaz et al., 2015; Tarqui-Mamani et al., 2009), but documented among some adults (4% with BMI≥30) (Romero, 2014), and there is a persistence of nutritional deficiencies and poor growth performance among children (Huamán-Espino and Valladares, 2006). However, nutritional transition research in Peru has typically focused on the general population, with negligible consideration of ethnicity or intra-household nutritional status (Huamán-Espino and Valladares, 2006; de Mola et al., 2014).

Nutritional transitions for Indigenous Amazonian peoples are modulated by existing socioeconomic and environmental trends in the region. Research indicates, for example, that the changing nutritional profiles across different generations of Indigenous Amazonian peoples is better explained by household-level socioeconomic and environmental dynamics than genetic predisposition for low stature of individual members (Horta et al., 2013; Godoy et al., 2005; Ferreira et al., 2016; Foster et al., 2005). Proposed pathways for the effect of socioeconomic and environmental factors on nutritional transitions include the role of household socioeconomic status (Port Lourenço et al., 2008; Leite et al., 2013), income (Welch et al., 2009a), insufficient access to adequate dietary needs (both quantity and quality) (Benefice et al., 2006; Foster et al., 2005), breastfeeding and weaning practices (Roche et al., 2011; Horta et al., 2013), access to education (Foster et al., 2005; Leite et al., 2013), health status and sanitation (Hidalgo et al., 2014), and parenteral characteristics (e.g., nutritional status, age, and schooling) (Benefice et al.,

2006, Leite et al., 2013). Yet despite growing recognition of household factors in influencing individual nutritional outcomes, and evidence of intra-household variation, consideration of the nutritional profiles of adults and children within a single study has been negligible.

A double burden of malnutrition (DBM) within Peruvian Indigenous Amazonian households might also add complexity to food security planning and evaluation among vulnerable populations. Peruvian food security interventions only consider the percentage of children under 5 years of age who are stunted as the key indicator of food utilization, even though overweight might also be an emergent condition among Indigenous Amazonian adults (Romero et al., 2014). DBM within households indicates that quality of the diet among different members varies (Pinstrup-Andersen, 2009; Saibul et al., 2009; Caballero, 2005). Thus, information about the nutritional profile of adult household members is also relevant to guide Peruvian food and nutritional policy.

This paper characterizes the nutritional profiles of children and their parents and measures household food security in Indigenous Shawi communities in the Peruvian Amazon. We seek to contribute to a nascent evidence base by characterizing emerging patterns of double burden not only between households but also within households, and in vulnerable and remote Indigenous communities. We investigate the DBM within households and the associations between pediatric nutritional outcomes and parental/household factors. This research aims to inform nutritional and food policies targeted at vulnerable Indigenous communities in the Peruvian Amazon in general, and Shawi communities in particular, by documenting nutritional profiles and determinants during a time of nutritional transition.

3.4 Methods

3.4.1 Study population and location

The Shawi people — previously called "Chayahuita" — encompass more than twenty thousand individuals, predominantly located in the Loreto region of northern Peru (Census Peru 2007). The Shawi people largely maintain their traditional livelihoods, including hunting, fishing, gathering, and cultivating cassava and plantain. Additionally, some families raise domestic animals, including chicken and pigs, mainly for obtaining cash or for self-consumption in difficult times. In some communities, cows graze freely; livestock typically belong to the whole community and cows are not used for milk. This study was conducted among Shawi communities located along a tributary of the Huallaga river. Shawi Indigenous communities were identified as a highly vulnerable priority population by a previous international health research program in consultation with regional and local Indigenous organizations.

3.4.2 Data collection

Prior to entering communities, we consulted with Indigenous authorities to present, discuss, and collaboratively revise research objectives, methods, and benefits. Following a census of 18 of the 19 communities in the region (one community declined to participate in the census), we selected communities for inclusion based on two criteria: 1) the most populated communities with respect to households with children ≤5 years old, and 2) accessible by a maximum of 2 hours by vehicle plus 5 hours on foot from the closest city (Yurimaguas). Eleven communities were thus selected and invited to participate in the research. All of the 11 invited communities consented to continued participation. Within each participating community, all accessible households with children ≤5 years of age were invited to participate. Communities were typically organized around a central area where a communal soccer field and one or two homes were located. The

majority of households were scattered deeper in the forest and could be reached by walking 15-60 minutes. It was also common for families to have crop fields located at a distance from their main house (0.5-2 hr by walking), where they often spent more than one night. This reduced our ability to contact and invite 100% of eligible households identified during the census. We visited and invited 92% of households with children ≤ 5 years of age (n=188 of 204) (see Appendix 1 for community profiles).

From June to July 2014, two fieldwork teams visited households: 1) an interview team, including eight Shawi research assistants previously trained and supervised by the main investigator (CZ), and 2) a health team, including a non-Shawi nutritionist, a non-Shawi nurse, and a Shawi research assistant. During the first visit to each household, interviewers presented the research and sought written consent to participate. Participating household members were then asked whether they consented to a second visit by the health team during the following days. At the second visit, children and parents were measured for weight, height (length for children < 24 mo), and hemoglobin.

Interviews were conducted orally with participants in the local Shawi language, with responses recorded on a paper questionnaire. Response rates varied between different instruments: 94-95% for questionnaires, 88-89% for children's anthropometric/hemoglobin measures, and 79-80% for adult anthropometric/hemoglobin measures. Non-participation was predominantly related to lack of time or lack of interest in the research.

3.4.3 Instruments

An individual questionnaire was completed for one child ≤ 5 y, randomly selected, and for both parents (mother and father). In cases where either of the parents was absent (and there was uncertainty of the parent's return date), the responsible caregiver of the same sex was invited to

answer the individual adult questionnaire. According with the Shawi traditional norms, grandparents take care of children in absence of parents. One food security questionnaire was completed per household (see Appendix 1 for individual and food security questionnaire). Questions asked about demographics, including age, sex, education, occupation and whether adults had engaged in food production activities during the last two weeks, including their purpose (e.g., consumption, selling, gifts). We asked mothers whether they were currently pregnant. Pediatric questionnaires were completed by the mother. In addition to demographics, pediatric questionnaires queried early feeding practices, including total length of breastfeeding, the child's age when food other than breastmilk was first introduced, and the kind of food first introduced.

The household food security questionnaire used a locally adapted version (for language, culture and context) of the United States Department of Agriculture (USDA) Household Food Security Survey Module (HFSSM) (Bickel et al., 2000). Questions progress from an initial level of anxiety that food will run out to a more severe experience when first adults and then children are experiencing hunger or are not eating for a whole day. The recall period used was one month. The household food security questionnaire was completed with the head of the household in the presence of the person who prepares food to corroborate the information. Codification and then imputation were developed following the original guidelines of the HFSSM (Bickel et al., 2000). Responses received a value of 1 or 0 depending on whether the response reflected a positive or negative food security condition, respectively. The scale was found to be acceptable and reliable for this population (Cronbach's $\alpha = 0.74$). (See Appendix 1 for adaptation, codification and imputation process).

Anthropometric body measurements were taken using a SECA 803 ® digital scale with the precision of 100 g and a wooden stadiometer with 2mm of precision, built as recommended by the Peruvian National Center for Food and Nutrition (CENAM). In addition, three drops of blood by finger prick were obtained from each participant to determine their hemoglobin level using a portable device (brand HemoCue Hb 201+). All equipment was calibrated before beginning the survey, and every morning their correct functioning was monitored. All measurements were performed by the same Peruvian anthropometrics expert who had been trained previously by the CENAM.

3.4.4 Variable definition

Table 1 shows child and parent nutritional outcome descriptions and value definition. The World Health Organisation's suggested values were used to calculate z-scores for anthropometric indices to assess nutritional status among children. Height-for-age, weight-for-height and weight-for-age z-score values were used to define stunting, wasting, underweight and overweight for children, respectively. Body mass index (BMI) was calculated based on weight in kilograms divided by the square of height in meters for all adults except pregnant women. Anemia was also defined by WHO standards for children and adults (World Health Organization (WHO), 2011). To determine the prevalence of co-existence of under- and over-nutrition within Shawi households, we created a new variable per household to describe parents' BMI as normal, underweight or overweight. (Table 3-1).

Table 3-1. Nutritional variable definitions

Variables	Description	Definition
Children (≤5 years old)		
Stunting	Height for age z-score value or the number of standard deviations below or above the reference WHO median value	Stunting if height for age z-score < -2SD; normal if height for age z-score ≥ -2 SD
Wasting	Weight for height z-score or the number of standard deviations below or above the reference WHO median value	Wasting if weight for height z-score < -2SD; Normal if weight for height z-score ≥ -2 SD & ≤+2 SD Overweight if weight for height z-score > +2SD
Underweight	Weight for age z-score or the number of standard deviations below or above the reference WHO median value	Underweight if weight for age z-score < -2SD; Normal if weight for age z-score ≥ -2 SD
Anemia	Anemia is defined as a low level of hemoglobin in red blood cells	Anemia if hemoglobin (Hb) <11.0 g/dL Normal if hemoglobin (Hb) ≥11.0 g/dL
Parents		
BMI	Body mass index (BMI) calculated based on weight in kilograms divided by the square of height in meters for adults except pregnant women.	Underweight if BMI (for non-pregnant participants) < 18.5 kg/m^2 Normal if BMI ≥18.5 & <24.9 Overweight if BMI ≥ 25.0 & <29.9 Obese if BMI ≥30
Anemia	Anemia is defined as a low level of hemoglobin in red blood cells	Anemia if Hb<13.0 g/dL for adult male; Hb<12.0 g/dL for non-pregnant women and Hb<11.0 g/dL for pregnant women
Households		
Parents' nutritional condition	Defined base on individual BMI category of female and male adults.	Underweight when at least one parent was underweight Normal when both parents had a normal BMI Overweight when either mother or father was overweight.

Covariates were organized in three levels: child, parents, and household (Table 3-2). Child covariates included age, sex, and early feeding practices (length of breastfeeding and introduction time of solid food and *masato* beverage). Parental covariates of child nutrition included demographics (sex, age), socioeconomic factors (formal education, paid job), and nutritional status (height, BMI, and presence of anemia). Household covariates included child food security score, parents' food-related production activities, and diet consumed by household members the day before the interview. Household food security status was defined according to USDA updated standards (Ballard et al., 2013). Children's food security status was classified using the eight questions referring to the child's food conditions in accordance with previous research (Nord, 2009). Parents' information regarding food production activities for self-consumption were combined to create household variables describing whether any parent engaged in fishing, agriculture, animal rearing, or hunting during the previous two weeks. Lastly, diet was classified into three main groups to reflect differences in major nutrient content (Table 3-2).

3.4.5 Data processing and statistical analysis

Data were analyzed descriptively and statistically in Excel v10 and Stata 13.1 respectively. Anthropometric data were processed using 2006 WHO growth standards within a Stata macro program (WHO, 2011). Means with 95% confidence intervals (CI) were presented for continuous variables (if normally distributed). Percentages were presented for categorical variables. We used a Kaplan Meyer test to estimate the mean duration of early feeding practices due to right censoring of the data (some children were still breastfeeding at the time of our visit).

Two-sample Student's t-tests were used to assess significant differences in continuous outcomes between binary groups (e.g., difference in parents' height between children with and without

stunting). Chi square or Fisher's exact tests were used to evaluate the relationship between categorical independent variables and outcomes. Logistic regression was used to evaluate the role of all covariates, except early feeding practices where a log-rank test was used to investigate differences between means of children with or without stunting. We generated both unadjusted (univariable) and adjusted (multivariable) logistic regression models to assess associations between nutritional indicators (dependent variable) and attributes of children, parents, and households (independent variables).

Table 3-2. Covariates definitions

Variables	Description	Definition
Children (≤5 years old)		
Age	Reported age.	Continue from 0 to 60 months old
Sex	Participant's reported sex	Dichotomous (Male/Female)
Length of breastfeeding	Self-reported length of total breastfeeding time.	Continue in months
Introduction time of semi-solid and solid food	Self-reported age child started to receive semi-solid (e.g. mashed plantain) or solid food (e.g. fish) different from human milk	Continue in months
Introduction time of *non-fermented masato*	Self-reported age child started to receive masato beverage. *Masato* is a local beverage that is typically made of boiled and chewed cassava that adults drink after it ferments for a couple of days. Young Shawi children receive "*masato dulce,"* non-fermented masato.	Continue in months
Parents		
Age	Self-reported age.	Continue in years old
Sex	Participant's reported sex	Dichotomous (Male/Female)
Formal education	Father or mother's reported education level from primary to the highest educative level	Total years of school attendance
Paid job	Whether the father or the mother reported having a job that provided any regular income	Dichotomous (Yes/No)
Height	Height of father or mother	Continue in meters
BMI	BMI of father or mother	Continue in kg/m^2
Anemia	Whether the father or the mother has anemia, determined from hemoglobin values	Dichotomous (Yes/No)

Table 3-3. Continued

Variables	Description	Definition
Household		
Household food security level	Total points resulted from18 questions in the adapted HFSSM questionnaire. Level of food security was stablished following the updated version of food security classification (Ballard et al., 2013)	High food secure if 0 points Marginal food secure if 1-2 points Low food secure if 3-7 points Very low food secure if 8-18 points.
Children food security level	Total points resulted from apply the HFSSM including only children questions (from 10 to 18 question). Level of food security was stablished following the work of (Nord, 2009)	High food secure if 0 points Marginal food secure if 1 point Low food secure if 2-4 points Very low food secure if 5-8 points.
Food-related production activities during the past two weeks	Parent information regarding food production activities for self-consumption were joined to create household variables to describe whether any parent engaged in fishing, agriculture, animal rearing, or hunting	Dichotomous (Yes/No)
Household members reported diet the day before was classified into three main groups to reflect differences in major nutrient content.	Animal sources reflecting access to protein rich sources whether household reported eat meat, fish, *suri* larvae, poultry, eggs and milk Grains and starchy vegetables reflecting carbohydrate-rich sources whether household reported to eat cereal, tuber, roots or plantain Non-starchy vegetables reflecting a mixture of micronutrients whether the household reported to eat fruits, wild fungus and heart palm	Dichotomous (Yes/No)
Access to *masato* beverage the day before of the interview	*Masato* beverage was reported by participants as food to relieve "hunger" when there is nothing else to eat, we have separated consumption of only *masato* the day before as an independent variable	Dichotomous (Yes/No)

3.4.6 Ethics

This research was approved by the McGill University Research Ethics Board in Montreal, Canada and the Institutional Ethics Committee at the Universidad Peruana Cayetano Heredia in Lima, Peru, and built upon previous work in the region on the ethics of community engagement in research (Sherman et al., 2012). Informed consent was acquired from authorities in each community, individuals, and from both parents in the case of children. Prior to field work, extensive consultation with Indigenous community authorities was conducted to confirm community consent and to clarify investigation benefits and compensation for participation, as well as appropriate procedures for informed consent and locally-appropriate ethical research practices (Sherman et al., 2012). According to the resulting agreement with Indigenous authorities, and as per standard ethical research practice with vulnerable populations, investigators designed this study to integrate the following components: 1) Research project prioritized training and selection of Shawi youth with a secondary education and high proficiency in both Shawi and Spanish, 2) Purchasing of all food supplies for the field team from Indigenous local producers, 3) For their participation, each household received a small present (less than $3, either a recycled bag, fruit, or supplies for making traditional jewelry, 4) A nutritionist working with the research team provided nutritional consultation (with a Shawi translator) to the entire household and in cases where anemia was detected; iron was supplied to anemic individuals in coordination with the closest health post, 5) Local health personnel were notified to facilitate follow-up medical consultations with individuals diagnosed with any malnutrition condition, and 6) On-going knowledge translation and consultation on emerging results was conducted during follow-up visits by the main investigator (CZ) and the research team.

3.5 Results

3.5.1 Child demographics and early feeding practices

A total of 177 households with children ≤ 5y were evaluated in this study, representing 94% of invited households (177/188) and 87% (177/204) of all households with children ≤ 5y in the selected communities. The average age of children that participated was 29 mo (95% CI 26.7-30.8mo, youngest: 6 mo). Of the 177 children surveyed, 57% were female. The mean duration of breastfeeding was 14 months, with infants typically starting solid or semisolid food and masato around 7 mo (Table 3-3). Plantain, cassava and fish were reported as common first food (Table 3-3).

Table 3-4. Sociodemographic and early feeding practices among Shawi children ≤ 5y

Characteristics	N	n (%)	mean (95 %CI)
Sex: ref female	177	100 (56.5)	
Age (months)	177		28.7 (26.7-30.8)
Breastfeeding duration (months)[1]	167		14.4 (13.1-15.7)
Age the child started foods (solid or semisolid) (months) [1]	163		6.9 (6.3-7.3)
Age the child started drinking *masato* (months)[1]	161		7.2 (6.5-7.8)
First complementary food	160		
Plantain		61 (38.1)	
Cassava		26 (16.1)	
Fish alone or plus any of these plantain, cassava or rice		21 (13.0)	
Game		15 (9.3)	
Sachapapa (local root vegetable)		9 (5.6)	
Rice		6 (3.7)	
Eggs		6 (3.7)	
Cassava & plantain		5 (3.1)	
Rice with plantain or with noodles		4 (2.5)	
Milk or infant food preparation		4 (2.5)	
Chicken		3 (1.9)	

[1] Values calculated using survival analysis and Kaplan Meier test

3.5.2 Parents' (or caregiver) demographics and household characteristics

Fathers or male caregivers were on average older and had more years of schooling compared to mothers or female caregivers (Table 3-4). Female adults were pregnant in about 18% of cases, and the primary female caregiver was a grandmother for 22% of children. Participation in remunerated jobs was low among fathers and absent among all mothers or female primary caregivers. Agriculture and raising domestic animals were the two most frequent activities performed for getting food during the past two weeks, while half or less than half of parents did fishing and hunting to access food.

3.5.3 Individual nutritional status and household food security

Stunting and anemia were high among the Shawi children (Table 3-5). More than forty percent of children were stunted, and more than sixty were anemic. Prevalence of acute malnutrition or wasting was lower at 4.2%, and 17.2% of all children were underweight. There were overweight cases among children, although these were rare (1.8%). Underweight among adult primary caregivers was low (1.9%), while the prevalence of overweight in the adults was 12.1% overall, with similar rates for men and women (Table 3-5). We found no cases of obesity among adults. Although anemia among parents (35%) was lower than among children (66%), pregnant women had the highest prevalence of anemia (62.0%) after male children (71.8%). Undernutrition among children and over-nutrition among parents was present in the same households (Table 3-6): 12.9 % (9/70) of children who were stunted had at least one overweight parent and 18.6% (19/102) of children who were anemic had at least one overweight parent. Ninety-nine percent of Shawi households reported very low food security at some time during the last month (175/177) and 94% (167/177) of children in these households experienced very low food security (Table 3-7).

Table 3-5. Parents (or caregivers) and household characteristics of Shawi children ≤ 5 y

Characteristics	N	n (%)	Mean (95% CI)
Mother (or female caregiver)[1]			
Age (years)	174		30.3 (28.9-31.6)
Pregnancy (self-reported)	177	31 (17.5)	
Highest education attained	168		
No formal schooling		48 (28.6)	
Some schooling (nursery or any level of primary)		110 (65.9)	
Some schooling (any level of secondary)		9 (5.4)	
Some schooling (higher education of any form)		0 (0.0)	
Currently have a paid job	167	0 (0.0)	
Father (or male caregiver)[1]			
Age (years)	162		35.2 (33.8-36.8)
Highest education attained	155		
No formal schooling		21 (13.5)	
Some schooling (nursery or any level of primary)		104 (67.1)	
Some schooling (any level of secondary)		27 (17.4)	
Some schooling (higher education of any form)		3 (1.9)	
Currently have a paid job	151	11 (7.3)	
Household food provision activities during the past two weeks			
Parent engaged in agriculture for self-consumption	172	135 (78.5)	
Parent rears animals for self-consumption	172	108 (62.8)	
Parent engaged in fishing for self-consumption	173	84 (49.0)	
Parent hunt for self-consumption	165	48 (29.1)	
Food eaten by household members the day before			
Household accessed cereal, tuber, roots or plantain	176	154 (87.5)	
Household accessed foods from animal sources	176	121 (68.8)	
Household accessed fruit or wild fungus	176	53 (30.1)	
Household accessed nothing or only masato as food	176	9 (5.1)	

[1] Caregiver was grandmother or grandfather in 21.6% and 6.0% of children's households, respectively

Table 3-6.Description of nutritional indicators for Shawi children ≤ 5y and their parents

Nutritional indicators	N	Total n (%) or mean (95% CI)	Female n (%) or mean (95% CI)	Male n (%) or mean (95% CI)
		Children		
Height-for- age z-score	165	-1.88 (-2.03 to -1.73)	-1.72 (-1.91 to -1.53)	-2.09 (-2.33 to -1.86)
normal		93 (56.4)	57 (60)	36 (51.4)
stunted [1]		72 (43.6)	38 (40)	34 (48.6)
Weight-for-age z-score	167	-1.1 (-1.25 to -0.95)	-1.01 (-1.22 to -0.80)	-1.21 (-1.4 to, -0.99)
normal		138 (82.6)	82 (86.3)	56 (77.8)
underweight[2]		29 (17.4)	13 (13.7)	16 (22.2)
Weight-for-height z-score	165	-0.08 (-0.23 to -0.09)	-0.09 (-0.32 to -0.15)	-0.07 (-0.33 to -0.19)
normal		155 (93.9)	90 (94.7)	65 (92.9)
wasted[3]		7 (4.2)	4 (4.2)	3 (4.3))
overweight[4]		3 (1.8)	1 (1.1)	2 (2.8)
Anemia	166			
No		57 (34.3)	37 (38.9)	20 (28.2)
yes[5]		109 (65.7)	58 (61.1)	51 (71.8)
Hb (g/dL)	166	10.59 (10.44 to 10.74)	10.72 (10.51 to 10.92)	10.42 (10.19 to 10.65)
		Parents		
Weight[6] (kg)	265	53.3 (52.42 to 54.20)	48.8 (47.77 to 49.76)	58.24 (57.34 to 59.16)
Height (cm)	291	153 (152 to 154)	148 (147 to 149)	159 (158 to 60)
BMI[6,7] (kg/m2)	265	22.5 (22.24 to 22.75)	22.09 (21.69 to 22.44)	22.95 (22.64 to 23.28)
BMI[6,7] (kg/m2)	265			
normal		228 (86.0)	117 (84.8)	111 (87.4)
underweight		5 (1.9)	4 (2.9)	1 (0.8)
overweight		32 (12.1)	17 (12.3)	15 (11.8)
obese		0 (0.0)	0 (0.0)	0 (0.0)
Hb [6] (g/dL)	260	12.87 (12.67 to 13.07)	12.0 (11.80 to 12.21)	13.80 (13.56 to 14.05)
Anemia	260			
no		168 (64.6)	71 (52.6)	97 (77.6)
yes [5,6]		92 (35.4)	64 (47.4)	28 (22.4)
Hb pregnant women (g/dL)	26	n/a	10.7 (10.3 - 11.12)	n/a
Anemia pregnant women	26			
no		n/a	10 (38.5)	n/a
yes [5]		n/a	16 (61.5)	n/a

[1] Height-for-age <-2 SD from the WHO reference median value. [2] Weight-for-age <-2 SD from the WHO median value. [3] Weight-for-height <-2 SD from the WHO reference median value. [4] Weight-for-height >+2 SD from the WHO reference median value. [5] Hb: Hemoglobin (g/dl), anemia was <11.0 g/dL for children; <13.0 g/dL for adults male; <12.0 g/dL for non-pregnant women and <11.0g/dL for pregnant women. [6] Excluding pregnant women. [7] BMI< 18.5 underweight, ≥18.5 & ≤24.9 normal, ≥25 & ≤29.9 overweight, ≥30 obese

Table 3-7. Co-existence of under- and over-nutrition within the Shawi's households with children ≤ 5y

	Child ≤5	
	Stunted [1](N=70)	**Anemic[2] (N=102)**
	n (%)	**n (%)**
Parents BMI[3] condition		
Normal	59 (84.3)	82 (80.4)
Underweight	2 (2.9)	1 (0.9)
Overweight	9 (12.9)	19 (18.6)
Obese	0 (0.0)	0 (0.0)

[1] Height-for-age <-2 SD from the WHO international reference mean value.

[2] Anemia was Hemoglobin <11.0 g/dl

[3] BMI kg/m^2< 18.5 underweight, ≥18.5 & ≤24.9 normal, ≥25 & ≤29.9 overweight, ≥30 obese

Normal: both parents had normal BMI, Underweight: at least one parent had underweight BMI and the second was not overweight BMI, Overweight: at least one parent had an overweight BMI,

Table 3-8. Household and child food security level for Shawi households with children ≤ 5y

Food security level [1]	**Household**	**Children**
	n (%)	**n (%)**
High food security	0 (0.0)	0 (0.0)
Marginal food security	0 (0.0)	0 (0.0)
Low food security	2 (1.1)	10 (5.7)
Very low food security	175 (98.9)	167 (94.0)

[1] The USDA household food security survey module (HFSSM) was applied as per Bickel et al. (2000). Four levels of food security are presented following USDA updated version as per Ballard et al. (2013). Children's food security was calculated by using corresponding 8 child-referenced items

3.5.4 Child nutrition and correlates:

Children's individual characteristics did not have any significant effect on stunting. However, parenteral and household variables presented significant associations in both unadjusted and adjusted models. Father's stature and both the BMI and height of the mother were significantly associated with the occurrence of stunting. Children with stunting were more likely to have shorter parents and mothers with lower BMI compare with children with non-stunting. Household food security among children and consuming *masato* the day before were also significant (Table 3-8). For anemia, individual characteristics did not have any significant association. Parenteral and household variables have shown significance only in the unadjusted model. Anemia among fathers and parents that were engaged in fishing tended to be protective factors while household's consumption of cereals, tubers, or plantain were risk factors for anemia (Table 3-9). Early feeding practices and parental age were significantly associated with wasting although only in the unadjusted model. Children with wasting were breastfed for a significantly shorter duration compared to children without wasting. The difference in effect size was substantial: non-wasted children breastfed for over twice as long (14.9 months 95% CI 13.5, 16.4) compared to wasted children (7.3 months 95% CI 6.2, 8.4). The ages of both parents were significantly associated with wasting, with wasted children more likely to have older parents. Parents of children with wasting were estimated to be 10 years older than parents of children without wasting, though there were wide confidence intervals around age estimates for parents of wasted children due to the low number of children with wasting (Table 3-10).

3.6 Discussion

Nutritional status among Shawi children in this study was characterized predominantly by nutritional deficiencies with a few cases of overweight children. Indicators of poor nutrition

among Shawi children in our study were higher than the Peruvian national averages, and this was consistent across all nutritional indicators except overweight status (Centro Nacional de Alimentación y Nutrición, 2015); among Shawi children in our study, prevalence of stunting was more than twice the national average (44% vs 18%), prevalence of underweight was more than three times the national average (17% vs 4.5%), and prevalence of wasting was twice the national average (4% vs 2%) (Centro Nacional de Alimentación y Nutrición, 2015). The prevalence of poor nutrition among children in our study is consistent with rates reported elsewhere among other Peruvian Indigenous Amazonian children (Díaz et al., 2015; Anticona and San Sebastian, 2014), with the exception of anemia, which was notably higher in our study (65.7%) compared to rates found among the Achuar, Urarina and Quichua (57%) (Anticona and San Sebastian, 2014) and the Awuajun (51%) (Díaz et al., 2015). We found particularly high rates of anemia among pregnant mothers. This is consistent with higher prevalence of anemia reported among pregnant (versus non-pregnant) women in the general population in Peru (Centro Nacional de Alimentación y Nutrición, 2015). The prevalence of anemia (62%) among Shawi pregnant women, however, is twice that of the national average for pregnant women in Peru (30%)(Centro Nacional de Alimentación y Nutrición, 2015). No comparable national data exist for anemia among adult men.

Child stunting was associated with the height of both parents, maternal BMI, household food security among children in the home, and access to *masato*. This points to a potential role for both parental and household characteristics in influencing children's physical development. In previous studies conducted in low/middle income country contexts, household food insecurity has been frequently associated with child undernutrition, particularly when food insecurity is severe (Cuevas-Nasu et al., 2014). Households with very low food security in Latin America,

including Indigenous Amazonian contexts, commonly report access to a diet low in diversity and characterized by low consumption of animal food sources (Isanaka et al., 2007, Benefice et al., 2006). Among the Shawi, there is no research documenting a detailed quantification of dietary intake of children and parents to confirm or validate these observations. In addition to food security and dietary factors, previous studies have suggested that maternal nutritional status, assessed by height, influences a child's nutritional status, supporting the hypothesis that intergenerational transfer of nutritional impacts and status may play a role in persistent malnutrition among Indigenous Amazonian peoples (Benefice et al., 2006; Ramakrishnan et al., 1999). Our results confirm that maternal nutritional status is associated with child stunting. Results also point to a potential role for father´s height in modulating children's growth, though this association requires investigation to validate and replicate these early signals from our data.

The high level of food insecurity found among participants Shawi is one of the highest documented globally, and comparable with rates of Indigenous people who have been evicted from their original territories in Uganda (Patterson et al., 2017). Limitations in the measurement instrument to properly reflect the level of food insecurity of non-Western populations could explain why we did not find great variation across households; however, our nutritional data support the fact that Shawi participants were experiencing severe food restrictions and did not meet nutritional requirements for an active and healthy life. In contrast, we found variation in food security among children, which could be explained by parents prioritizing feeding their children even when the household has limited availability and access to food resources. Indeed, previous investigators using the same instrument applied in our study identified protection of young children as a common coping strategy within households (Nord and Parker, 2010; Nord, 2009). This is supported by the resulted of our model for anemia, which found that children

without anemia were more likely to have a father with anemia; however, this association was not significant in the adjusted model. The role of both parents in protecting child food security and nutrition requires more investigation.

There is a growing body of literature studying the paradoxical phenomenon of a stunted child with an overweight mother among low and middle-income countries (Lee et al., 2012; Jehn and Brewis, 2009; Freire et al., 2014; Kosaka and Umezaki, 2017). In Peru, the prevalence of a stunted child coexisting with an overweight mother in the same household varies from 10-15% depending on the reference value used to define pediatric nutritional status (Jehn and Brewis, 2009; Garrett and Ruel, 2005). Two main hypotheses have been proposed to explain this phenomenon (Garrett and Ruel, 2005). First that previous stunting affecting mothers during early life influences the likelihood of overweight during adulthood in a context of better household food availability and lower physical activity, but still insufficient nutritive food for children (Garrett and Ruel, 2005; Doak et al., 2005; Doak et al., 2016). Second, low quality of diet in terms of poor micronutrients and high saturated fats and sugars availability may influence children's inadequate growth pattern and adults excess weight gain (Sekiyama et al., 2015; Doak et al., 2016). Moreover, ethnicity has been found significantly associated with the development of this condition among households in Central America. For example, studies conducted in Guatemala have demonstrated that Indigenous households with an overweight mother have a greater chance of having a stunted child compared to non-Indigenous households in the same region (Lee et al., 2012, Lee et al., 2017, Freire et al., 2014). Our study found 12% of stunted and 19% of anemic Shawi children had overweight parents; however, we included both father and mother in our study, which limits our ability to directly compare our findings with other studies that only included mothers. Nonetheless, our results indicate that over- and under-nutrition

coexist within individual households in a population with low availability and access to food. These results point to the potential for emergence of a pattern of DBM among the Shawi if overweight increases among adults in the context of persistent child under-nutrition.

Parental demographics, education and access to income were not associated with stunting or anemia, although there is little variation among the study population in these factors. The Shawi population in general has poor access to formal education (INEI, 2009), and participation in the market economy is limited, so income and parental education play minor roles in modulating child nutritional status.

3.7 Conclusions

Shawi children (and their parents) have poorer nutritional profiles compared to the general Peruvian population, with implications for national and Indigenous equity. Parental malnutrition was characterized by a higher prevalence of overweight than underweight, and anemia was particularly high among pregnant women and male adults. These Shawi participants have one of the highest rates of food insecurity worldwide. Our results suggest that overweight may be emergent among Indigenous Shawi households in the Peruvian Amazon, which implies that further monitoring and research on chronic health conditions associated with changing diet patterns and physical activity are warranted. A growing intra-household heterogeneity of nutritional profiles has implications for health, nutrition, and food policy that must adapt to more complex and diverse needs. Characterization of changing nutritional profiles and evaluation of household food security among remote Indigenous communities such as the Shawi is a priority to ensure effective nutritional policy, inform food security programming, and decrease inequities in health.

Table 3-9. Child with stunting and individual, parenteral and household predictors

	N	Yes[1] n(%)	Yes[1] mean (95% CI)	No n(%)	No mean (95% CI)	Unadjusted OR (95% CI)	Adjusted[4] OR (95% CI)
Child characteristics							
Sex							
Male	165	35 (49.3)		36 (50.7)	36 (50.7)	ref	ref
Female		38 (39.6)		58 (60.4)	58 (60.4)	0.70 (0.3, 1.3)	1.55 (0.5, 4.7)
Age mean (months)	165		27.9 (24.7, 31.2)		28.9 (26.0, 31.7)	0.99 (0.9, 1.0)	0.97 (0.9, 1.0)
Breastfeeding duration (months)[2]	151		13.9 (11.9, 16.1)		15.1 (13.4, 16.8)	---	
Time the child started foods (solid, or semisolid) (months)[2]	148		6.5 (5.7, 7.3)		7.2 (6.5, 7.9)	---	
Time the child start drinking masato (months)[2]	146		6.5 (5.7, 7.2)		7.6 (6.7, 8.6)	---	
Father (or male caregiver)							
Age (years)	148		34.4 (32.2, 36.7)		35.9 (33.8, 37.9)	0.98 (0.9, 1.0)	
Schooling (years)	137		4.8 (4.0, 5.7)		4.3 (3.7, 5.0)	1.05 (0.9, 1.1)	
Height (cm)	119		157.6 (156.2, 159.0)		160.5 (159.4, 161.9)	**0.88 (0.8, 0.9)** **	**0.84 (0.7, 0.9)** *
BMI (kg/m^2)	119		23.0 (22.5, 23.6)		22.9 (22.5, 23.3)	1.01 (0.8, 1.2)	
Father with anemia	117						
No		40 (44.4)		50 (55.6)	50 (55.6)	ref	
Yes		11 (40.7)		16 (59.3)	16 (59.3)	0.85 (0.3, 2.0)	
Do you have a paid job currently?	134						
No		53 (42.7)		71 (57.3)	71 (57.3)	ref	
Yes		4 (40.0)		6 (60.0)	6 (60.0)	0.89 (0.2, 3.3)	
Mother (or female caregiver)							
Age (years)	162		29.4 (27.2, 31.7)		31.2 (29.3, 33.2)	0.97 (0.9, 1.0)	
Schooling (years)	150		2.8 (2.3, 3.4)		2.9 (2.4, 3.4)	0.99 (0.8, 1.1)	
Height (cm)	156		147.3 (146.2, 148.4)		149.9 (148.9, 150.9)	**0.88 (0.8, 0.9)** **	**0.83 (0.7, 0.9)** **
BMI (kg/m^2)[3]	131		21.5 (20.9, 22.1)		22.7 (22.2, 23.2)	**0.78 (0.6, 0.9)** **	**0.76 (0.5, 0.9)** *
Mother with anemia	153						
No		35 (52.2)		32 (47.8)	32 (47.8)	ref	
Yes		43 (50.0)		43 (50.0)	43 (50.0)	1.09 (0.5, 2.0)	
Household food security during the last month							
Children food security affirmative conditions (1 to 8 points, higher values indicate greater food insecurity)	153		6.7 (6.4, 6.9)		6.2 (5.9, 6.5)	**1.35 (1.03, 1.7)** *	**2.02 (1.23, 3.3)** **

[1] In bold those with >10% of statistical significance in the bivariate analysis [2] Values were calculated by using survival analysis and log rank test to detect significantly differences between means in each category [3] Excluding pregnant women. [4] Sex, age and variables with a p value p<0.10 in the univariable model were included in the multivariable model. Logistic regression was used to test statistical significance for the multivariable model. ** p<0.01 *p<0.05 † p<0.10

Table 3-8. Continued

	N	Yes[1] n(%)	Yes[1] mean (95% CI)	No n(%)	No mean (95% CI)	Unadjusted OR (95% CI)	Adjusted[4] OR (95% CI)
Food eaten by household members the day before							
Did household access any foods from animal sources?	159						
No		22 (43.1)		29 (56.9)	29 (56.9)	ref	
Yes		48 (44.4)		60 (55.6)	60 (55.6)	1.05 (0.5, 2.0)	
Did household access any cereal, tuber, roots or plantain?	159						
No		10 (47.6)		11 (52.4)	11 (52.4)	ref	
Yes		60 (43.5)		78 (56.5)	78 (56.5)	0.84 (0.3, 2.1)	
Did household access any fruit or wild fungus?	159						
No		48 (42.9)		64 (57.1)	64 (57.1)	ref	
Yes		22 (46.8)		25 (53.2)	25 (53.2)	1.17 (0.5, 2.3)	
Did household access nothing or only *masato* as food?	159						
No		64 (42.4)		87 (57.6)	87 (57.6)	ref	ref
Yes		6 (75.0)		2 (25.0)	2 (25.0)	**4.09 (0.7, 20.9)** †	**39.3 (1.8, 857.0)** *
Household food provision activities during the past two weeks							
Did any parent engage in agriculture for self-consumption?	155						
No		18 (54.6)		15 (45.5)	15 (45.5)	ref	
Yes		50 (41.0)		72 (59.0)	72 (59.0)	0.52 (0.2, 1.1)	
Did any parent engage in fishing for self-consumption? yes	156						
No		36 (46.8)		41 (53.3)	41 (53.3)	ref	
Yes		32 (40.5)		47 (59.5)	47 (59.5)	0.77 (0.4, 1.4)	
Did any parent rear animals for self-consumption? yes	155						
No		25 (46.3)		29 (53.7)	29 (53.7)	ref	
Yes		43 (42.6)		58 (57.4)	58 (57.4)	0.84 (0.4, 1.6)	
Did any parent hunt for self-consuming? yes	149						
No		48 (45.3)		58 (54.7)	58 (54.7)	ref	
Yes		18 (41.9)		25 (58.1)	25 (58.1)	0.87 (0.4, 1.7)	

[1] In bold those with >10% of statistical significance in the bivariate analysis [2] Values were calculated by using survival analysis and log rank test to detect significantly differences between means in each category [3] Excluding pregnant women. [4] Sex, age and variables with a p value $p<0.10$ in the univariable model were included in the multivariable model. Logistic regression was used to test statistical significance for the multivariable model. ** $p<0.01$ *$p<0.05$ † $p<0.10$

Table 3-10. Child with anemia and individual, parenteral and household predictors

	N	Yes[1] n(%)	Yes[1] mean (95% CI)	No n(%)	No mean (95% CI)	Unadjusted OR (95% CI)	Adjusted[4] OR (95% CI)
Child characteristics							
Sex							
Male	166	51 (71.8)		20 (18.2)		ref	ref
Female		58 (61.1)		37 (38.9)		0.61 (0.3, 1.1)	0.50 (0.2, 1.1)
Age mean (months)	166		26.9 (24.2 - 29.6)		31.1 (27.7, 34.6)	**0.97 (0.9, 1.0)** †	0.9 (0.9, 1.0)
Breastfeeding duration (months)[2]	151		14.7 (13.1, 16.2)		14.5 (12.0, 17.1)	---	
Time the child started foods (solid, or semisolid) (months)[2]	148		7.0 (6.2, 7.8)		6.7 (6.1, 7.4)	---	
Time the child start drinking masato (months)[2]	146		7.2 (6.4, 8.1)		6.9 (5.9, 7.9)	---	
Father (or male caregiver)							
Age (years)	150		34.7 (32.7, 36.7)		36.3 (33.9, 38.8)	0.98 (0.9, 1.0)	
Schooling (years)	140		4.3 (3.7, 4.9)		4.9 (3.9, 5.9)	0.93 (0.8, 1.0)	
Height (cm)	122		159.0 (157.9, 160.2)		159.8 (158.3, 161.2)	0.97 (0.9, 1.0)	
BMI (kg/m^2)	122		23.0 (22.6 - 23.3)		22.8 (22.3, 23.4)	1.08 (0.8, 1.3)	
Father with anemia	120						
No		64 (68.8)		29 (31.2)		ref	ref
Yes		13 (48.2)		14 (51.9)		0.42 (0.1, 1.0)*	0.48 (0.1, 1.2)
Do you have a paid job currently?	137						
No		82 (64.6)		45 (35.4)		ref	
Yes		6 (60.0)		4 (40.0)		0.82 (0.2, 3.0)	
Mother (or female caregiver)							
Age (years)	163		30.3 (28.6, 32.1)		30.1 (27.7, 32.4)	1.00 (0.9, 1.0)	
Schooling (years)	152		3.0 (2.5, 3.4)		2.8 (2.1, 3.4)	1.04 (0.9, 1.2)	
Height (cm)	156		148.8 (147.8, 149.8)		148.7 (147.4, 150.1)	1.00 (0.9, 1.0)	
BMI (kg/m^2)[3]	131		21.9 (21.5, 22.4)		22.5 (21.8, 23.2)	0.89 (0.7, 1.0)	
Mother with anemia	155						
No		50 (65.8)		26 (34.2)		ref	
Yes		52 (65.8)		27 (34.2)		1.00 (0.5, 1.9)	
Household food security during the last month							
Children food security affirmative conditions (1 to 8 points, higher values indicate greater food insecurity)	159		6.4 (6.2 - 6.7)		6.5 (6.2 , 6.8)	0.97 (0.7, 1.2)	

[1] In bold those with >10% of statistical significance in the bivariate analysis [2] Values were calculated by using survival analysis and log rank test to detect significantly differences between means in each category [3] Excluding pregnant women. [4] Sex, age and variables with a p value p<0.10 in the univariable model were included in the multivariable model. Logistic regression was used to test statistical significance for the multivariable model. ** p<0.01 *p<0.05 † p<0.10

Table 3-9. Continued

	N	Yes[1] n(%)	Yes[1] mean (95% CI)	No n(%)	No mean (95% CI)	Unadjusted OR (95% CI)	Adjusted[4] OR (95% CI)
Food eaten by household members the day before							
Did household access any foods from animal sources?	158						
No		34 (69.4)		15 (30.6)		ref	
Yes		68 (62.4)		41 (37.6)		0.73 (0.3, 1.5)	
Did household access any cereal, tuber, roots or plantain?	158						
No		10 (47.6)		11 (52.4)		ref	ref
Yes		92 (67.2)		45 (32.85)		**2.24 (0.8, 5.6)**†	2.47 (0.7, 7.9)
Did household access any fruit or wild fungus?	158						
No		76 (67.3)		37 (32.7)		ref	
Yes		26 (57.8)		19 (42.2)		0.66 (0.3, 1.3)	
Did household access nothing or only masato as food?	158						
No		98 (65.3)		52 (34.7)		ref	
Yes		4 (50.0)		4 (50.0)		0.53 (0.1, 2.2)	
Household food provision activities during the past two weeks							
Did any parent engage in agriculture for self-consumption?	155						
No		24 (72.7)		9 (27.3)		ref	
Yes		76 (62.3)		46 (37.7)		0.61 (0.2, 1.4)	
Did any parent engage in fishing for self-consumption? yes	156						
No		55 (71.4)		22 (28.6)		ref	ref
Yes		46 (58.2)		33 (41.8)		**0.55 (0.2, 1.0)**†	0.66 (0.2, 1.4)
Did any parent rear animals for self-consumption? yes	155						
No		38 (70.4)		16 (29.6)		ref	
Yes		62 (61.4)		39 (38.6)		0.66 (0.3, 1.3)	
Did any parent hunt for self-consuming? yes	149						
No		69 (65.7)		36 (34.3)		ref	
Yes		27 (61.4)		17 (38.6)		0.82 (0.3, 1.7)	

[1] In bold those with >10% of statistical significance in the bivariate analysis [2] Values were calculated by using survival analysis and log rank test to detect significantly differences between means in each category [3] Excluding pregnant women. [4] Sex, age and variables with a p value $p<0.10$ in the univariable model were included in the multivariable model. Logistic regression was used to test statistical significance for the multivariable model. ** $p<0.01$ *$p<0.05$ † $p<0.10$

Table 3-11. Child with wasting and individual, parenteral and household predictors

		Yes[1]		No		Unadjusted	Adjusted[4]
	N	n(%)	mean (95% CI)	n(%)	mean (95% CI)	OR (95% CI)	OR (95% CI)
Child characteristics							
Sex							
Male	165	3 (4.2)		67 (95.7)			
Female		4 (4.2)		91 (95.8)		0.98 (0.2, 4.5)	2.18 (0.1, 30.0)
Age mean (months)	165		20.9 (4.60, 37.12)		28.8 (26., 30.9)	0.95 (0.8, 1.0)	**0.87 (0.7, 1.0)** †
Breastfeeding duration (months)[2]	151		7.3 (6.2, 8.4)		14.9 (13.5, 16.4)	**0.71 (0.5 – 0.9)** *	0.55 (0.2, 1.1)
Time the child started foods (solid, or semisolid) (months)[2]	148		6.7 (4.4, 8.9)		6.9 (6.4, 7.5)	---	
Time the child start drinking masato (months)[2]	146		6.2 (4.9, 7.4)		7.2 (6.5, 7.9)	---	
Father (or male caregiver)							
Age (years)	148		44.2 (32.9, 55.60)		34.7 (33.2, 36.2)	**1.09 (1.01, 1.1)** *	1.14 (0.9, 1.4)
Schooling (years)	137		3.3 (0.5, 6.1)		4.6 (4.1, 5.1)	0.84 (0.6, 1.1)	
Height (cm)	119		155.7 (147.9, 163.6)		159.4 (158.5, 160.3)	**0.86 (0.7, 1.0)** †	0.85 (0.6, 1.0)
BMI (kg/m^2)	119		24.1 (20.8, 27.4)		22.9 (22.6 23.)	0.144 (0.9, 2.2)	
Father with anemia	117						
No		5 (5.6)		85 (94.6)			
Yes		1 (3.7)		26 (96.3)		0.65 (0.0, 5.8)	
Do you have a paid job currently?	134						
No		7 (5.7)		117 (94.4)		ref	
Yes		0 (0.0)		10 (100.0)		1	
Mother (or female caregiver)							
Age (years)	162		41.6 (27.7, 55.4)		29.8 (28.3, 31.4)	**1.12 (1.0, 1.2)** **	1.11 (0.9, 1.3)
Schooling (years)	150		2.4 (-0.3, 5.0)		2.9 (2.5, 3.2)	0.91 (0.6, 1.2)	
Height (cm)	156		151.0 (145.4, 156.6)		148.7 (147.9, 149.4)	1.10 (0.9, 1.3)	
BMI (kg/m^2)[3]	131		22.7 (19.7, 25.9)		22.1 (21.8, 22.5)	1.14 (0.7, 1.7)	
Mother with anemia	153						
No		3 (4.0)		72 (96.0)		ref	
Yes		3 (3.8)		75 (96.2)		0.96 (0.1, 4.9)	
Household food security during the last month							
Children food security affirmative conditions (1 to 8 points, higher values indicate greater food insecurity)	158		6.7 (5.8, 7.5)		6.4 (6.2, 6.6)	1.24 (0.6, 2.4)	

[1] In bold those with >10% of statistical significance in the bivariate analysis [2] Values were calculated by using survival analysis and log rank test to detect significantly differences between means in each category [3] Excluding pregnant women. [4] Sex, age and variables with a p value p<0.10 in the univariable model were included in the multivariable model. Logistic regression was used to test statistical significance for the multivariable model. ** p<0.01 *p<0.05 † p<0.10

Table 3-10. Continued

	N	Yes[1] n(%)	Yes[1] mean (95% CI)	No n(%)	No mean (95% CI)	Unadjusted OR (95% CI)	Adjusted[4] OR (95% CI)
Food eaten by household members the day before							
Did household access any foods from animal sources?	157						
No		3 (5.9)		48 (94.1)		ref	
Yes		4 (3.7)		102 (96.2)		0.62 (0.1, 2.9)	
Did household access any cereal, tuber, roots or plantain?	157						
No		1 (4.8)		20 (95.2)		ref	
Yes		6 (4.4)		130 (95.6)		0.92 (0.1, 8.0)	
Did household access any fruit or wild fungus?	157						
No		6 (5.4)		106 (94.6)		ref	
Yes		1 (2.1)		46 (97.9)		0.37 (0.0, 3.2)	
Did household access nothing or only masato as food?	157						
No		6 (4.0)		143 (95.9)		ref	
Yes		1 (12.5)		7 (87.5)		3.40 (0.3, 32.2)	
Household food provision activities during the past two weeks							
Did any parent engage in agriculture for self-consumption?	153						
No		1 (3.0)		31 (96.9)		ref	
Yes		6 (4.9)		115 (95.1)		1.61 (0.1, 13.9)	
Did any parent engage in fishing for self-consumption? yes	154						
No		4 (5.2)		71 (94.7)		ref	
Yes		3 (3.8)		76 (96.2)		0.70 (0.1, 3.2)	
Did any parent rear animals for self-consumption? yes	154						
No		2 (3.7)		52 (96.3)		ref	
Yes		5 (5.0)		95 (95.0)		1.36 (0.2, 7.3)	
Did any parent hunt for self-consuming? yes	147						
No		4 (3.8)		100 (96.2)		ref	
Yes		3 (7.0)		40 (93.0)		1.87 (0.4, 8.7)	

[1] In bold those with >10% of statistical significance in the bivariate analysis [2] Values were calculated by using survival analysis and log rank test to detect significantly differences between means in each category [3] Excluding pregnant women. [4] Sex, age and variables with a p value $p<0.10$ in the univariable model were included in the multivariable model. Logistic regression was used to test statistical significance for the multivariable model. ** $p<0.01$ *$p<0.05$ † $p<0.10$

4 CHAPTER 4: INDIGENOUS SHAWI COMMUNITIES AND NATIONAL FOOD SECURITY SUPPORT: RIGHT DIRECTION, BUT NOT ENOUGH

4.1 OVERVIEW

In this chapter, I characterize the diet, food sources, and food preferences of Shawi households. This empirical work, in contrast to the previous chapter, focuses on household-level experiences and interactions in order to investigate Shawi household food security. While Chapter 3 used standard nutritional (quantitative) metrics that focus on the individual and household levels, this chapter broadens the scope of analysis to capture inter-household and external inputs to Shawi food security. In doing so, I used mixed (qualitative and quantitative) methods, and consider the role of culture on food preferences and food substitution, as well as the use of food sharing networks as a mechanism to deal with food scarcity.

This chapter addresses Objective 2 of my thesis: *to characterize the diet, food sources, and food preferences of Shawi households.* This research informs the identification of non-climatic determinants of food security vulnerability among Shawi people, which provides an important contribution to understanding the drivers of *sensitivity* to climate impacts within the vulnerability approach I use in this thesis. Notably, the results of this chapter demonstrate that external food and economic aid are poorly aligned with the needs and cultural preferences/traditions of Shawi. I find that cultural and social values related to food represent strong modifiers of household food security.

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4.2 Abstract

Food insecurity is a major challenge facing Peru's Indigenous Shawi communities, who receive food support through national level programs. There is limited research, however, on how national food and social programming support is perceived, received, and used among Indigenous communities. We address this research gap by characterizing the preferred diet and coping mechanisms among Shawi Indigenous households, and investigating community perspectives on the national food program and national social supports. We used a mixed methods approach, including a quantitative survey among eleven Shawi communities in the Peruvian Amazon (n=177 households), and semi-structured interviews with key informants (n=24). We found that national food programs in Peru rarely provide foods that are desired and preferred among the Shawi, particularly familiar and locally-sourced protein sources such as bushmeat and fish. Food and social programming requirements do not integrate consideration of the remoteness of many vulnerable households, and are considered culturally or linguistically inaccessible to many families. In some cases, foods supplied by national programs are not consumed as they are perceived as unfamiliar. Key opportunities to improve food and social programing include: monitoring and revising eligibility requirements for remote and highly vulnerable households; increasing provision of locally-preferred protein food and familiar food types; avoiding use of written Spanish as a sole source of information to support programming; extending food provision outside of school months; developing contingency plans during education sector strikes; considering hiring of staff with working knowledge of local languages

for community distributions; using visual or oral communication rather than written communication to increase accessibility of programs; increasing knowledge on the use and nutritional value of external food; and considering exemptions to school and health eligibility requirements during the rainy season and during sector strikes. Nationally-developed programming that does not consider Indigenous and cultural contexts risks inefficiency, limited improvement of health outcomes, and the potential to increase inequities in Indigenous health.

4.3 Introduction

Despite recent economic gains, high food insecurity remains a national challenge in Peru (Ministerio de Desarrollo e Inclusión Social, 2012). The Peruvian government has launched ambitious initiatives to improve nutritional indicators with notable success; for example, among children under 5 years, stunting has decreased from 37% in the 1990s to 19% in 2014 (Urke et al., 2014). National initiatives have been unable, however, to reduce high malnutrition among vulnerable and remote rural populations, particularly among children (Huicho et al., 2016). Targeted nutrition-related programming in Peru has typically focused on geographically isolated and economically deprived areas since the rural poor have had the highest rates of child malnutrition in the country (Programa Juntos, 2014). There has been limited consideration, however, of the unique needs and contexts of Indigenous peoples – often among the poorest and most remote populations in the country – within nutrition programs (Ministerio de Economía y Finanzas, 2009). Yet significant disparities in malnutrition rates have been consistently reported between Indigenous and non-Indigenous children in Peru and globally, with ethnicity recognized as an important factor underlying social determinants of child malnutrition (Díaz et al., 2015; Lutter and Chaparro, 2008).

In the last two decades, Peruvian authorities have shifted from their initial approach of food assistance programs to national social interventions with an emphasis on household well-being (Programa Juntos, 2017). Evaluation of the *Vaso de Leche* (Glass of Milk) initiative − the largest food program in the country – has identified no detectable evidence of impact on child malnutrition (Stifel and Alderman, 2006; Copestake, 2008). The *Juntos* program − a cash conditional transfer program implemented in 2005 to promote access to health services and improve nutrition among children and pregnant women from disadvantaged households − has been credited with much of the decrease in malnutrition in Peru over the last decade (Acosta and Haddad, 2014; Perova and Vakis, 2009; Sánchez and Jaramillo, 2012). Despite this, investigation to confirm or validate presumed linkages between nutrition sensitive programs and malnutrition in Peru remains limited and with mixed results. Critiques of *Juntos* have highlighted that while the program supports consumption of nutritious food, quantitative evidence linking *Juntos* to reductions in malnutrition is limited and still in early stages (Gahlaut, 2011; Escobal and Benites, 2012a; Saldaña et al., 2009; World Bank, 2009; Pérez-Lu et al., 2016). Concurrently, qualitative investigations have highlighted constraints to on-the-ground success of the *Juntos* program, including unclear and restricted eligibility of who qualifies for the program (e.g. single mothers and widows often excluded) (Jones et al., 2008; Streuli, 2012; Saldaña et al., 2009; Escobal and Benites, 2012b).

Peruvian food and cash transfer programs specify the need to be nutritive and/or culturally adapted for local populations (Programa Juntos, 2016; Ministerio de Desarrollo e Inclusión Social, 2016); yet, there has been limited characterization of whether these interventions are in fact approaching food security in the context of Indigenous traditional food systems. For example, information on the acceptability and use of food and cash transfer programs among

Indigenous peoples in Latin America, and particularly in Peru, more generally remains scarce (Gutiérrez et al., 2012). We identified one report from Peru involving Andean and Amazonian communities, highlighting limitations for the implementation of *Juntos* in different cultural contexts (Correa and Roopnaraine, 2013).

Globally, the nutritional and social characteristics of many traditional food systems among Indigenous communities have been documented, yet the bulk of this research has been based in populations from high income countries, with more limited comparable research in low and middle regions (Kuhnlein et al., 2009; Roche et al., 2008; Amaral, 2005; Perreault, 2005; Lardeau et al., 2011; Romeo et al., 2015; Ortiz et al., 2013). Limited knowledge of food systems, including diet and coping mechanisms to deal with food insecurity, among remote Indigenous communities constrains our ability to effectively evaluate existing food programs and tackle persistent inequity in food security between Indigenous and non-Indigenous Peruvian populations.

We contribute to addressing this research gap by characterizing diet and coping mechanisms for food insecurity among Indigenous Shawi communities located in Loreto region in the Peruvian Amazon, with emphasis on community experiences of national food and social support programs. The Balsapuerto District (predominantly Shawi ethnicity) was ranked as the third most vulnerable district for food insecurity in Peru (Ministerio de Desarrollo e Inclusión Social, 2012). Our previous research in this area indicated that virtually all households with young children were food insecure, with high prevalence of stunting and anemia among children ≤ 5 years old (Zavaleta et al., in prep). Here, we characterize the context of the food systems underpinning this level of malnutrition and food insecurity among the Shawi, and the role of national food programming in responding to remote Indigenous food insecurity. This work aims

to inform evidence-based national, regional and local programming to tackle food insecurity among Peruvian Indigenous peoples in general, and Shawi communities in particular. Our objectives include: 1) characterizing the typical and preferred diet and coping mechanisms among Shawi households, 2) investigating community perspectives on national food programs and social support, and 3) providing practical recommendations for Peruvian national food security programming.

4.4 Background: National food security programing in Peru

Peru has promoted and implemented multiple initiatives, from different sectors and working at national and local levels, targeted at improving mother's and children's nutrition (Programa Juntos, 2017). The longest running and still active program, *Vaso de leche*, works locally through municipalities to provide a daily serving of food over the year to poor and extremely poor households. The most recently introduced and well-known national programs, however, include the conditional cash transfer program, *Juntos,* and the national school feeding program *Qali Warma.*(Vigorous child) These two programs are part of the main national strategy aimed at improving food security and nutrition in Peru by supporting mothers and children (Food and Nutrition Security Plataform, 2016).

The *Vaso de leche* program distributes fortified whole milk − sometimes complemented with oat, rice, or quinoa flour – or other nationally produced food. Food distribution is prioritized based on need, with priority given to those households with children <6 years old, and/or pregnant and lactating women. Children aged 7 to 13 years, elders, and TB patients comprise the second prioritized group, accessing support only when the first priority sub-populations have been serviced (Stifel and Alderman, 2006). The implementation, distribution, supervision and

evaluation of this program are the responsibility of the municipality. Additionally, each community has an elected *Vaso de Leche* mothers' committee, which is responsible for collecting, preparing and distributing the food (Alcázar, 2007).

The *Qali Warma* program, launched in 2012, was designed to provide quality food service for children >3 years attending public schools. The program aims to "Ensure food service every day of the school year according with users' characteristics and areas where they live" (Ministerio de Desarrollo e Inclusión Social, 2016). Depending on district poverty levels, some schools qualify to receive breakfast only, whereas others under extreme poverty will receive breakfast and lunch. A feeding school committee or CAE (*Comité de Alimentación Escolar*) is implemented to manage food aid from *Qali Warma*. In cases where the food is provided as a prepared meal, the CAE must receive and verify that the food is in a good state, and distribute and supervise consumption. When food is provided un-cooked, the CAE must also store, cook and organize food distribution daily (Programa Nacional de Alimentación Escolar Qali Warma, 2014).

While *Qali Warma* delivers food directly through the school, the *Juntos* program – active since 2005 − was designed to promote human capital and tackle poverty by promoting households' access to several public services included health and nutritional (Programa Juntos, 2017). Households are eligible if they have at least one target member (pregnant woman, child or adolescent under 19 years), who must attend health services or school to receive a monetary incentive of two hundred soles every two months (~ 60USD). Pregnant women and children under 5 years must complete health attendance requirements, which include ante- and post-natal evaluation, growth monitoring, a series of vaccinations, and provision of micronutrients (iron

and vitamin A for children, iron and folic acid for pregnant women). Children 6-14 years are required to attend school at least 85% of the academic year (Ministerio de Salud, 2011, Programa Juntos, 2014). One adult woman per household is selected to receive the economic benefit after signing an annual agreement, with suspension in cases where a participant does not attend or comply with the required health and/or educative conditions.

4.5 Methods

This study was conducted among Shawi communities in the Loreto region of northern Peru, as part of a larger investigation aimed at measuring and characterizing the nutritional and food security status of Indigenous households with young children with the Indigenous Health Adaptation to Climate Change (IHACC) research program.

A mixed methods approach was used for this investigation. A household questionnaire was used to estimate frequencies of common practices and food preferences among participants; semi-structure interviews with key informants provided the context, depth, and rationalization underpinning the quantitative data, in particular the acceptability and use of food and social support (Creswell J.W. and Planco Clark V.L., 2011). A theoretical framework for food security was used to design the fieldwork, including the collection of quantitative data, the construction of the semi-structure guide, and *a priori* deductive coding. Our theoretical approach drew on the recognition that physical, social, cultural and temporal determinants of food security will influence individual and collective nutritional status also known as nutrition security (Gross et al., 2000).

4.5.1 Quantitative component

Study site and sampling

Fieldwork was conducted among eleven Shawi communities selected from a total of eighteen communities located along a stream ─ name withheld to ensure confidentiality of qualitative respondents ─ in the Loreto region (Figure 4-1). Communities were selected were those with the highest number of households with children ≤5 y, and accessibility (maximum of 2 hours drive plus 5 hours on foot from the closest city, Yurimaguas). Following a census of the eleven communities, households with children ≤5 y were invited to participate, with a response rate of 94% (177/188 households) for the household questionnaire. A more detailed description of the study design, is available in Chapter Three of this thesis. Data were collected between June and July 2014 by Shawi research assistants who were trained and actively supervised by the main investigator (CZ). Household-level and individual written informed consent were acquired prior to every research stage.

Instruments, data processing and analysis

A household questionnaire was used to record information on household demographics, participation in activities related to food procurement and any external aid or food support. Questions focused on: household head demographics such as age and sex; animal rearing or farming of crops; and whether some household members had received any food or economic support from any relative, program or institution. A description of food that household members ate the day before, including the source of food, was collected with a household food security questionnaire. Paper questionnaires, written in Spanish but orally translated into Shawi, were applied by local research assistants with each household (n=177). All survey instruments are available in Appendix 2.

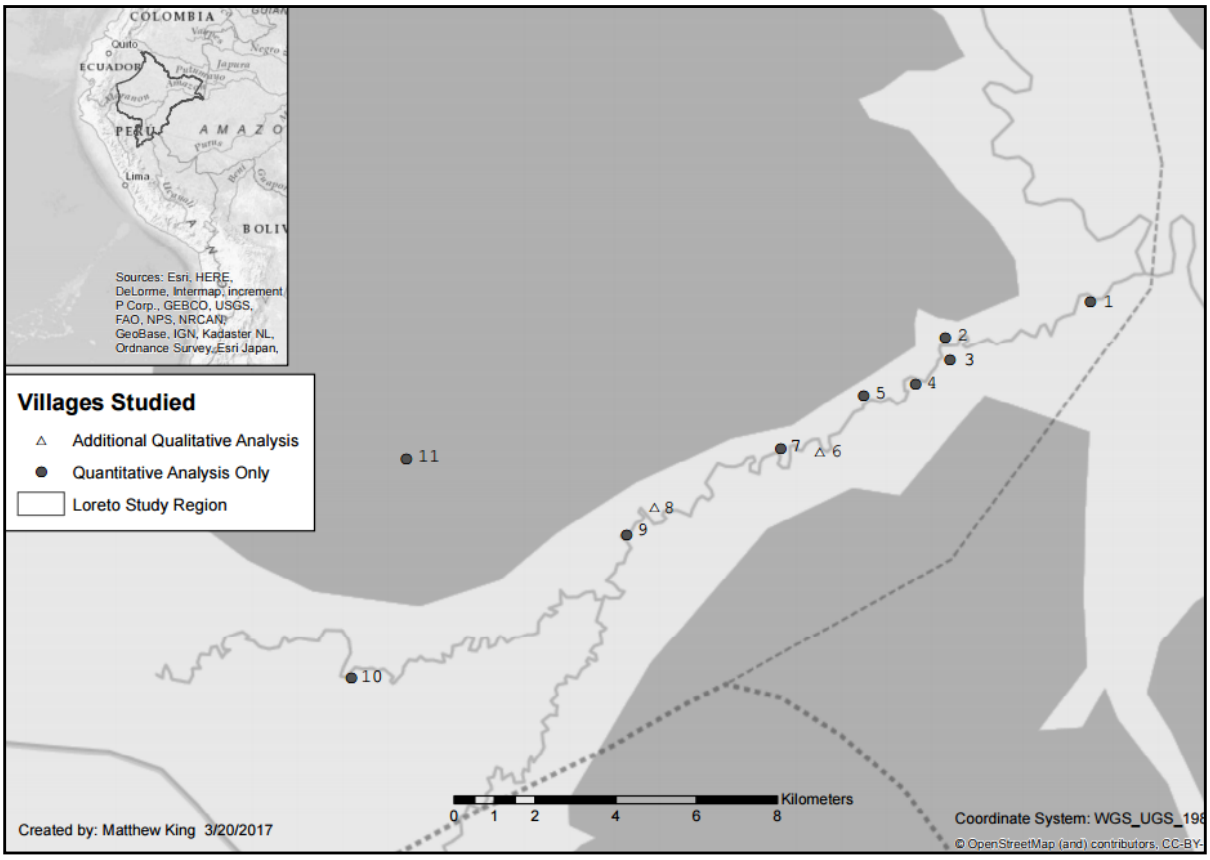


Figure 4-1 Study site of Shawi communities in Loreto region

Note: To protect the confidentiality and privacy of qualitative respondents, the name of the specific river and communities within Loreto Region are not shown. To further protect privacy, we have randomly adjusted the spatial location of the communities to retain the overall spatial trends but mask specific community locations.

Data were analyzed for descriptive statistics in Excel v10. To present diet and food consumed the day before of our visit, we collapsed the food items consumed by Shawi participants into three dominant groups, guided by the FAO/WHO food system (FAO and WHO, 2016), and reflecting the predominant foods Shawi households reported. These three groups reflect differences in

major nutrient content: 1) meat, fish, insects, poultry, eggs and dairy products (animal protein sources); 2) cereal grains, roots, tubers and plantain (grains and starchy vegetables reflecting carbohydrate-rich foods); 3) fruits, wild fungus and heart of palm (non-starchy vegetables, reflecting a mixture of micronutrients). The primary goal of collecting food type data was to generate preliminary descriptive information about household access to different nutritional sources. For this phase of the research, we did not measure the *quantity* of consumed food.

4.5.2 Qualitative component

Study site and sampling

To explore Shawi Indigenous food system — including local and external coping mechanisms — in more depth, and to compliment quantitative data, we interviewed adults in two communities (n=24). We selected two communities located between the most easily accessible and the most distant community to reflect an intermediate diversity of access experiences in the region (Figure 1). We conducted semi-structured interviews with nine men and nine women, selected and invited among parents of a child ≤5 years old. Participants were selected according to the location of their household to reflect a range of geographical access to the center of the community, where main educational and health services (if any) were located. In addition, we interviewed two teachers to provide information about the school feeding program, and four elders who were named by community members as founders of those communities (characteristics of participants are available in the Appendix 2). The participation of elders was sought to provide a richer historical and contextual understanding of traditional food systems.

Instruments, data processing and analysis

A qualitative interview guide was designed to cover the four main components of food security (availability, access, utilization and stability). In this context, we sought not only to determine

whether households had *enoug*h food, but also whether they had *acceptable access* to *nutritious* and *preferred foods* (Jones et al., 2013). Example questions included: What do you do to obtain your food? What kind of difficulties do you have in obtaining food? What foods do you prefer to eat? What food do you consider is better for your health? Each interview lasted 30-60 minutes and was held at the participant's home after s/he provided her/his consent. The complete (translated) interview guide is available in the Appendix 2. The fieldwork was conducted by the main investigator (CZ), who is a Peruvian female with introductory knowledge of the Shawi language, and facilitated by a bilingual (Shawi -Spanish) male Shawi interpreter who was previously trained.

Semi-structured interviews were conducted orally with participants directly in the local language, Shawi. Responses were recorded when participants agreed. When recording was not possible, simultaneous translation to Spanish was combined with note-taking. Extensive field notes were collected during the interview in order to register information, non-verbal observations, and to triangulate with translations, including emotional expressions and to identify emerging topics that required further exploration (Gatrell and Elliott, 2014). Qualitative data were transcribed and examined using thematic analysis (Miles et al., 2013). We conceptualized the experiences of households and individuals sharing social and cultural characteristics across four core dimensions of food security (availability, access, utilization and stability) (Jones et al., 2013). We also considered *a posteriori* inductive themes that emerged during field work and/or coding, using an exploratory approach on the ground in order to identify local Indigenous perspectives (Johnson and Onwuegbuzie, 2004). Additional themes that emerged through this initial analysis (e.g., diet and substitution) were then applied to the transcripts for a second analysis. In a third stage, data were analyzed seeking perspectives on cultural food security elements (e.g., sharing

food) and acceptability of food and social programs. Qualitative themes were compared with quantitative data, seeking to corroborate, compare or contrast, and triangulate results (Johnson and Onwuegbuzie, 2004). Finally, member checking was applied during a posterior visit for results dissemination on Dec 2015 with the authorities of communities and community members (Miles et al., 2013, Baxter and Eyles, 1997).

4.5.3 Ethics

This research was approved by the McGill University Research Ethics Board in Montreal, Canada and the Institutional Ethics Committee at Universidad Peruana Cayetano Heredia in Lima, Peru, and built upon previous work in the region on the ethics of community engagement in research (Sherman et al., 2012). Informed consent was acquired from authorities in each community, individuals, and from both parents in the case of children. Prior to field work, extensive consultation with Indigenous community authorities was conducted to confirm community consent and to clarify investigation benefits and compensation for participation, as well as appropriate procedures for informed consent and ethical research practices within the local.

4.6 Results

4.6.1 Household characteristics

The head of the household was most often reported as the father (88.0%). Most caregivers reported living in a long-term relationship, although single parents were also present (11%). On average, households had 5.7 members (95% CI: 5.4-6.1), 1.8 children $\leq$5 years (95% CI: 1.6-1.9), and 1.7 children 6-11 years (95% CI: 1.6-1.8). Farming the land and rising animals − mainly chickens − were practiced among almost all (>95%) households (Table 4-1).

4.6.1 Diet: food preferences and substitution

Shawi community members indicated in qualitative interviews that a "good" traditional diet contains either meat or fish. One male participant expressed this cultural food preference: "*In first place is bushmeat, second fish; if I cannot find bushmeat or fish, then I look for suri caterpillars or heart palm" (male, AA025).* The analysis of food consumed the day before the interview indicated that households accessed a diet predominantly based on starchy vegetables such as plantain, cassava or rice (Figure 4-2). Access to proteins from animal sources was low and varied throughout the day. For example, animal sourced foods were predominantly consumed at breakfast: 60% (106/176) of households accessed animal sourced food for breakfast compared to only 14.2% (25/176) at lunch and 16.0% (28/176) for dinner (Figure 4-2a, 4-2b and 4-2c). Fish represented the most frequently consumed animal food, with bushmeat (typically small mammals) also part of the diet. Other animal sources — including chicken, canned fish, eggs and milk — were consumed by a few families.

Table 4-1 Characteristics of Shawi household with children ≤5y

	N (%)	Estimate (95% CI)
About the head of the household		
Sex (n=177)		
Male	156 (88.1)	
Female	21 (11.9)	
Family role (n=177)		
Father	152 (85.9)	
Mother	19 (10.7)	
Grandfather	3 (1.7)	
Grandmother	2 (1.1)	
Other member of the family (e.g. aunt or uncle)	1 (1.1)	
Marital status (n=177)		
Single/widow/widower	20 (11.3)	
Long-term relationship (married, cohabiting partner)	157 (88.7)	
Age (years, mean) (n=177)		34.4 (32.9 - 35.9)
Household size		
Mean number of household members (n=177)		5.7 (5.4 - 6.1)
Adults (n=170)		2.3 (2.1 - 2.4)
Children ≤ 5 years (n=168)		1.8 (1.6 - 1.9)
Children 6-11 years (n=121)		1.7 (1.6 - 1.8)
Household activities related to food production		
Household currently raises animals (n=172)	166 (96.5)	
Household currently raises chickens (n=164)	156 (95.1)	
Household currently raises ducks (n=170)	44 (25.9)	
Household currently raises pigs (n=174)	46 (26.4)	
Household currently raises cows (n=175)	34 (19.4)	
Household farms land? (n=176)	176 (100.0)	

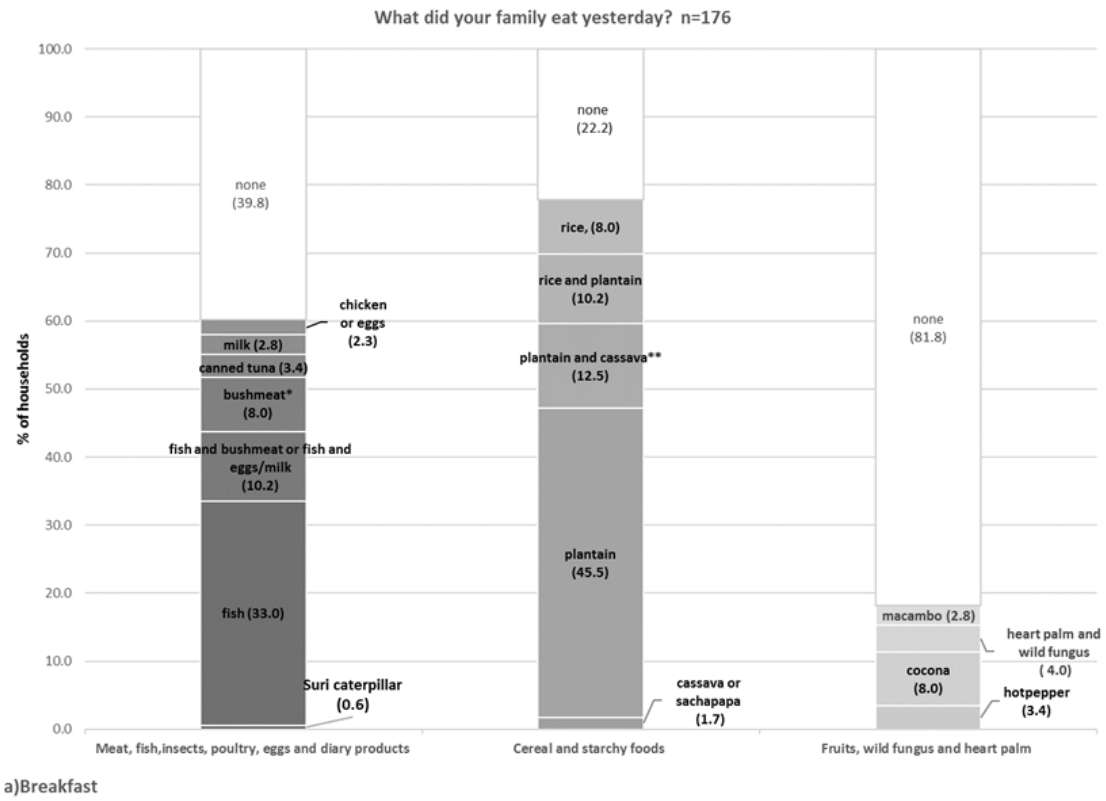


Figure 4-2 Diet the day before of the interview among Shawi households: a) breakfast

Note: *Bushmeat (deer, perdiz, peccary, paca, agouti), ** In addition to plantain and cassava four households declared consumption of bread and three household reported eating noodles. Masato beverage was not included in these figures.

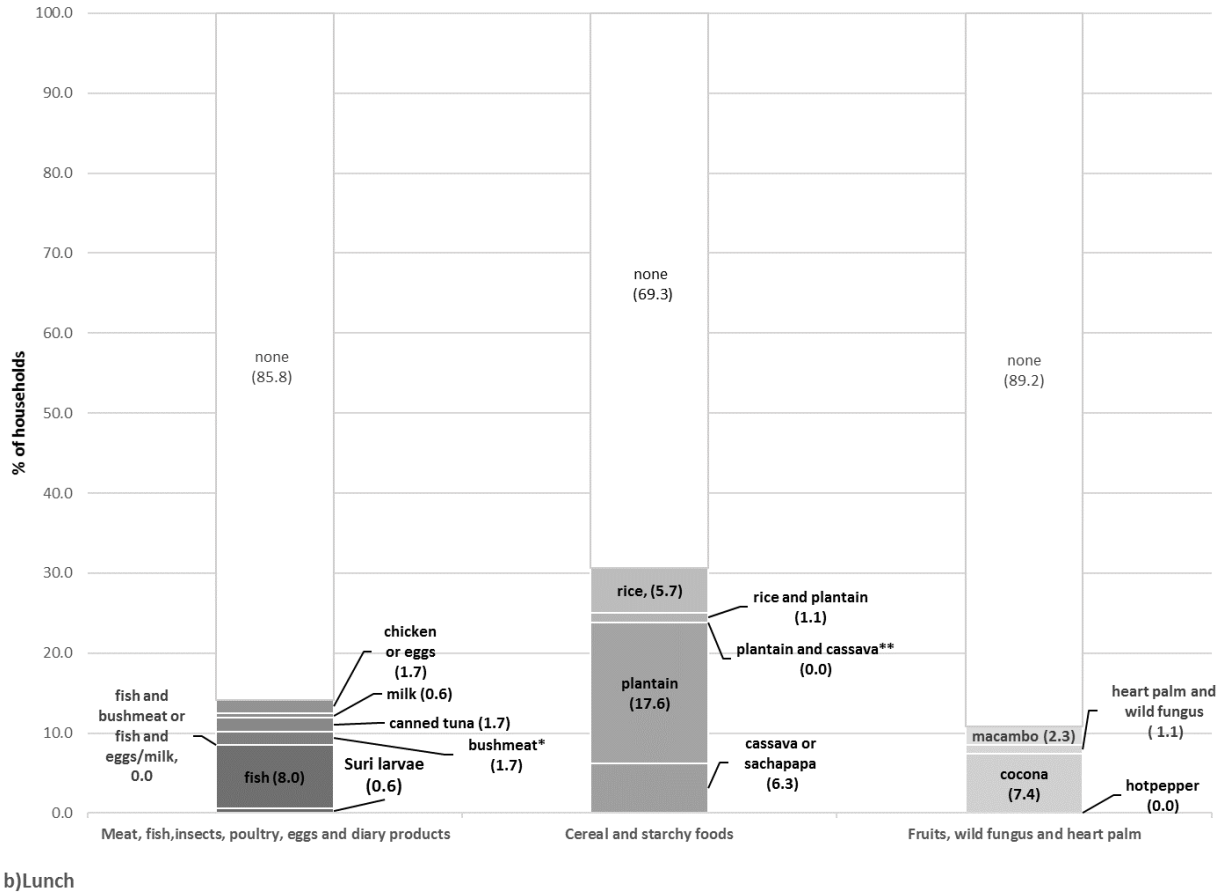


Figure 4-2. Continue b) lunch

Note: *Bushmeat (deer, perdiz, peccary, paca, agouti), ** In addition to plantain and cassava four households declared consumption of bread and three household reported eating noodles. Masato beverage was not included in these figures.

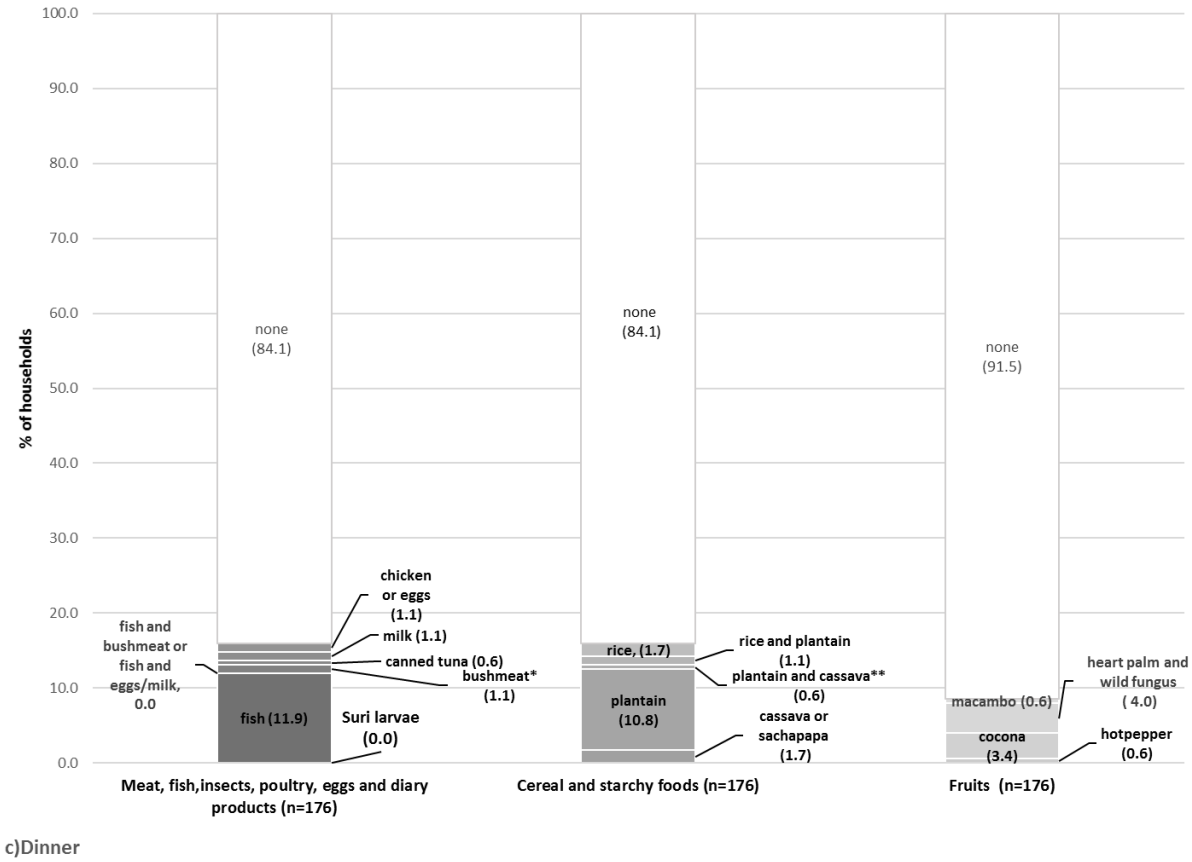


Figure 4-2. Continue c) Dinner

Note: *Bushmeat (deer, perdiz, peccary, paca, agouti), ** In addition to plantain and cassava four households declared consumption of bread and three household reported eating noodles. Masato beverage was not included in these figures.

Key informants also clarified that even when they receive food from donations —such as canned fish or milk — they preferred food from the forest, preferably fresh meat and fish; one women stated: *"there is not good or bad food, but everything coming from the forest is good" (female, AA028).* Lack of access to preferred animal protein thus represents an important cultural characteristic of food insecurity among Shawi families, and access to the land and local resources were considered critical in this context. A key informant emphasized: "*for us go to the forest is like for non-Shawi people go to market to obtain food" (male, AA030).*

Even when households reported accessing preferred animal sourced foods, qualitative interviewees noted that quantities were not sufficient to satisfy the entire household's needs. According to elder informants, food was "*abundant*" in the past ("*Bushmeat and big fish*"), and sufficient for three meals per day. They now report having only one or maximum two meals per day, and more than half of households report not eating at all or only consuming *masato* for lunch or dinner (Table 4-2). Participants reported that *masato* — a traditional beverage based on cassava — was consumed to calm hunger, particularly at lunch and dinner times. Moreover, difficulties in accessing animal foods is considered particularly problematic for elders, who depend on relatives to access food for them. One female elder noted: *"when my son finds something to eat in the forest, either fish or meat, he invites me to eat, or sends a little piece for me, but sometimes there is not enough for me" (female, AA013).*

Table 4-2. Meal frequency the day before of the interview among Shawi households (N=176)

	Breakfast	**Lunch**	**Dinner**
	n (%)	**n (%)**	**n (%)**
Other foods[1]	161 (91.5)	75 (42.6)	44 (25.0)
Only *masato*[2]	12 (6.8)	33 (18.8)	42 (23.9)
Nothing	3 (1.7)	68 (38.6)	90 (51.1)

[1] either animal food, grains, starchy vegetables or fruits

[2] traditional beverage based on cassava

Substitution of food is a frequent mechanism used by Shawi households to cope with food availability constraints. Key informants reported that under extreme lack of food, they replaced preferred foods or *"nuya kusharu"* with less preferable foods or *"ku yainwe kusharu."* Given an absence of game and fish, for example, people seek to increase their consumption of plantain and cassava; both are local crops harvested throughout the year, and are high in carbohydrates but limited in proteins. One informant declared: "*These days, there is nothing, but there are still some small fish, but little ones, that's what we eat. But when there are not [fish], we look for cassava, plantain; and also eat that, with some cocona and salt" (females, AA020).* Rice, a good source of carbohydrates but not of protein, is favored among adults and children, and frequently replaces foods rich in proteins. One key informant mentioned:

> "*We are worried about what will we eat. Where will we find food? There are not animals as there were in the past. What are we going to do? There is nothing. Then planting rice, at least that, for eating" (male, AA022).*

Decreasing availability of food in traditional hunting grounds was often reported by participants as a phenomenon taking place over years (generations), although adverse periods for accessing food through the year were also identified. Wet season, prolonged health illnesses, time to clear the land for planting, and mothers postpartum were identified as critical times of food access difficulty. It is a cultural tradition among the Shawi, for example, for both parents to stay at home for one month after birth to attend to a newborn child, making the postpartum period a difficult time for household food acquisition

4.6.2 Local resources and food sharing

Preferred food types are sourced almost exclusively from local resources. The majority of the bushmeat and fish eaten by households comes from local resources: 60.0% (18/30) of bushmeat

are sourced from hunting in the forest, for example, and 70.5% (66/95) of fish are accessed from fishing in rivers (Figure 4-5). Family sharing networks are also an important source of food in the case of bushmeat (40.0%), and to a lesser extent fish (10.5%) and plantain or cassava (9.7%). Bushmeat is exclusively hunted or shared, while there is some local purchase of fish (18.9%). In contrast, foods provided by food programs were consistently non-preferred food. Food programs most frequently provided rice, milk, and oil. According to key informants, preferred foods, specifically bushmeat and fresh fish, were never received via food aid programs. Rice, canned fish, milk and noodles were available for purchase.

During times of very low food security, particularly related to difficulty in sourcing bushmeat or fish locally, key informants mentioned that traditional Shawi society uses food sharing as one strategy to maximize availability and access to preferred foods. Key informants explained that sharing food is a traditional Shawi practice, typically by sharing game or fish. According to key informants, ill feelings such as "*meanness*" are associated with families who do not share food. Quantitative data confirm that shared food was predominantly comprised of preferred food sources, including protein sources such as bushmeat or fish (Figure 4-3).

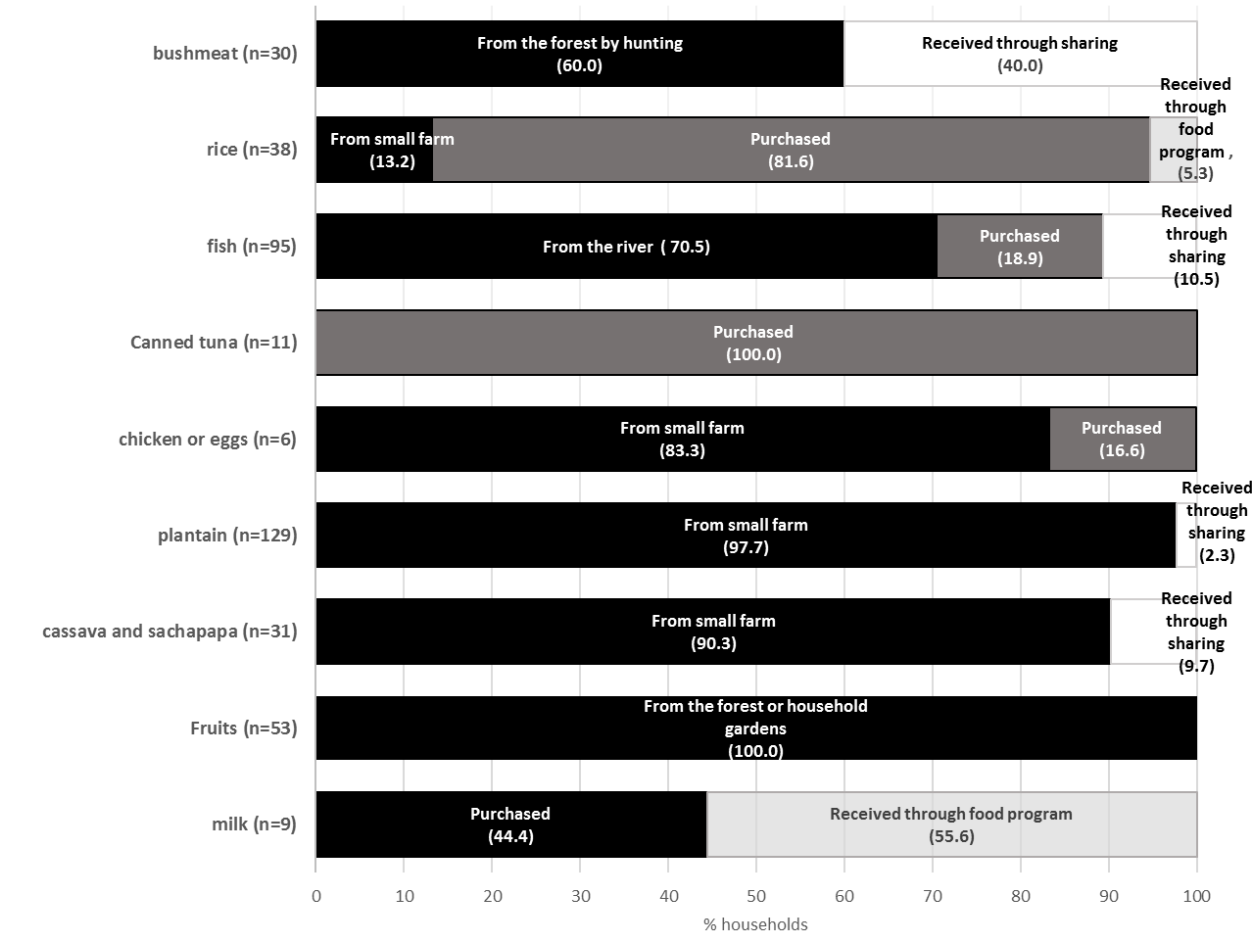


Figure 4-3 How households obtained the food they ate the day before of the interview

One participant noted: *"when we find a big animal, we share with our brother and his family, this is our custom. The same when he finds a big amount of fish; he shares with us. That is how we Shawi eat" (male, AA021).* Key informants clarified that they did not share purchased foods or small catches of fish or game. Data presented in Figure 3 corroborate that neither rice, canned fish, eggs, nor milk consumed the day before were obtained by sharing.

Qualitative data also indicate that sharing of preferable food is a mechanism to provide food to people who cannot access preferred foods themselves. For example, key informants noted that single mothers count on male relatives to access bushmeat. According to key informants,

provision of food is associated with differential gender roles, whereby hunting is reserved for men, while crop production and fishing are practiced by both women and men. Consequently, for single mothers, access to bushmeat depends on a male relative such as brother, father or older son to share meat; women will typically share cassava or plantain in exchange.

During data collection, we observed that sharing food is also an intra-household practice, where male and female adult members eat separately, sharing a single plate of food each group. Usually fathers share their plate with youth and other male adults; similarly, mothers share their plate with youth and other female adults, although children of both sexes eat with their mother. One key informant pointed out, *"It is same within women, one single plate [meat or fish] to share, with children as well, their mother feed them, sometimes, when more food is available, mother gives a separate plate to child to eat next to her" (male, AA021).*

Sharing foods also plays an important role in traditional and cultural community relations, including collective opening new plots in the forest for cropping where often starchy food are cultivated. During events when a household requires substantial labour, such as building a house or cultivating a large agricultural plot in short period of time, community members reserve preferred foods such as bushmeat or fish to feed relatives in exchange for labour; this is referred to in Shawi as *Mairesu*. One key informant indicated *"I store some fish to invite people to do my Mairesu, where I will cultivate my land" (women, AA020).* Consequently, sharing mechanisms using preferred traditional foods affect the availability of replacement foods as well.

4.6.3 Household external food support

Food aid was received by 74.5% (120/161) of households: 11.8% (19/161) received food at school, while 80.8% (139/172) obtained financial aid from the government (Table 4-3). Regular remittances (economic or food support) from relatives working in another town were negligible

among Shawi households (1.1%). Participants identified *Vaso de leche* and *Qali Warma* as the dominant programs from which food aid was received. *Juntos* — and to a lesser extent *Pension 65* — were the main sources of financial aid. Key informants reported that sometimes food and financial aid were not received on a regular basis, except *Qali Warma,* where food is received during school terms only. Twelve percent of households receiving food aid from *Vaso de leche*, for example, received their last food support two months prior to our survey (May or April). Similarly, 14% of households receiving financial aid last received money two months prior to the survey (May or April) (Table 4-3).

4.6.4 Indigenous perspectives on national food programs

Key informants indicated that food from the *Vaso de leche* and *Qali Warma* programs were welcomed in the communities given the high level of food insecurity. However, communities reported concerns related to both the *quantity* and *quality* of food distributed. Teachers reported that their sector was assigned by *Qali Warma* to receive one meal per day at school. Teachers reported during interviews that they felt the Shawi communities in this sector had been misclassified as more food secure than they actually were, with children in need of *Qali Warma* support twice per day. Teachers indicated that the key contention for this (mis)classification relates to reporting in the last census of ownership of domestic animals among households. They noted that the original census lacked cultural context in understanding local food and livestock systems. According to qualitative interviews, domestic animals are reserved for feeding families predominantly during extreme circumstances, for example, when constant or heavy rain prevents them from accessing their gardens or the forest, if they need to feed more people than usual (e.g., a family celebration), and for selling to access cash. One mother reported that she was raising chicken "*to sell, and to kill it, when there is nothing to eat, as in winter. I cannot leave to the*

forest to look for fish because there is a lot of rain (female, AA027)". Moreover, Shawi authorities reported that even when they habitually raise multiple animals, it did not mean that they are "*rich*"; for example, they explained that most of the animals are young and very few reach adulthood when owners are able to eat or sell them.

Teachers reported that *Qali Warma* food aid was insufficient to feed all children in each family since amounts are based only on the number school-aged children. As noted by a teacher:

> "*...when we serve [Qali Warma] breakfast, it is not only for our children, it is also for their little [not yet school-aged] siblings; therefore, each portion gets reduced, and there is not enough for everyone (teacher, BB015)."*

In addition to these concerns regarding the *amount* of food provided, households highlighted food programs did not supply *preferred* food sources, specifically bushmeat or fish; most of the food received was predominately milk (power or canned), canned fish, and rice (Table 4-3). Community participants indicated a desire for donated food, either *Qali Warma* or *Vaso de Leche*, to include preferred food types — fresh fish was suggested most frequently — or increase the amount of other protein sources such as eggs, beans, or fresh food such as chicken or even pork. One respondent reported that pork had a flavour similar to local bushmeat.

Table 4-3. External support among Shawi household with children ≤5y

	N (%)
Household have family members or friends working in another town or country who regularly send products or money (n=177)	2 (1.1)
Household receive food from Municipality (*Vaso de leche* program) (n=161)	120 (74.5)
What kind of food is received? (n=115)	
Power or canned milk / milk plus cereal	112 (97.4)
Milk plus other rich protein source (canned fish or beans)	3 (2.6)
When did you last receive food? (n=107)	
Sporadically	6 (5.6)
Same month of the survey	36 (33.6)
One month before the survey	52 (48.6)
Two months before the survey	13 (12.2)
Household have any member who receive food at school (*Qali Warma* program) (n=161)	19 (11.8)
What kind of food is received? (n=17)	
Power or canned milk / milk plus cereal	0 (0.0)
Milk plus other protein source (canned fish or beans)	17 (100.0)
When did you last receive food? (n=18)	
Sporadically	0 (0.0)
Same month of the survey	18 (100.0)
One month before the survey	0 (0.0)
Two months before the survey	0 (0.0)
Household have family member who received any economic support from the government, any programs or institutions (n=172)	139 (80.8)
From whom? (n=139)	
Juntos	138 (99.0)
Juntos & Pension 65	1 (1.0)
When did you last receive economic support (n=138)	
Sporadically	0 (0.0)
Same month of the survey	11 (8.0)
One month before the survey	108 (78.3)
Two months before the survey	19 (13.8)

Attending school to access food aid was reported as an important barrier to accessing *Qali Warma* support in the remote context of the Shawi communities we surveyed. Since *Qali Warma* is a school feeding program, school-aged children must attend school in order to access donated

food. Respondents in qualitative interviews reported, however, that long travel distances to schools and intense rain influence the ability of children to consistently attend school. Notably, our survey was conducted among the 11 most accessible communities in our study area, and thus underrepresents the most remote communities where access to school is presumably more difficult. Moreover, since *Qali Warma* is implemented as a national school program, it functions during school terms only (mid-March to December). Key informants confirmed that from January to March and during school/education sector strikes, *Qali Warma* is non-functioning, and consequently children do not receive food from the program.

Exposure to new food sources (e.g. from *Vaso de leche* food program donations) has triggered community concern and curiosity regarding the use and preparation of unfamiliar foodstuffs. In general, processed foods are met with skepticism since they are of unknown and unfamiliar origin, and Shawi households have limited information or experience in their preparation. Key informants reported, for example, that they are not informed about the correct proportions for young children when preparing reconstituted canned or powdered milk. Since the information is normally labelled in writing and in Spanish, high levels of illiteracy limit the capacity of households to read and interpret labels and instructions on processed food. Although milk was perceived as more acceptable for children, key informants reported that canned fish is perceived as less convenient. Participants reported that once a can is open the fish does not stay good for a long time, several interviewees reported that children experienced skin reactions, and people are unfamiliar and distrustful regarding the preparation and use of canned food in general. One participant noted:

> "*For me, canned fish is not good. People are saying things like 'it is horse meat'… it could be even human meat, better no for me. About milk, people say it is dog milk. Since*

we do not see how [canned fish and milk] were made, we think many things… This is why sometimes we reject this new food (female, AA022)

The second most frequent external aid program relevant to improving food security is *Juntos,* which provides economic support (Table 4- 3). According to key informants, families have received financial aid from *Juntos* since approximately 2009. Currently, they received S/200.00 ($60.00 US) every other month, as long as their children attend the health post and school regularly. Key informants reported being satisfied with this financial aid, but did not identify food as the only priority expense, and reported that *Juntos* support was not adjusted for the number of children in the household:

"*When my wife received Juntos, she had 200 hundred soles, but she has five children: forty soles per kid is not enough. We have to buy school supplies, a backpack costs 30 soles plus other cloths, it is not enough (male, AA030)".*

Informants consistently reported that money from *Juntos* was also used to buy supplies to source preferred foods such as bushmeat and fish, including bullets, batteries and flashlights for hunting. One single mother reported: "*With the money, I bought cloth for my newborn, also batteries and bullets to give to my brother for getting food" (female, AA028).* In addition, one key informant expresses his concern about the use of *Juntos* money to buy other things such as alcohol *"People go to receive Juntos bringing a container to buy 'trago' [sugar cane alcohol], what will remain for their food?" (male, AA014).*

Community members frequently reported anxiety related to meeting *Juntos* eligibility obligations. Since not all communities have their own school, and houses are frequently highly dispersed in the forest, children must walk considerable distances every day to attend school.

Parents report that some children must cross streams or a river, which they identified as particularly dangerous for small children. One female key informant reported:

> "*This month, I got suspended from Juntos. I must go to Yurimaguas to solve it. It is the second time that I got suspended. The first time was because my child did not go to school. It is because we live far from school. My child must walk too much (~45 minutes) every day to go to school, there are other kids who live even farther than that. This time I do not know why I got suspended" (female, AA028).*

Key informants have explained that they choose to live in dispersed locations as a traditional cultural practice of respecting the privacy of neighbouring families. For example, one female informant noted: *"I live here [distant ~30 min from the community center] for eating quietly and to raise my chickens freely without disturbing my neighbors (female, AA020)*. Parents also reported that meeting the requirement of attending health check-ups was constrained by health sector strikes. During the time this research was done, both the education and health sectors were on strike, with the consequence that parents were unable to take their children to complete their vaccinations and check-ups.

Literacy, language, and communication culture were also reported as barriers to Shawi households benefiting fully from external cash support such as *Juntos* and also *Pension 65*. The Shawi speak their traditional Indigenous language, called "*Camponan"* which is translated locally as *"our language"* and frequently do not (or prefer not) speak Spanish. Additionally, communication among the Shawi is oral; reading skills and knowledge of Spanish are thus low, particularly among women and elders. In the case of *Juntos,* for example, women who do not know how to buy in Spanish are forced to give the money to male relatives to buy goods in the

city. Participants suggested that incorporating staff with a working knowledge of the Shawi language, would improve access to aid programs.

4.7 Discussion

Our results show that Shawi participants prefer a diet based on local animals and rich in protein, such as bushmeat and fish (Box 4-1). Despite these food preferences, almost one third of households did not eat any kind of animal protein the previous day, and improving access to local or familiar protein sources was a high priority among Shawi. A diet based on animal protein, local crops such as cassava and plantain, as well as wild food, including insects and fruits, is typical among many Indigenous populations in the Amazon region, inside and outside of Peru (Dufour, 1991; Da Silva and Begossi, 2009; Huamán-Espino and Valladares, 2006).

Recent reports document rapid changes in Amazonian diets, favoring a shift away from local traditional foods toward more energy dense and processed food (van Vliet et al., 2015); this has been termed the 'nutrition transition' in some Indigenous contexts (Kuhnlein et al., 2004; Damman et al., 2008). This transition is occurring despite growing research recognizing and documenting the nutritional value of traditional Amazon diets (Roche et al., 2008, Dufour et al., 2016). Shifting diets away from traditional sources has been attributed to easier geographical access to urban areas and associated markets, an increasing availability of cash income and participation in the cash economy, the role of governmental aid programs, and environmental-change mediated food availability (Nardoto et al., 2011; de Jesus Silva et al., 2016; Piperata et al., 2011a)

Summary of key points

1. Shawi households prefer locally-sourced foods, particularly bushmeat and fish.
2. Traditional foods, particularly bushmeat, play an important role in Indigenous culture and sharing networks.
3. When local protein sources are not available, households substitute with starchy vegetables high in carbohydrates but limited in proteins.
4. National food programs predominantly provide food types inconsistent with Shawi dietary preferences, and the availability and amount of food is insufficient.
5. In particularly remote Shawi households, children are often unable to access school during the rainy season, and are thus excluded from access to *Juntos* eligibility requirements.
6. Children do not receive *Qali Warma* food support out of school terms or during frequent teacher strikes.
7. Shawi report frequently discarding foods supplied by national food programs since they have difficulty preparing unfamiliar processed foods, they are uncomfortable with foods of unknown or unfamiliar origin, or cannot read documentation/instructions.
8. Many Shawi cannot access or understand *Juntos* documentation since it is available only in Spanish.

Box 4-1 Summary of key points

Early investigations with non-Indigenous populations have reported that households substitute with lower quality foods as a common coping mechanism in times of food insecurity (Bickel et al., 2000). Shawi participants replaced their primary preference of food sourced from animal protein with consumption of starchy vegetables when animal proteins were not available. This indicates Shawi consideration of animal sourced (and locally sourced, fresh) foods as a higher *quality* food. Few households included processed foods as substantial contributions to their diet. The remoteness of Shawi communities limits access to large markets and government services, and has likely constrained the rapid transition to increased consumption of processed food sources that has been documented elsewhere in the Amazon (Dufour et al., 2016; Murrieta et al., 2008). Longitudinal studies would be necessary, however, to investigate temporal changes in

Shawi diet and to understand how governmental programs have impacted traditional diets, food security and nutritional outcomes over time. Research elsewhere in the Amazon has found, for example, that even where Indigenous women received cash transfers over seven years, they did not increase their dietary diversity; their proportion of purchased food increased, and there was no documented increase in their food security (Piperata et al., 2011a). In-depth analysis of temporal and seasonal trends in Shawi food security and access to traditional foods was beyond the scope of this paper, but is the focus of a separate, complementary paper by our team.

Sharing food is an important cultural and practical coping mechanism among Shawi, promoting consumption of preferred foods and social support networks. Sharing of food among Shawi plays three key roles: increasing availability and access to preferred foods; community and familial support for vulnerable individuals who cannot practice hunting, such as elders and single mothers; and cultural initiation of, and compensation for, work projects requiring communal labour. Sharing food among Indigenous peoples in the Amazon has been extensively documented (Welch, 2014; Yuyama et al., 2008; Murrieta et al., 2008; Gurven et al., 2000). Among the Shipibo of the Peruvian Amazon, for example, sharing food represents a traditional adaptation to maintain food security during hard economic periods or during extreme environmental circumstances (Sherman et al., 2015). Given that Shawi communities in this study share mainly protein-dense food, our results point to nutritive value attached to this type of coping mechanism. Others have highlighted the role traditional food sharing may play in moderating rates of ill-health within communities; for example, increases in chronic conditions such as overweight and obesity have been documented with, and in some cases assumed to be

attributed to, rapid economic development among Indigenous communities, though this has not been causally validated (Welch et al., 2009b; Brabec et al., 2007).

Aid provided by national programs is an important mechanism complementing Shawi diet and food systems. High levels of malnutrition and food insecurity (See Chapter Three in this thesis) indicate, however, that existing food systems and external national programs are insufficient in both quality and quantity in Shawi communities. Our results point to constraints and opportunities to the acceptability and efficacy of governmental social and food programs. A common thread across these results is a general failure to recognize, value, and integrate consideration of traditional food systems and cultural norms into programming. Within existing programs, this undermines the operability, efficacy, and indeed ethicality of food and social programs in Peru. In this context, we have proposed practical recommendations to inform a review of, and revision to, national food programming (Box 4-2).

4.7.1 To evaluate programs to identify why high vulnerable households are not receiving aid

All households in this study had children under 5 years old, and should thus be theoretically eligible to received *Juntos* cash and *Vaso de leche* food support. Despite this, approximately one fifth of households reported that they did not have access to these programs. Additionally, despite the *Vaso de leche* directive that food should be delivered on a daily basis, over 60% of participating households reported last receiving aid 1-2 months prior to our visit. We recommend that social and national food programs be evaluated to identify critical constraints to eligibility and receipt of aid, specifically in the context of households and communities that are highly vulnerable and theoretically eligible, particularly remote Indigenous communities. The use of domestic animal ownership as a core metric for regional eligibility remains contentious, for

example, and has not been validated as reflective of regional variations in food insecurity and malnutrition. Metrics of food insecurity and high seasonal scarcity provide alternatives to inform regional rankings for national support. Indeed, the use of household-level food security measures has been suggested within Peru to improve national social programing, including *Juntos*, and particularly in the context of remote populations reliable on subsistence food sources (Ministerio de Desarrollo e Inclusión Social, 2012). Review of aid programs should herein include as a priority: a) verification of the frequency of cash or food distribution, b) review of regional food security classifications in Indigenous communities, and c) identification and review of common constraints to program access within in the context of remote communities and Indigenous culture (e.g. language of communication).

Recommendations for national food programming among Indigenous Amazonian communities in Peru

***Vaso de leche* food program**

1. Monitoring activities to detect eligible households who are not receiving aid, and verification of frequency of food distribution to assure eligible households receive aid on regular basis.
2. Include provision of local or preferred foods within food programs in Shawi communities. Bushmeat or fish should be a primary option, with other protein sources such as eggs, insects, or fresh food (chicken or pig) as secondary alternatives. Nutritional value of local plant food should also be considered for incorporation into food programing.

Qali Warma school feeding program

1. Review classification of food insecurity needs in Indigenous Amazonian sectors, particularly related to reliance on poultry and livestock census data.
2. Include provision of local or preferred foods within food programs in Shawi communities. Bushmeat or fish should be a primary option, with other protein sources such as eggs, insects, or fresh food (chicken or pig) as secondary alternatives. Nutritional value of local plant food should also be considered for incorporation into food programing.
3. If processed food is provided, include provision of visual or oral explanations for its origin, use, and preparation. For example, by working with Shawi communities to develop training in food preparation, and by developing locally-acceptable recipes with food sources available through national programming.
4. Avoid use of written Spanish as a source of information for foods provided to remote Shawi households.
5. Extend provision of *Qaliwarma* services to include months outside of school terms (January to mid-March).
6. Develop contingency plans for highly vulnerable communities to access food support during school or education sector strikes.

Box 4-2: Recommendations for national food programming

Recommendations for national food programming among Indigenous Amazonian communities in Peru

***Juntos* economic support:**

1. Increase monitoring activities to detect eligible households who are not receiving aid.
2. Distribute *Juntos* funds via staff with working knowledge of Shawi (or appropriate local language), or provide visually- or orally-accessible documentation.
3. Revisit and revise requirements for school attendance in remote Indigenous populations, for example through exemptions to this requirement for children living long distances from school or during the rainy season. To consider a home tutor for children living far from schools
4. Provide exemption consideration for households unable to fulfill health check-up requirements due to health sector strikes.

Box 4-2. Continue

4.7.2 Improve nutritional quality of distributed food:

Given the high rates of chronic malnutrition and anemia documented among Shawi children and their primary female caregivers (See Chapter Three) and similar health gradients reported among other Indigenous peoples in the Peruvian Amazonia (Díaz et al., 2015; Salud Sin Limites Peru and Health Poverty Action, 2012) ─ Peruvian national food programming should evaluate the nutritive contribution of distributed foods within the context of existing (and shifting) traditional diets. Even where over-nutrition rates remain below national levels, information from other Indigenous contexts suggest that rapid transition of diets towards less traditional foods (Uauy et al., 2001, Urlacher et al., 2016) represents a real risk of a double-burden of malnutrition (concurrent undernutrition and over-nutrition) in Amazonia communities; this has already been reported elsewhere (Piperata et al., 2011b, Port Lourenço et al., 2008), and is in the early stages in Peru (Romero et al., 2014). Close coordination of national food programs with

public health authorities will be critical to prevent emergence of similar rates of nutrition-related chronic disease among Indigenous food program recipients, as has been already reported among non-Indigenous peoples in Peru (Chaparro et al., 2014).

4.7.3 Provide more culturally-appropriate food sources for Indigenous traditional contexts

The Peruvian National Food Security Strategy formally recognizes the importance of traditional preferences and diet of recipients (Comisión multisectorial de seguridad alimentaria y nutricional-Peru, 2013). Our results indicate, however, a disconnect between traditional and preferred foods and those distributed by national food support, which is a critical constraint to the success of programming. Among Indigenous Shawi, inclusion of bushmeat and fresh fish would increase provision of proteins from preferred sources and cultural acceptability/ access. Giving their nutritional contribution to young children, an increasing provision of traditional animal sources (e.g. fish and *suri*) has been previously recommended for Awuajun communities in the Peruvian Amazon (Roche et al., 2011). Chicken and pig are potential alternative food sources that could be incorporated into food provision. Consideration of risks associated with new food sources will be necessary, however; Cysticercosis infection, for example, has been associated with pig farming elsewhere in Peru (García et al., 2003). Existing local initiatives that recognize and value traditional food systems are already in-place and provide opportunities for collaboration or cross-fertilization of new approaches; a Shawi fish farming cooperative, for example, has been developed to allow Shawi farmers to sell fish to the local municipality food program (Richmond and Ross, 2009). Improved coordination and collaboration with national food programs to ensure competitive prices for local producers would improve local employment and provision of locally-acceptable protein sources (*Terranova* representative, personal communication). Inclusion of other plant-based foods would also be appropriate in this context

given that plantain, cassava, and local fruits are well accepted among many Indigenous Amazonian peoples in general, and the Shawi in particular.

Support for bushmeat provision into national food programming requires caution and consideration within the context of environmental sustainability. Financial support from *Juntos*, for example, is reportedly used to buy supplies for hunting food in the forest. Given the local Shawi preference for bushmeat, its value as a protein-rich food source, and its role in food sharing, *Juntos* aid has the potential to favor and/or mobilize internal social capacity to promote food security. Sustainability of wild food sources is an important consideration, however, particularly in the context of rapid population growth and reports among Shawi communities of declining wild food resources. Sustainable pathways to ensure nutrition provision, culturally-appropriate food sources, and maintenance of wild food resources will require collaboration, and reflects a critical research and policy gap. Drawing on experiences in farming bushmeat in tropical areas, researchers have recommended, for example, the diversification of animal protein sources (e.g. including domestic animal rearing) in order to diminish pressure on wild sources (van Vliet, 2013).

4.7.4 Provide locally-adapted documentation and education for unfamiliar foods

Where unfamiliar and processed foods are included, success is predicated on programs providing support and educational mechanisms acceptable to communities. Community education on nutrition of local, purchased, and donated foods is appropriate and recommended, but must be developed with a culturally sensitive approach that recognizes and values complementarity with traditional Shawi food sources and systems (Penafiel et al., 2016). Visual

or oral information about origin, preparation and uses of external food is necessary given relatively low levels of literacy, particularly among women who are most likely to be in charge of household food preparation and distribution.

4.7.5 Inclusion of staff with local language proficiency

The use of Spanish in communication and documentation was perceived as a major barrier to communication and a sign of disrespect among communities. The *Juntos* program, for example, requires signatures on documentation in order to receive financial aid, and this is predicated on both parties ─ government representative and local participant ─ clearly understanding the agreement and having culturally and linguistically appropriate access to documentation. This is currently not the case for many Shawi, who have limited or no knowledge of Spanish, or who may have limited literacy. Training of local staff interpreters, for example, could improve access and transparency of program requirements for Shawi households, in particular to assist during information visits and distribution of financial aid. More generally, targeted hiring of Indigenous staff or training of non-Indigenous local works in local language proficiency would improve communication, program efficacy, and signify improved national recognition and respect for Indigenous traditions and language.

4.7.6 Review & revise requirements for school attendance in remote Indigenous

Geographical access to educative services, as well as seasonal weather conditions, should be integrated into the design of Peruvian food and cash aid programing. This might include more flexible exemptions to this requirement by, for example, allowing children living long distances from school to meet a lower requirement for school attendance, or for attendance requirements to

be modified during rainy days when conditions for school commuting are difficult. Options such as weekly boarding facilities at schools or mobile educational options should also be considered for feasibility and appropriateness. In addition, provision of school supplies such as backpacks and uniforms for all children of households participating in *Juntos* could decrease the proportion of money spent on school materials, as was reported by our participants. Allowing children to wear traditional clothing when attending school might be prudent to consider and assess via consultation with communities as a sign of cultural respect. In some cases, meeting the requirements of *Juntos* negates any additional financial gain after purchasing school supplies or paying for transportation, suggesting limited potential to impact food insecurity. In fact, implementation of conditionalities have been criticized for the risk of increased exclusion of vulnerable families, and for adding obligations to Indigenous households (Álvarez et al., 2006, Bastagli, 2009). A revision of current conditionalities among communities that experience geographical or social constraints to access distribution facilities is thus a high priority for programming. Colombia has, for example, explicitly adapted its cash transfer program, "*Families in action,*" to include Indigenous considerations, among these the remoteness of communities and local language and cultural differences. This was implemented, for example, through the election of an '*Indigenous mother'* in each community who acts as a facilitator for language or cultural communications, and in cases where these constrain fulfillment of obligations (Medellín and Sánchez Prada, 2015).

Adjustment of support provision to vary according to the number of children in a household would be an appropriate revision to aid programming, and has been integrated elsewhere for similar cash transfer programs in Latin America. The *Opportunities* program in Mexico, for

example, provided a monthly fixed health stipend plus additional educational stipends for each school aged child per household (Parker and Teruel, 2005).

4.8 Conclusion

Currently, national investment in nutrition programming is constrained by a disconnect between food provision and benefits to Indigenous nutrition, with mixed evidence of success in reducing malnutrition rates. Investment in more culturally-appropriate food sources and provision has the potential to increase the efficacy of food programming towards the goal of combating malnutrition and Indigenous health inequity in Peru. Local Indigenous perspectives will be critical in these discussions: our results demonstrate that nationally-developed programming that does not consider Indigenous and cultural contexts risks inefficiency, limited improvement of health outcomes, and the potential to increase inequities in Indigenous health. Consideration of Indigenous traditional diets and food systems is not only a health issue, but also a moral imperative to respond to and resolve historic and persistent Indigenous health inequities in Peru.

5 CHAPTER 5: INDIGENOUS FOOD SYSTEMS AND CLIMATE CHANGE ADAPTATION AMONG THE SHAWI OF THE PERUVIAN AMAZON

5.1 OVERVIEW

In this chapter, I characterize the Shawi food system more broadly to discuss the distal determinants that have not been substantively explored in previous chapters, including both the climatic and non-climatic distal determinants of food security. This chapter addresses Objective 3 of my thesis: *to characterize the Shawi food system and interactions between climatic and non-climatic determinants of Shawi food security*. In doing so, it responds to the overarching goal of my thesis, which is to assess the vulnerability of Shawi Indigenous people to food insecurity and to identify entry-points and opportunities for climate change adaptation interventions.

The previous two chapters presented baseline health data on prevalence and developed an understanding of key non-climatic drivers of Shawi food security. My first empirical chapter demonstrated that the Shawi already have very low food security, which represents a high sensitivity to climatic events, while my second chapter showed that households have implemented a series of coping strategies, and that cultural and social values are important determinants of Shawi food security. These previous chapters thus reflect a focus on the individual and household levels and, within a vulnerability approach, provide characterization of the sensitivity and adaptive capacity of the Shawi food system. In this final empirical chapter, I pull together these observations and add community-level characterization of food security and research on climatic events to synthesize insights on the vulnerability of Shawi food security to climate change. While some food systems characterizations are revisited in this chapter, they are

developed within a broader analysis that integrates climate change considerations and uses the lens of the vulnerability approach to synthesize key insights towards my overall thesis goal. Repetition of some content in this chapter also reflects the manuscript-style format of this thesis.

Proposed list of coauthors: Carol Zavaleta, Lea Berrang-Ford, James Ford, César Cárcamo, Elmer-Alejandro Llanos Cuentas, Nancy Ross and Sherilee L. Harper. "Indigenous food systems and climate change adaptation among the Shawi of the Peruvian Amazon". Carol Zavaleta was the primary author of the manuscript. She collected and transcribed the data, conduced analyses, interpreted results, and wrote the manuscript. Prof. Berrang-Ford and James Ford contributed to the conception of the paper, provided comments and edited the final version. Prof Sherilee Harper and Prof Nancy Ross provided intellectual feedback on the draft and edited the manuscript. Elmer-Alejandro Llanos Cuentas and César Cárcamo contributed with the conception and provided comments and edits to the manuscript.

5.2 Abstract

Climate change is affecting food systems globally, with implications for food security, nutrition, and the health of human populations. There are limited data characterizing the current and future consequences of climate change on local food systems for populations already experiencing poor nutritional indicators. Indigenous Amazonian populations have been reported to have high prevalence of nutritional deficiencies. This paper characterizes the food systems of the Shawi of the Peruvian Amazon and their vulnerability to climate change. We used a contextual vulnerability approach to characterize community food systems, to investigate climatic and non-climatic factors, and to identify proximal and distal drivers of Shawi food insecurity to climate

change. Semi-structured interviews with key informants, photovoice, transect walks, a food calendar exercise, and participant observation were conducted with two Shawi communities in the Balsapuerto District in the Peruvian Loreto region. The Shawi food system is based on three main food sub-systems (forest, farming and externally-sourced). Climate variability, population growth and educational desire were identified as key proximal drivers of Shawi food security vulnerability. Population recovery, exclusion of Shawi social norms, and institutions into the dominant Peruvian economic development trend are important distal drivers of Shawi vulnerability to climate change. Effective climate change adaptation measures must avoid erosion of local adaptive capacity, particularly in the context of high burden of malnutrition and food insecurity reported among Shawi participants.

5.3 Introduction

Climate change is affecting food systems globally, with implications for food security, nutrition and the health of human populations (Vermeulen et al., 2012; Porter et al., 2014). Despite a growing body of research characterizing climatic impacts on food systems, research has predominantly focused on the macro level scale (global or regional) and climate impacts on agriculture (Nelson et al., 2009; Vermeulen et al., 2012; Schmidhuber and Tubiello, 2007; Tubiello et al., 2007; Rosenzweig et al., 2014; Brown and Funk, 2008). Less is known about how human populations react to climatic impacts on food security at the local level, and how climate and weather interact with other drivers of health (Wheeler and Von Braun, 2013; Rosegrant and Cline, 2003; Thornton et al., 2014; Haines et al., 2006; Lloyd et al., 2011). The ways in which climate change risks impact food security and human nutrition are mediated by local food systems (Porter et al., 2014; Myers et al., 2017; Phalkey et al., 2015). These interactions will

differ across contexts and will be localized in nature, and provide an important entry point for informing adaptation options and responses to projected climate impacts.

Indigenous peoples are particularly sensitive to climate impacts on food (Keleman Saxena et al., 2016; Sherman et al., 2016; Kronik and Verner, 2010). Emerging research has documented the experiences of Indigenous peoples and their food systems in the context of climate variability and extreme events, highlighting the importance of concurrent cultural, social, and economic conditions that can undermine or support food security (Ford and Smit, 2004; Ford, 2009; Furgal and Seguin, 2006; Ford et al., 2013; Sherman et al., 2015). Despite a growth in such research, however, the majority of studies have been conducted among Indigenous populations in developed countries (Ford, 2012). Research among Indigenous Amazonian peoples is nascent and has been identified as an important gap, particularly to inform health-related climate change policies and climate-related health policy (Brondízio et al., 2016).

Changing climatic conditions have already been reported in Amazonia, affecting the food security of local populations, although consequences for Indigenous food systems are still unknown. Warming temperatures have been documented, with an average increase of 0.34C per decade recorded since 1980 (Jiménez-Muñoz et al., 2013) along with more frequent and intense hydrological events (Espinoza Villar et al., 2009, Marengo et al., 2012). In the Peruvian Amazon, increasing temperatures and more severe prolonged seasonal flooding and droughts are affecting agriculture and fisheries (Lavado Casimiro et al., 2013; Espinoza et al., 2012). For Peruvian Indigenous Amazonian populations, however, initial research has suggested that non-climatic drivers such as economic disadvantages and cultural marginalization are acting to magnify climatic impacts on food security (Hofmeijer et al., 2013, Sherman et al., 2015, Szlafsztein,

2014). Given that some Indigenous Amazonian populations have consistently worse nutritional outcomes compared to non-Indigenous populations in the region (Horta et al., 2013; Díaz et al., 2015; Benefice et al., 2006), climate change impacts on local food systems threaten to exacerbate health disparities. Yet this research is only nascent, and our understanding of how Indigenous Amazonian food systems interact with climatic and non-climatic changes to affect food security, nutrition, and ultimately health is limited.

We contribute to this research gap by characterizing the complex food system and interacting climatic and non-climatic determinants of food security within one Peruvian Indigenous Amazonian population ─ the Shawi ─ structuring our work using a vulnerability approach. In doing so, we seek to identify entry points and opportunities to inform local, regional, and national public health policy and promote adaptation of food systems in a changing climate.

5.4 Conceptual and methodological approach

5.4.1 Food security and food systems

Food security represents a state of complete physical and economic access to sufficient, safe and nutritious food that meets a person´s dietary needs and food preferences for an active and healthy life (Pinstrup-Andersen, 2009, Webb et al., 2006). *Food systems* are understood as a set of human activities to produce, process, distribute and consume food, and underpin the food security of human populations (Ericksen, 2008; Gregory et al., 2005; FAO, 2008a). Given the high reliance of Shawi livelihoods on natural resources (Huertas Castillo and Chanchari Lancha, 2011; Fuentes, 1988; Ormaeche and Barclay, 2008) and recognizing the importance of food systems, not only for nutrition but also for other health and socio-cultural components (Ericksen, 2008; Gregory et al., 2005), this paper focuses on how disruptions in any of the four key food security

components (e.g. availability, food access, utilization and stability) affect household and community food systems vulnerability to climate change, building upon studies completed by Ford (2009) and Sherman et al. (2015). Under this framework *availability* is driven by food production, exchange, or distribution. *Access* represents the ability to consume preferred food sources, and *utilization* refers to the quality and the social value that people give to their food. At the same time, these food security components need to be *stable* over time to assure food security (FAO, 2008a). For example: food might be available but may not satisfy cultural preferences; food could be available and culturally acceptable but not necessarily cover individual nutritional needs, or; food could cover nutritional needs and be cultural acceptable, yet availability over the year is not guaranteed.

5.4.2 Vulnerability approach

We structure our research using a 'vulnerability approach,' common in the natural hazards and human dimensions of climate change scholarship (McDowell et al., 2016; Jurgilevich et al., 2017; Rasanen et al., 2016). This approach focuses on how various climatic and non-climatic factors interact to affect how people experience and respond to climate change (O'Brien et al., 2007). Various disciplines have contributed to the evolution of vulnerability research, and this approach has been used by public health researchers to investigate climate-sensitive health outcomes, to prioritize vulnerable populations, and to evaluate adaptation options (Ebi et al., 2006a, Sari Kovats et al., 2003).

Vulnerability can be defined as "the propensity or predisposition to be adversely affected" by the occurrence of climate change impacts (Field et al., 2014), and comprises three main dimensions: exposure, sensitivity, and adaptive capacity (Adger, 2006, Ford and Smit, 2004). Exposure

captures the nature of the climatic risk affecting the system of interest, in this case the Shawi food system. Sensitivity encompasses the characteristics of the food system that mediate climatic effects (currently or potentially) and reflects non-climatic drivers of health, such as socioeconomic conditions and existing health gradients. Adaptive capacity represents the ability, resources, behaviours or any other function of the food system that helps people respond to exposures and minimize impacts (Ford et al., 2006). Adaptive capacity, exposure, and sensitivity are not mutually exclusive; on contrary, they are interconnected and interact across different spatial and temporal scales.

5.5 Study location and population

5.5.1 Demographic and climatic characteristics

The Shawi are one of the five most numerous Indigenous peoples in the Peruvian Amazon (INEI, 2009), with a population of more than 20,000 inhabitants residing in more than 200 communities. Shawi settlements are located in the northern Peruvian Amazon along minor streams and rivers at the foot of the eastern slope of Peruvian Andes in Loreto and San Martin region (See Figure 2-2 in Chapter Two of this thesis). Shawi communities have been exposed to multiple waves of visitors, missionaries, and representatives of governmental initiatives, many of whom have focused on encouraging or compelling the Shawi to centralize their originally dispersed settlements and re-define their political and social organization (Pitman et al., 2014; Fuentes, 1988). Evangelization, exploitation of natural resources, legalization of native communities, and imposed education are among these changes (Fuentes, 1988; Gonzáles, 2013; Ormaeche and Barclay, 2008). Shawi continue to speak their own language and practice hunting, fishing and subsistence farming (Gonzáles, 2013).

The Shawi territory has diverse elevations and generally represents a sloping territory. Most of the communities are located in regions of non-seasonal flooding, although there are places that suffer periodic flooding in the rainy or wet season, especially those close to the edge of the larger rivers and down to the confluence with the Huallaga river (Gonzáles, 2013). Precipitation occurs throughout the year, although rainfall is particularly intense from December through April (wet season), with lighter rains from May through October (dry season) (Ministerio del Ambiente, 2016; Pitman et al., 2014; Gobierno regional de Loreto et al., 2015). High temperatures over the year vary with altitude from an average of approximately 19◦C in the highest part close to Balsapuerto to an average of approximately ~27◦C in the lowlands close to Yurimaguas (Gobierno regional de Loreto et al., 2015).

There are no downscaled climate projections specifically for the region encompassing the Shawi settlements. Data from the nearest region, San Martin, however, indicate that temperatures are projected to increase up to +1.8◦C, with few changes to precipitation by 2030 (Ministerio del Ambiente, 2016). It is projected that rainfall will stay within its normal annual variability (+/-5◦C), although seasonal precipitation changes are expected from -3% between December through March to +3% in April through June (SENAMHI, 2009). In addition, over the past four years, a series of floods have been reported by local authorities in Shawi communities. For example, in 2016 a major flood forced national authorities to declare a state of emergency in Balsapuerto district (El Peruano-Peruvian official newspaper, 2016). Crops, poultry, housing, and school infrastructure were reported as being the most affected (Sistema Nacional de Defensa Civil-Balsapuerto, 2014; Sistema Nacional de Defensa Civil-Balsapuerto, 2015; Sistema Nacional de Defensa Civil-Balsapuerto, 2016)

5.5.2 Study population

We worked with Shawi communities located along a river in the Balsapuerto district. To respect the confidentiality of respondents, and to prevent the possibility of reverse identification of individuals, we do not specify the name of the river or specific location of study communities. This paper reflects the results of qualitative research in two of the 18 communities along a river in this area (See Figure 4-1 in Chapter Four)

5.6 Methodology

5.6.1 Data collection

We employed a community-based participatory research (CBPR) approach to characterize the household and community Shawi food system and to investigate how climatic and non-climatic drivers affect vulnerability to climatic risk. Data collection was conducted between June and August 2014 and was guided by a vulnerability approach, focusing on exposure, sensitivity, and adaptive capacity of food systems. Consistent with CBPR, all data collection methods were designed to allow for identification and exploration of emergent themes (Chambers, 1994). The use of multiple methods allowed flexibility in collecting key themes that may emerge through different data collection approaches, opportunities to triangulate results, and a chance to conduct iterative member checking with participants (Chambers, 1994).

5.6.2 Methods

We used semi-structure interviews, photovoice, transect walks, food calendar building, and participatory observation. Table 5.1. describes the aims of each method and its participants. Instruments were designed following the food security and food systems framework explained previously (See section *5.4.1*.)

All fieldwork was facilitated by one lead Shawi interpreter who was fluent in both Shawi and Spanish. The majority of participants preferred to converse in the Shawi language during research activities. Translations to Spanish were conducted in the presence of each participant to corroborate answers. Interviews were audio recorded, after participants provided consent. Reflective and descriptive journals were kept by the main investigator (CZ). Semi-structured interviews were conducted with key informants, including teachers and elders. Key informants were invited to participate, looking to reflect the diverse opinions of households located at different distances from the main community centre. Teachers provided complementary information about food sources received at the school, and elders were included as the founders of those communities. Example questions included: What time of year is the best for eating well? What are factors that make this a good time for food? Do you remember a time when there was severe food scarcity for you and your family? We did not explicitly ask questions about climate change, as we sought to understand more broadly how weather and seasonality affect food systems in the context of non-climatic conditions. Transect walks were conducted with two participants, who conducted tours of their lands. This approach sought to observe food production on the land and to explore constraints related to crop production and food processing. Detailed instrument guidelines are provided in the Supplemental Materials.

Table 5-1 Description of methods, topics investigated and demographic characteristics of participants

Method		Aim	Total	No of participants
Transect walks with adults	**Characterize Exposure, Sensitivity, Adaptive Capacity**	Characterize crop ***production*** and ***processing***	2	1 adult male; 1 adult female
Food calendar building (focus group)		Characterize seasonal patterns of food ***production*** and ***processing***, as well as gender-age dimensions of these activities	1	6 adult males; 2 adult females
Participatory observation (home stay)		In-depth characterization of household experiences with food ***distribution*** and ***consumption***	1	Community assembly suggested CZ live with one typical Shawi household for observations
Semi-structured (individual) interviews		Characterize food security, focusing on ***availability***, ***access***, ***utilization***, and ***coping mechanisms*** in the context of food scarcity over time	24	9 adult males; 9 adult females; 4 elders; 2 teachers
Photovoice (focus group)		Identify perceived factors that constrain or promote food security	3	6 adult females; 4 adult males; 4 females and 3 male youth (13 to 16 y)

A photovoice exercise was conducted with three groups: females (23 – 37 y), males (28 – 37 y) and youth of both sexes (13 – 16 y). Photovoice is a participatory method that allows participants to answer a research question with pictures that represent issues or concerns relevant for

individuals and the community (Palibroda et al., 2009). It is often used with marginalized populations to provide insight into their internal conceptualization of their world and their problems (Lorenz and Kolb, 2009). Two workshops were performed with each photovoice group. In the first workshop, the researcher explained the purpose of the exercise, the role of photovoice, the specific research questions, and how to use a digital camera. We sought individual and parental permission (in case of minors). The research questions were "What helps you eat well?" and "What prevents you from getting food?". Participants were instructed to avoid taking photographs that included personal identifiers (e.g. faces) to ensure the privacy of community members. Each participant kept a camera for a period of 2 to 3 days, with photography aiming to capture visual pictures responding to the research question. During the second workshop, each participant was asked to select 5-6 photographs that they considered the most representative or important to answer the research question. These selections were printed and formed the basis of discussions in the second workshop.

Debriefing sessions were held every night with the principal investigator and the Shawi interpreter to identify emergent themes and to determine whether extra information or corroboration was needed over the following days (Morse et al., 2002). For example, recognizing the need to capture food production cycles and key crops, we invited household members to collaboratively construct a calendar outlining crop types, seasons, and food production roles. Eight of the previously interviewed key informants were invited to build the seasonal food production calendar.

Two meetings were organized with community members and authorities to disseminate initial results. During those meetings, we also validated emerging themes and verified community

perspectives on possible pathways for adaptation (e.g. importance of education and constrains to market participation).

5.6.3 Data analysis

All data were transcribed and examined using thematic analysis (Miles, Huberman, & Saldana, 2013). Data were initially coded to characterize key elements of Shawi food security following the theoretical framework to explain food security under environmental changes (Ericksen, 2008, Gregory et al., 2005, FAO, 2008a). We then posteriorly characterized themes related to climate change vulnerability dimensions at community level, which is consistent with analytical approaches taken in the human dimensions of climate change field (Ford, 2009, Smit and Wandel, 2006, Sherman et al., 2015). *Exposure* characterized climatic risk to the food system (proxied here by weather and seasonality), *sensitivity* included social, environmental and economic drivers, and *adaptive capacity* considered individual, collective or external coping and response efforts. We used narrative analysis for interpretation and presentation of the data (Wiles et al., 2005, Richmond and Ross, 2009). Narratives were contrasted with main themes identified in early stages to localize speakers' information within the vulnerability framework. Narrative analysis allowed us to separate the researchers' definition on the duality of *food security-food insecurity* from Shawi cultural definitions and perspectives (Kearns, 1993). Narrative analysis also enhanced the process of language transcription from Shawi–Spanish–English by offering opportunities to re-evaluate and re-visit what participants *actually* intended to communicate (Wiles et al., 2005). We additionally draw on information from relevant literature about Shawi (primarily in Spanish) and other Indigenous ethnic groups in the Amazon to validate, triangulate, and/or complement results.

5.7 Results

Results are organized around the key constructs of the vulnerability approach, beginning with characterization of the contemporary Shawi food system, and followed by synthesis of exposure, sensitivity, and adaptive capacity dimensions. The e*xposure* dimension focuses on how Shawi food system are susceptible to normal annual rainfall patterns and recently reported extreme weather events. The s*ensitivity* dimension characterizes how food systems are affected by non-climatic demographic and environmental factors. Finally, the *adaptive capacity* dimension identifies Shawi strategies to manage their food security under climatic risks in the context of other livelihood challenges and trends.

5.7.1 The Shawi food system

Three main food sub-systems are currently ongoing and interact with each other in the Shawi communities participating in this study (Figure 5-1). These included: 1) wild food accessed from the forest, 2) food cultivated through farming, and 3) food acquired from external sources. Traditional food systems encompass food acquisition from wild forest resources and food production in household gardens, and more distant land spaces in the forest that are adapted to produce crops annually and throughout the year. Cash conditional transfer programs and food aid distributed within the community or at school represents more recent and external components within the food system. Access to cash income to purchase food remains rare within the communities.

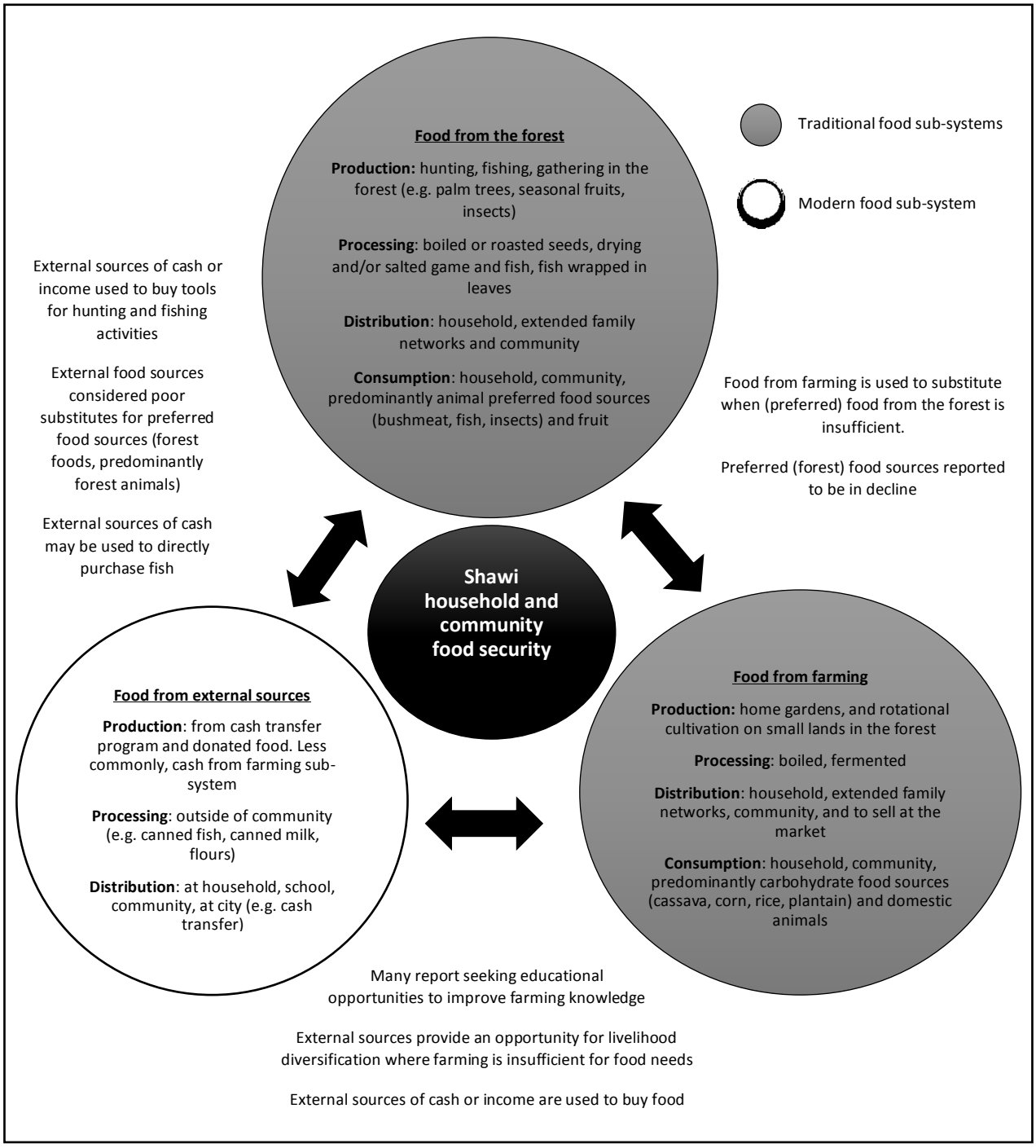


Figure 5-1. Food sub-systems among Shawi in two communities in Peruvian Amazon region.

The forest was reported by participants as a space where hunting, fishing and gathering food were conducted throughout the year. Forest resources such as leaves and vines were additionally reported as important materials for food production, processing, and transportation. For example, male youth described as a key theme "*plants that are needed to bring food to our home,*" where they explained the importance of some toxic plants to fish, leaves to wrap and prepare meat or fish, and vines to prepare baskets for transporting food. Participants documented techniques to identify animals for hunting, fishing and gathering in the forest (Table 5-2). Similar strategies and knowledge for accessing food from the forest have been reported among other Shawi communities and used by other Indigenous people in the Amazon (Ormaeche and Barclay, 2008; Huertas Castillo and Chanchari Lancha, 2011; Fuentes, 1988; Amaral, 2005)

Table 5-2. Wild food system activities

Description of food activities performed in the forest	
Hunting	*Chapaña* is a hunting strategy involving hiding in the forest near wild fruits that are attractive to animals; this approach is used only during daylight and in quiet places
Fishing	*Huaca* (*Clibadium spp.* in Shawi A*kawa*) is a plant reported to be used to prepare a kind of paste for fishing, where the *huaca* preparation is placed inside a traditional basket and sunk into the water, usually in calm waters. The resulting toxic affect of *huaca* on fish is describe as temporary *Barbasco* (*Lonchocarpus spp*. *In* Shawi *Pena Nin*) is used for catching more diverse and larger fish species. When *barbasco* is used, typically multiple families within the same community participate and usually inform communities down the river to take advantage of the fish downstream.
Gathering	*Suri* (larvae of the order *Coleopterus spp*) and S*iquisapa (*ant order of *Cephalotes spp*) were also reported to be consumed and highly appreciated

Farming activities include the production of multiple crops and rearing domestic animals. Shifting cultivation is typically conducted on distant plots in the forest (30-60 minutes walking distance from the family home) called "*chacras*" in Spanish, while chicken and ducks are usually kept in backyards. Fruit plants, including plantain, papaya, cocona, and some palms, are also kept in the *chacras*. This is consistent with previous studies, which have described Shawi traditional communal arrangements that distribute land to their founding family units for multipurpose use, including farming, hunting, fishing and house construction (Ormaeche and Barclay, 2008). Cassava, plantain and sachapapa (*Dioscorea trifida.* a yam in Shawi *Ma'ma yaraton or Ma'ma wiriton)* were reported to be the main crops harvested for self-consumption on farmed land.

External sources of food comprise a variety of food types sourced outside of household or community production, typically received through external aid or to a lesser extent through purchase. Some Shawi households received external aid in the form of cash income or food aid as part of national initiatives to increase food and social security of vulnerable populations in Peru (Programa Juntos, 2017). A more detailed characterization of the three main governmental programs ─ the *Juntos* cash transfer program, the *Vaso de Leche* food security program, and the *Qali Warma* school feeding program ─ and their contribution to Shawi food security has been reported in Chapter four of this thesis.

Some key informants also reported that they occasionally buy food by travelling to the closest city or from sellers that sporadically visit the community (*regatones*). We observed that *regatones* generally sold salty fish. One of our study communities had a small local store. We observed eggs (not locally produced), canned tuna, cookies, rice, sugar, candies, beer and

cigarettes for sale in the store. One key informant explained that neither cassava nor plantain was sold in the local store because "*everyone has it*". No vegetables were available at the store, with the exception of onion and garlic.

Participants reported dynamic interactions among these three food sub-systems (Figure 5-1). These were characterized by three dominant interactions. First, there was consensus among participants that large and highly-valued forest animals, which represent the most preferred type of traditional food, are increasingly unavailable. In this context, the Shawi reported increasingly turning to minor, less preferred species such as rodents, small species of fish, insects, and crustaceans (e.g. river small shrimp). Male photovoice participants identified "*food that is simple to get*" as a key theme, presenting a series of photographs depicting the type and amount of food that they are increasingly accessing to substitute diets when other larger and preferred species are unavailable. Photographs within this theme depicted rodents, fish, cassava and plantain, described as foods that are available but less desired. In contrast, photographs of larger animals such as deer, pecari, armadillo, monkey, and alligator were seen as declining yet traditionally preferred. Other food sources reported as substituting for a decline in preferred forest animals included farmed foods or domestic animals, purchase, and external food aid.

Second, access to food aid with the external food sub-system is restricted by eligibility requirements, including childhood educational requirements (*Qali Warma*) and other household criteria for the *Juntos* cash transfer program. Cash obtained by selling products from farming was reported to be used to buy food, although participants generally indicated that other expenses ─ particularly school supplies ─ were often prioritized over food. Third, key informants reported using cash to buy tools to support hunting and fishing to utilize preferable food sources or to

directly acquire fish or game meat. This pattern of using money to favour, directly or indirectly, preferred food sources is consistent with researchers working elsewhere with other Shawi communities (Fuentes, 1988; Ormaeche and Barclay, 2008).

Food system roles and responsibilities within a household were reported as clearly patterned by gender and age, and often involved collective activities (Table 5-3). Photographs identified and discussed during the photovoice exercise indicated that adult men predominantly engage in hunting and fishing for animal food sources, while women mainly participate in gardening/cropping activities focused on subsistence cassava cropping and food preparation at home. Collective activities to produce, distribute, and consume food were described as an important component of the traditional Shawi food system. The two transects walks were focused on communal activities oriented towards preparing the land for the cultivation of maize (with a male participant) and harvesting of cassava (with a female participant). Communal activities were reported by key informants as critical to efficiently and effectively organize the necessary labour for time-sensitive initiatives.

5.7.2 Exposure

Annual food production comprises cropping, raising domestic animals, and accessing wild foods from the forest. Many crops follow a seasonal and/or inter-annual pattern of planting and harvesting. Figure 5-2a shows crops and fruits often consumed by Shawi participants according to their availability and growth cycles. Crops such as maize and rice have shorter harvest cycles (3-4 months) and are harvested once a year. Cassava and plantain are considered to have moderate-length harvest cycles (up to 18 months); these crops are produced continuously over a year but require frequent weeding. Fruit trees were reported as long-term crops that take five

years to fruit, and then fruit only once per year. Figure 5-2b shows the availability period of domestic and wild animal food sources. Domestic animals are only consumed when there is "*nothing to eat*" ─ for example during winter when heavy rain constrains people's ability to visit the forest or their crops to access food. Domestic animals are thus retained as an asset for consumption during difficult times, and not otherwise used for daily food consumption. Domestic animals were also reported as important for selling and access cash when traveling to the closest city to buy food, cover health expenses, education supplies, and transportation fees.

Annual variability of precipitation is important for crop food production and affects forest food accessibility. The dry/summer season lasts from about May to September, while the wet/winter season lasts from October to April. Key informants explained that the dry (summer) season ─ when rainfall decreased ─ was a more productive time for crop cultivation. During the dry season, community members typically engage in cleaning, burning, and planting crops. Key informants explained that some rain is necessary to soften the soil to plant cocoa trees and palms species so that they will produce fruit in the winter months. Rice, maize, plantain, and several fruit trees, however, require extended periods free of rain to allow for clear cutting and burning of vegetation for effective sowing of crops (Figure 5-2a).

Table 5-3. Food system activities patterned by age, gender, and collective participation

Food activity	Female	Male	Youth/children	Collective participation
Fishing	Catching minor fish species using toxic plants and with bare hand technics Processing and preparation of fishing food such as *Shikana (wrapped* dry-out fish*)*	Use of fishing tools and toxic plants	Children know how to fish with a hook Youth help to prepare plants for fishing	Practice with other relatives or close friends. Also, an activity where the whole community members can participate
Farming	Production, processing, preparation, and serving, especially cassava based food e.g. *masato* Rearing chicken and ducks	Cash crop production: maize, rice, and sometimes plantain Planting and harvesting larger fruit trees	Harvesting beans with their mothers Adolescent girls taught food knowledge by their mother	Among relatives and close friends within the community (e.g. *mairesu* in Shawi*)*.
Hunting	Normally do not participate	Use of shot guns and techniques for hiding/tracking in the forest	Adolescent males taught hunting knowledge accompanying their father	Among relatives (grandfather, son in law and grandson) and close friends within the community
Gathering	Family activity	Family activity	Collecting insects from the forest	Among relatives and close friends within the community

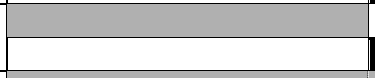
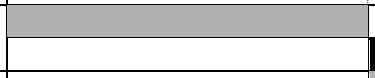
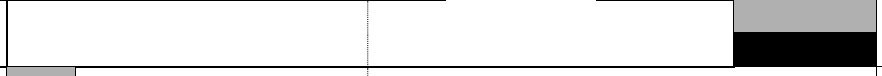
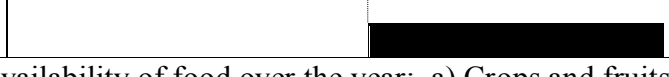
Food	Dry season apr may jun jul aug	Wet season sep oct nov dec Jan feb mar	Main purpose
Cassava*			Self-consumption
Plantain*			Self-consumption
Sachapapa[1*]			Self-consumption
Local bean[4*]			Self-consumption
Rice[3*]			Self-consumption,sale
Maiz[3*]			Self-consumption,sale
Pineapple*			Self-consumption,sale
Peanut[5*]			Self-consumption,sale
Cacao[2*]			Sale
Caimito[6*]			Self-consumption
Macambo[6*]			Self-consumption
Pijuayo[6*]			Self-consumption
Zapote[6*]			Self-consumption
Mangua[6*]			Self-consumption
Mandarina[6*]			Self-consumption
Guaba[#]			Self-consumption
Cocona[#]			Self-consumption
Papaya[#]			Self-consumption
Kumala palm[*#]			Self-consumption
Ungurahui palm[*#]			Self-consumption
Shebon palm[*#]			Self-consumption
Wasai palm[*#]			Self-consumption
Aguaje palm[*#]			Self-consumption,sale

Figure 5-2. Availability of food over the year: a) Crops and fruits

Food	Dry season apr may jun jul aug	Wet season sep oct nov dec jan feb mar	Main purpose
Hen[8*]		mainly in wet season	Sale
Pig[8*]		mainly in wet season	Sale
Cow[8*]	mainly on community anniversary (June)		Sale
Majaz[7#]	mainly in summer		Self-consumption
Anuje[7#]	mainly in summer		Self-consumption
Deer[7#]	mainly in summer		Self-consumption
Sloth[8#]	mainly in summer		Self-consumption
Fish[9#]			Self-consumption

Figure 5-2. Continue: b) Animals food sources

1: Harvest one year after planting; 2: Harvest three years after planting; 3: Harvest 3-4 months after planting; 4: Produces only once per year; 5: Harvest four months after planting; 6: Harvest five years after planting only one harvest per year; 7: Available in the past all year around, but specially in summer; 8: Not eaten in the past; 9: Only few species and small amounts;
* Food from the farm sub-system; # Food from the forest sub-system

Figure 5-2. Availability of food over the year a) Crops and fruits and b) Animals food sources

In addition, during the dry season when water recedes and water bodies are shallower, fish are easier to harvest. Walking on forest paths to travel distances and hunt wild animals is also easier during the dry season. In contrast, during the heavy rainy season (winter), crop production is poor, access to game and fish sources from the forest is difficult, and fulfilling food aid eligibility requirements is often challenging (e.g. school attendance during heavy rains, transportation on muddy paths and crossed streams). Foods from the forest, including wild animals and palm fruits,

were reported to be available throughout the year, although mainly accessible in the dry or summer period (Figure 5-2b).

Recent perceived alterations in climate variability are affecting the Shawi food system and compromising availability of food. During transect walk activities, participants noted that temperatures have warmed in recent years, making it difficult to spend long working hours on the land. In addition to elevated temperatures, respondents reported that the predictability of seasons was also changing, with winter perceived as starting earlier than usual in the year. Traditional "*August winds"* that mark the beginning of the winter season were reported as occurring one month earlier than normally expected. One key informant stated:

> "*In the past, we had a specific time when the summer began, when the winter is. Today there are days when it rains during the summer, it rains for a whole week! It is no longer in order, it is in disorder*" (B001, male 25 years old).

Adult women in the photovoice sessions explained that when the rainy season comes early, they are unable to effectively clear and prepare the land for planting their main staple crops, cassava and plantain. Women use fire to burn their fields in preparation for planting; early or extended rains during the dry season interfere with this traditional crop preparation activity. Our results are consistent with reports from Shawi communities elsewhere, with observations of changing and increasingly unpredictable weather affecting land preparation, burning, and crop production (Huertas Castillo and Chanchari Lancha, 2011).

5.7.3 Sensitivity

Participants reported high food insecurity in their communities, mainly characterized by a lack of animal food sources. This is consistent with research documenting high rates of malnutrition among Shawi children, and very low food security in eleven Shawi communities along the same river (See Chapter Three in this thesis). Younger key informants noted that they did not remember a time when game and fish were abundant. Older adults and elders consistently reported a marked decrease in game and fish, noting that these changes have occurred over the past 20-30 years. For example, one adult woman reflected:

> "*When I was a child, I remember my parents had enough game. I saw it. Even when I was an adolescent I had food, but when I got married and my oldest child was born [24 years ago], I noticed the difference. Sometimes you find food [game], other times you don't*" (AA016 female, 44 years old).

Respondents in our study attributed high food insecurity to a combination of factors affecting their food system, namely: rapidly expanding population, change of settlement pattern, and natural resource degradation affecting wildlife.

Key informants and photovoice participants consistently reported that the population and number of new Shawi communities is increasing, with implications for availability and access to wild animal food sources:

> "*When I was a child, there was animal food every day. Although, we had some [meat] at least until I was fifteen years old. Then more people started to appear and they eat the animals*" (AA014, male, 34 years old).

Local authorities concurred with these trends during results dissemination meetings, noting that food security in communities was affected by an increasing population, reflected in the creation

of new villages. Elders in particular agreed that an increasing local population was associated with decreasing animal food sources. They also attributed animal food availability in the forest to a shifting settlement pattern — from more dispersed to more centralized — with higher densities of people competing for access to animal sources of food. Other researchers have highlighted access to schools and education as a key driver of changing settlement pattern among Shawi people (Ormaeche and Barclay, 2008; Huertas Castillo and Chanchari Lancha, 2011; Fuentes, 1988). A perception of disrespect of traditional norms was reported by elders when discussing the expanding population. One elder key informant explained:

> *"Only my family used to live in this zone, we had to walk far to find another house. This is the reason that we used to have a lot of bushmeat. Before, nobody crossed your path. If a person crossed your path, it means that you did not deserve respect and were a source of conflict. It was like a rule. These days, [rules] have disappeared; there are no rules. Everyone walks the same path that you are walking"* (AA011, male 70 years old).

Shawi youth participants in the photovoice exercise were also aware of the very low food security that their households were experiencing. They referred to the impact that more people might have on the availability and access of wild food sources in the future. Shawi youth expressed a desire to have fewer children than their parents (1-2 vs 4-5 children). They specifically asserted that they wanted to "*feed their children better*".

Furthermore, more people are carving out new plots, in many cases via deforestation along the river shore. Deforestation and erosion of river edges has been associated with changing river structure (wider and shallower) and have been leading to new habitats that are not suitable for larger fish. In response to difficulty catching fish, participants reported that there is increased use of fishing techniques that involve poison (e.g. rotenone poison based), which are exacerbating

damage to the river ecosystem. Key informants reported concerns that this practice might further diminish the availability of remaining wild river resources. Damage to water sources has been also reported among several other Shawi communities (Ormaeche and Barclay, 2008, Huertas Castillo and Chanchari Lancha, 2011). In parallel, given high levels of food insecurity, consumption of wild food and smaller animals is also increasing as a substitution for traditionally preferred foods, which at the same time imposes pressure on biological resources.

5.7.4 Adaptive capacity

Wild food and its importance for climatic events

For the Shawi, social activities and celebrations are based on wild food to compensate for the collective labour carried out in the community. Preparing the land for cultivation by practicing collective activities — *Mairesu*, for example — is considered critical to avoid rains during planting. Early arrival of rains and unpredictable seasons makes this collective capacity even more crucial. Since wild animals are central to preparing meals to organize this activity, the scarcity of game and fish compromises the ability of families to organize social activities around land cultivation and food availability from the farming sub-system is thus also affected. Shawi participants from other communities have also reported on the importance of game and wild fish for their community socialization (Ormaeche and Barclay, 2008). Moreover, food sharing networks are embedded predominantly in the wild food sub-system and to a lesser extent the farming sub-food system, but not at all within the modern sub-system.

Wild food is a critical back-up when natural hazards destroy crops or other food: the wild food system is thus an important safety net. Key informants recalled a major flash flood accompanied

by a mudslide in 1995, which were also reported by Peruvian authorities in the Balsapuerto district (Sistema Nacional de Defensa Civil-Peru, 1995). Key informants explained that because of intense rain in the highlands at the head of the river, a slope of the mountain had collapsed, causing a landslide. Participants explained that after this event they turned to the forest and wild food sources as a substitute for the damaged crops. Recognition of multiple plant varieties, animals, and wild fungus was critical to accessing food as part of the communities' coping strategy to access food during this 1995 event. Key informants mentioned that they were able to survive on typical forest foods during this time, including macambo (*Theobroma bicolor)*, cocona (*Solanum sessiliflorum),* churo (*Pomacea maculata*), congompe (specie of snail), callampa (wild edible fungus), suri (multiple species of larvae) and chonta (multiple species of heart palm tree). Key informants also concurred that they could access *masato* during the climatic event. Elder women explained that during extreme conditions, it was possible to harvest cassava from old gardens to prepare *masato*.

Traditional knowledge of climatic risks, lack of appropriate economic opportunities, and desire for education

The Shawi reported knowledge of what do to in response to flash flooding. Key informants reported that the local river experiences sudden level changes, with flash flooding typically occurring at some point in the beginning and end of the wet season, between September-October and March-April respectively. They described water increases that rapidly lead to water overflow, with flooding typically lasting a few minutes to a maximum of one hour, and reaching only few centimeters high, thus affecting low lands and some parts of the center of the community. Elder participants mentioned that they did not deforest, crop, or build their homes on

these low lands or close to the edges of the river to reduce the risk of flooding. They reported, however, that demographic and economic conditions associated with seeking education constrained their ability to properly respond to climatic events, thus reducing adaptive capacity. Elders clarified that flooding is "*serious*" when the water covers fields (e.g. plantain, cassava, peanut, or maize); this level of flooding has the potential to damage crops and/or housing, as well as injure or kill domestic animals. The elders recalled the flood of 1995 as one of the most severe flood events in the last decade. In addition, key informants also reported that living and cropping in higher lands was seen as a better place for secure cultivation and safety during flood events. One female elder recalled what she and her family did during the 1995 flood:

> *"The water was up to our knees. Because it was during the daylight, we could run to the highest part of the community, carrying our possessions such as clothes and domestic animals. We did not lose anything important, only used mocahuas and callanas [traditional clay vessels], and our house was moved by the water flow only a bit"* (AA013, female).

Another key informant reported that her family did not lose anything important during the 1995 flood. The water reached her house but did not affect her crops because her family always farms on high ground. One younger participant declared that the 1995 flood reached his house while his parents were in the forest. He had to travel by canoe to cross the river and to reach the highest part of the community for safety.

Despite the risk that river edges represent for crops, key informants described the need to plant new plots close to the edge of the rivers because of the increasing number of people per community and the increasing dependence on farmed food. This marginal cropping was reported to occur in the context of limited opportunities to access cash and decreasing wild animal food

sources. Cropping near the river is recognized as exacerbating the exposure of people and crops to climatic hazards. In parallel, lower tree density arising from deforestation for cropping along river edges negatively affects water dynamics and compromises fishing access.

Producing cash crops was identified as one alternative to generate cash income, however many Shawi reported concern that their crops garnered very low prices at the closest market where prices are generally imposed by buyers. One key informant highlighted the case of the *sacha inchi* (*Plukenetia volubilis*), for which prices have fallen dramatically; 10 year ago, this product sold for 10 soles per kilogram and now garners only 1 sol per kilogram. As a response to low cash income from crop sales, and based on their past experiences, Shawi key informants reported that these days most of their food production is for consumption at home. Our elder participants reported on periods of their lives when they worked in rice production when this crop was economically important in the region, although low prices in the closest markets currently discouraged them to pursue rice production. Larger crops of maize are a notable exception to this, as are times when fruits prices increase sufficiently in the closest city to justify the sale of some surplus. Access to cash from the farming system is thus highly unstable over time. One male interviewee explained his decision to sell plantain:

> "*All year-round we have plantain, however there is a time when the price is high. When a bunch of plantain has a good price, we sell it at 15 soles. Other times the price is low, around 7 soles*" (AA021, male 50 years old).

Similarly, continued education was seen as increasing access to paid jobs and was perceived as one alternative to improving incomes. However, community authorities highlighted that even when they supported their children to attend school, usually travelling to distant communities to

access secondary school or better training, few job opportunities were available in their territory for returning students. Previous research documented that only 7% of fathers and no mothers of preschool Shawi children had a paid job (See Chapter Three in this thesis). Community leaders expressed frustration that there are few employment alternatives or local jobs:

> *To support agriculture that is an alternative to Shawi youth, that is the only alternative, where young adolescents are paralyzed with completed secondary studies. There is no alternative for them. We know when youth achieve a high level of education, they share [the benefits] with their family. If s/he has something [an income], s/he will share with his/her family.* (RD, 001, June 2014)

Accessing cash income to pay for school was reported as a key driver of deforestation, with implications for natural resource degradation. Despite this, education was widely perceived as an important option for livelihoods diversification in the future. Community authorities recognized that even when local regulations exist to prevent indiscriminate deforestation, poor access to cash income for children's school expenses (e.g. parents' association fees, school supplies, transport) led them to agree to sell trees from their land to visitors, who were frequently illegal loggers. Selling to illegal loggers implies that benefits are not guaranteed and there is greater chance of exploitation. Desire for further education was also expressed by youth participants during the photovoice activity. Youth participants discussed the importance of achieving a superior level of education as one of their main goals and options to learn new techniques to improve their farming production in the future.

5.7.5 Shawi food security vulnerability to climate change

There are two key proximal pathways within the Shawi food system that reduce local capacity and increase the vulnerability of Shawi food security to climate change (Figure 5-3). First, demographic changes in the context of concentrated community settlements are elevating pressure on wild food sources and extending the spatial extent and patterning of farming by using river edges for crop production, which in turn increases natural resource degradation. The use of larger scale fishing techniques has also decreased wild food sources. As long as fishing and other wild food sources are less available, the traditional Indigenous mechanisms for organizing collective work for crop production are compromised. The increased number and density of people seeking food in the forest are also encroaching household land boundaries and affecting Shawi social norms. This trajectory leads to diminishing traditional social institutions and the knowledge associated with the production and use of wild food, which is essential to responding to climatic hazards events. Furthermore, people are building new crop lands on river edges, which increases their exposure to crop failure due to more often flooding events (Sistema Nacional de Defensa Civil-Balsapuerto, 2014, Sistema Nacional de Defensa Civil-Balsapuerto, 2015, Sistema Nacional de Defensa Civil-Balsapuerto, 2016). Consumption of wild food combined with increasing population will compromise the availability of wild food, implying that this cycle is unlikely to be sustainable.

The second proximal pathway, desire for educational opportunities, presents a trade-off between investing in education (purchase of school supplies and transport), maintaining food security, and facilitating illegal logging (Figure 5-3). Increased education, in its current form, may conflict with and compromise traditional knowledge, as children spend less time with their parents, and

youth leave the community for school, often losing knowledge of the land and food production. Desire for education is also driving changes in settlement patterns, with impacts on people's access to and relationship with wild food sources. Few opportunities for paid jobs for educated returnees and the low prices for local crop production also represent barriers to accessing cash and decrease opportunities for improved food security.

External aid in the form of school feeding programs or cash conditional transfers in theory can strengthen this educational pathway. Educational opportunities are likely critical for future generations of Shawi but should be developed in a way that does not erode existing coping mechanisms for food security and does not compromise food sources. Access to educational opportunities is a corollary of the conditional *Juntos* cash transfer program (Programa Juntos, 2017). *Juntos* provides economic incentives ($60.00 US bimonthly) to poor and extremely poor households under the condition that household participants must complete various requirements, including 85% attendance at school for children 6-14yrs (Programa Juntos, 2017). At the same time, the *Qali warma* feeding program delivers food only to children who attend school. This implies that external aid could exacerbate a maladaptive trajectory by promoting education in a place where economic job opportunities are limited for educated Shawi and where access to cash to cover expenses for superior education is also scare. Currently, education does not lead to job opportunities and yet is having a substantial impact on food insecurity. The sacrifices made for educational opportunities — prioritizing expenditure on education over food, facilitating deforestation to access cash, adjusting settlement patterns to be closer to schools, reducing access to wild foods, supplementing with non-traditional food sources, and resulting in a loss of

traditional knowledge among youth — have to-date shown little benefit in the form of increased job opportunities or improved food security among Shawi.

The Shawi's susceptibility to changing climactic conditions potentially magnifies the negative impacts of non-climatic drivers of food security (Figure 5-3). Shawi communities are located in districts near steep mountains that are susceptible to landslides, particularly when rain is constant and intense (Gobierno regional de Loreto et al., 2015). Precipitation triggers erosion and collapse of mountains, which fall into the river, cause overflow, and affect housing domestic animals and crops, as recently reported by various Shawi communities (Sistema Nacional de Defensa Civil-Balsapuerto, 2014, Sistema Nacional de Defensa Civil-Balsapuerto, 2015, Sistema Nacional de Defensa Civil-Balsapuerto, 2016). In addition, constant changes in the water's river volume happen rapidly, and flash flood events favor erosion of river edges, sedimentation, and alteration of the normal hydrological balance, which have implications for wild food in fresh water systems (Thorp et al., 2006). Given that climatic consequences on natural resources are still uncertain, but more likely negative in the Amazon (Frederico et al., 2016), traditional knowledge to respond to river and landscape changes represents is key to inform climate change adaptation (Vogt et al., 2016). By 2030, climatic projections for adjacent regions to Shawi communities anticipate positive trends in temperature, which would pose a significant threat to fishing (Frederico et al., 2016). Similarly, even when no significant net change is expected in annual precipitation, small changes in intensity or duration of climate anomalies could affect the frequency and intensity of floods or landslide in this physically susceptible district (Gobierno regional de Loreto et al., 2015).

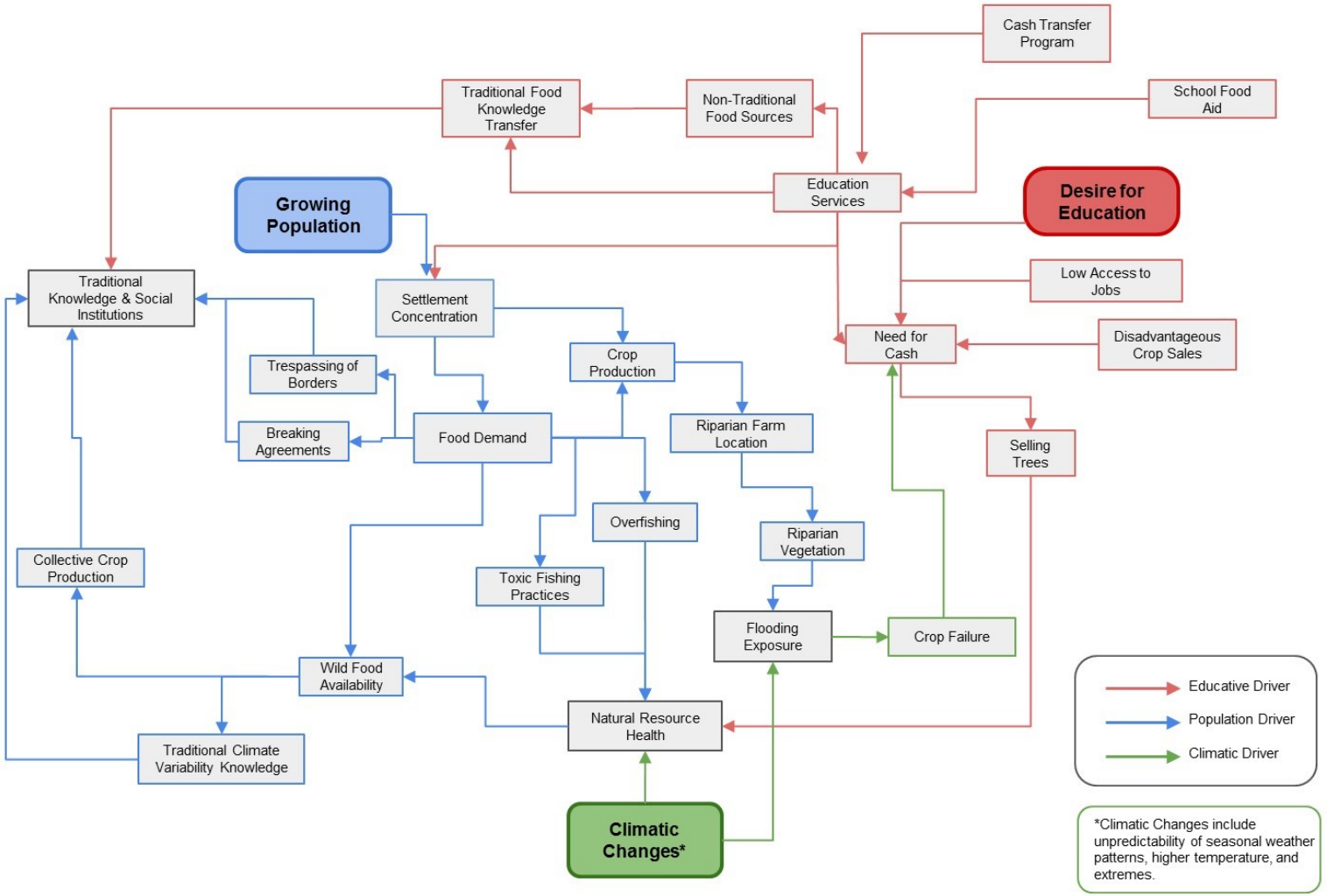


Figure 5-3. Non-climatic and climatic proximal drivers of food security vulnerability for Shawi communities

5.8 Discussion

The Shawi food system is underpinned by several mechanisms that enable the Shawi to cope with annual climatic variations and develop knowledge to respond to extreme climatic events. However, population growth, a concentrated settlement pattern, limited economic opportunities, a desire for educational opportunities, and natural resource degradation compromise food security, with potential consequences for nutrition and health. Climatic drivers can be expected to exacerbate current drivers related to demographic and educational trends by affecting crop production, jeopardizing options to access cash, and increasing natural resource degradation, with implications for an increase in extreme weather conditions.

The vulnerability of Shawi food security to climate change is also influenced by three key distal drivers: population recovery, economic development, and cultural exclusion. The Shawi have consistently increased their population over the last half century. Fuentes (1988) presented census data indicating that between in 1940 and 1981; the number of Shawi communities and the total Shawi population increased from 14 to 29 and from 608 to 4395, respectively. Improved access to health services, particularly vaccination, and the erosion of traditional fertility regulations (e.g. polygyny, marriage rules, contraception), have been hypothesised as key factors in the recovery of Indigenous Amazonian populations after major population declines following encounters with Western societies (McSweeney and Arps, 2005; Hern, 1994). A Peruvian Ministry of Health report indicated that Indigenous Amazonian Nanti suffered several respiratory disease outbreaks as a result of interactions with non-Indigenous peoples amidst limited access to appropriate health services (Ormaeche and Valdez 2003). The same report also indicated that the infant mortality rate among the Shawi (previously referred to as Chayahuita) was above 120 per 1000 boys/girls born alive during 1993 (Ormaeche and Valdez 2003).

Although we did not find updated Shawi data on infant mortality, the last Peruvian census (2007) indicates that the Shawi population is relatively young, with higher fertility rates compared to the Peruvian average (7.7 vs 2.6 children per women) (Dirección Técnica de Demografía e Indicadores Sociales, 2010). This implies that the Shawi population may continue to increase in the future. Youth participants' intentions to have fewer children, however, represents the potential for declining fertility rates if barriers to accessing appropriate and effective contraception planning are addressed.

Peruvian socioeconomic policies have influenced changing Shawi settlement patterns. A Peruvian law (D.L. 20653, 1975) was dictated to legalize Peruvian native communities and to provide incentives (e.g. economic aid and loans) to promote agricultural practices (Granero, 1990, Robiglio Valentina et al., 2015). The law intended to provide land ownership and promote economic participation among Indigenous populations. Despite this, the law has resulted in the fragmentation and reduction of ancestral Indigenous territory and has consequently limited Indigenous public access to wild food system activities (Ormaeche and Valdez 2003; Garcia Hierro et al., 2002; Huertas Castillo and Chanchari Lancha, 2011). Dispersion into the forest to access wild foods under extreme climatic events has been reported among other Amazon peoples, although typically in the context of a more dispersed settlement pattern. For example, the Yanomani people of the Venezuelan Amazon also practiced slash-and-burn agriculture, similar to the Shawi. The Yanomani turned to the forest to access food after an intense fire destroyed their crops during an extreme drought reported in the Amazon (1972-1973)(Meggers, 1994; Lizot, 1974). At that time, availability of forest wild food among the Yanomani was described as a reliable and important resource to supporting a *"nomadic existence*" (Meggers, 1994). Our results concur with reports from elsewhere in Latin America, suggesting that

alteration of settlement patterns associated with increasing dependence on agricultural activities represents a key determinant of Indigenous Amazonian food security vulnerability (Huertas Castillo and Chanchari Lancha, 2011; Sirén, 2007). This trend also implies decreasing capacity to adapt to hazardous climatic events.

Cultural values associated with food systems and resources are generally excluded from economic development initiates in the Shawi region. Practical benefits for food security of national and regional economic development are thus perceived to be negligible. Previous research reported on a boom in rice production in the closest city to our Shawi study communities during the 1980s, concurring with the time that our key informants reported being involved in rice production (Rhoades and Bidegaray, 1987). More recently, surrounding areas of Shawi settlements in the San Martin region, for example, were impacted by the promotion of bio-combustibles production (Robiglio Valentina et al., 2015) and the development of a mega road for transportation (Pautrat et al., 2009), with the Shawi expressing their concern about land tenure conflict, deforestation, and reduced game availability (Ormaeche and Barclay, 2008). Economic development may offer opportunities to improve local livelihoods, and therefore might increase adaptive capacity to face extreme climatic events, yet lack of recognition of cultural values (e.g. food preferences and food systems activities) and nutritional importance of forest resources continues to exclude the Shawi from economic and health benefits.

External food and aid operates under a Peruvian economic model that does not support local capacity, potentially increasing vulnerability because it erodes social cohesion by ignoring Shawi culture such as language, food preferences, and traditional social institutions (e.g. collective work). Food sharing networks are widespread among Shawi communities and ensure food for

vulnerable sub-populations (e.g. elders) in difficult times. Food sharing networks are mainly based on sharing of traditional food sources (See Chapter Four). However, food aid uses non-traditional or non-preferred foods and targets individuals within households with negligible consideration of cultural norms around sharing and food production. Shawi food system activities are based on gender participation, for example, where males are associated with hunting and women with gardening. Given that bushmeat is decreasing, males are also losing their main social activity *vis a vis* food provision, implying that males are facing the Shawi cultural equivalent of unemployment. However, national food and cash programs target mainly women and thus have limited consideration of the eroding social hunting norms among Shawi men while simultaneously increasing labour and responsibility for women.

5.9 Conclusion

Shawi community food systems are experiencing a transition from the use of wild food sources to increased dependence on farmed food and some limited use of external aid and food sources. Increased population size and density, as well as a desire for education in a context with limited effective cash income opportunities represent multiple maladaptive pathways amidst a changing climate. The increased frequency and intensity of extreme climatic events reported over the past ten years in the Amazon region suggest that planned adaptation strategies for Shawi communities need to consider protecting traditional knowledge about climatic risks, protecting wild food as a coping strategy during extreme events, and promoting an effective and equitable market for Shawi crop production. At the same time, it is fundamental to recognize Shawi social norms and institutions within national food security strategies and to ensure that socioeconomic development does not erode local adaptive capacity, particularly in the context of high levels of malnutrition and food insecurity that are reported among the Peruvian Shawi.

6 CHAPTER 6: SUMMARY AND CONCLUSIONS

6.1 OVERVIEW

This thesis aimed to characterize the vulnerability of the Shawi Indigenous people living in the Peruvian Amazon to food insecurity in the context of a changing climate. In this last chapter, I summarize the key findings and policy contributions of this thesis. In doing so, I will demonstrate how individual specific objectives have been accomplished and how each informs the thesis' overarching goal. I also highlight limitations and pathways for future research.

The specific objectives of this dissertation were:

4. To characterize the nutritional and food security status of Shawi Indigenous Amazonian children ≤ 5yrs and their parents;
5. To characterize the diet, food sources, and food preferences of Shawi households;
6. To characterize the Shawi food system and interactions between climatic and non-climatic determinants of Shawi food security.

6.2 Key findings and knowledge contributions

6.2.1 Characterizing health inequities in an under-represented population

This thesis provides place-based evidence on nutrition and food security in an under-represented population and highlights local Indigenous perspectives on adaptive options in order to inform more effective and equitable responses to climate change (Adger et al., 2005, O'Brien et al., 2007). Food security has multiple health consequences, including physical, mental, and emotional conditions that will appear across the life course (Pérez-Escamilla, 2017). In the Indigenous Amazonian context, however, the role of food security as a determinant of health has not yet been extensively investigated (Brondizio et al., 2016, Gracey and King, 2009). Chapter Three demonstrated that nutritional indicators and food security levels for this population are

much worse than the national average. Moreover, my results also found strong associations between child stunting and both parents' nutritional indicators and their household's food security. These results indicate that pediatric nutritional disparities are not just a historical artifact, but likely a complex phenomenon driven by past and present social mechanisms. Chapters Four and Five develop this point further by characterizing how current national food and social programming are not addressing local food security needs; on the contrary, external aid has the potential to exacerbate health inequities and lead to maladaptation.

6.2.2 A baseline for Shawi nutrition and food security in a changing climate

My thesis contributes a baseline assessment of nutrition and food security in a context of uncertainty about climatic impacts in Amazonia (Frederico et al., 2016, Ministerio del Ambiente, 2016, Malhi et al., 2008) (Chapter 3). Severe food insecurity affected virtually all participating Shawi households, implying that availability, access, and utilization of food in the Shawi context represent critical health concerns. Multiple researchers have characterized the changing climate of the Amazon, particularly over the past twenty years (Marengo et al., 2016, Jiménez-Muñoz et al., 2013, Malhi and Wright, 2004). Model projections, however, indicate that changes in the Amazonian climate system will differ across different sub-regions (Cox et al., 2004; Cook et al., 2012), implying that impacts are likely to be localized and that climate impact studies must be validated across local levels to explore the extent to which trends are likely to be heterogenous. Data collected in this thesis can guide the monitoring of progress on health indicators and the evaluation of adaptation and development efforts under climatic and social change, specifically in the western-Amazon sub-region.

6.2.3 The nutritional transition in Amazonia

Chapter Three contributes to the nascent literature on the role of severe food insecurity in determining unequal nutritional outcomes within household members in Latin America. The coexistence of underweight and overweight affecting children and adults living in same household is consistent with emerging research in Latin America indicating that severe household food insecurity is strongly associated with a household double burden of malnutrition (Gubert et al., 2017, Pérez-Escamilla, 2017). Findings from Chapter Three also indicated that household factors (diet and food security among children) as well parents' nutritional status (e.g. stature and BMI) were significantly associated with stunting, indicating that the proximal environment is important in determining child growth patterns. This finding contributes to knowledge on the 'transmission' of chronic nutritional conditions from parents to children, where parents with stunting had a greater chance of having a stunted child (Ramakrishnan et al., 1999).

6.2.4 Contrasting national programming with local and Indigenous perspectives

My characterization of Peruvian food and social aid programs *vis a vis* Shawi traditional food systems (Chapter Four) points to a substantial disconnect of existing programs with local perspectives, food preferences, cultural practices, and the Shawi language. Additionally, most Shawi households are still highly dependent on local food sources (e.g. bushmeat, fish). This dependability on wild food represents a high sensitivity of Shawi households to the impacts of environmental changes, including climate change; this finding is consistent with previous research on food security among others Indigenous peoples in the Peruvian Amazon in a more economically developed context (Kuhnlein et al., 2009, Roche et al., 2008, Amaral, 2005,

Perreault, 2005, Lardeau et al., 2011, Romeo et al., 2015, Ortiz et al., 2013). These findings contribute a knowledge gap regarding contemporary Indigenous food systems in countries that are experiencing improvements in national wealth but still face persistent social inequity (CEPAL, 2016).

6.2.5 Characterizing the role of non-climatic factors in mediating climate impacts on health

Chapter Five contributes to previous research on the proximal and distal non-climatic factors shaping the vulnerability of food security to climate change (O'Brien et al., 2007; Sherman et al., 2015). The identification of climatic and non-climatic determinants of food security among Shawi participants in this thesis informs the literature about adaptive pathways that are potentially associated with negative health externalities in the face of climate change responses. For example, the development of agricultural practices and a growing population are negatively affecting fresh water ecosystems, which has implications for access and use of wild food sources. Findings from Chapter Five inform the overarching thesis goal by showing that Shawi food security is vulnerable to changing climatic conditions, not only due to the climate hazard *per se*, but also due to a series of pre-existing conditions that are constraining the ability of the Shawi households and communities to take advantage of national initiatives to improve their access to income and diversify their livelihoods.

6.3 Policy contributions

6.3.1 Informing health and climate adaptation priorities at the global level

This research contributes to adaptation planning at the global, local, and national levels by exposing current health and social disparities among an Indigenous Amazonian population. Latin

America has some of the greatest inequalities globally (CEPAL, 2016). In this context, and without explicit consideration of Indigenous social gradients and their causes, historically-excluded populations, such as the Shawi, may be excluded from the benefits of adaptation efforts and investment. Multiple authors have reported on the poor nutritional condition of Indigenous Amazonian peoples in Latin America (Section 2.3.6), yet food security and nutritional status among Indigenous peoples in Amazonia remains underrepresented in the food policy and climate change literature that inform global adaptation negotiations (Porter, J.R. et al. 2014). For example, the most recent report on the state of global food security and nutrition highlighted high levels of food insecurity, stunting, wasting, and anemia among African populations, noting that Latin America has seen substantial improvements on nutritional indicators (FAO 2017). Such results, while positive for Latin America in general, risk masking continued malnutrition and the potential widening of health gradients among populations such as the Shawi. My thesis thus provides important place-based knowledge that will be critical to guide sustainable and equitable development planning among under-represented populations (Griggs et al., 2013).

6.3.2 Existing coping mechanisms could inform climatic policy actions

My thesis helps to identify and highlight existing coping mechanisms within communities and households that could be recognized and valued by policymakers in order to improve food security and planning for adaptation interventions nationally and regionally. For example, my thesis highlights the importance of valuing local approaches to food utilization, such as cassava. The Shawi as well as other Amazonian peoples have developed a system to process cassava following an ancient fermented process that results on a traditional beverage called "*Masato*". Drinking *masato* has been described among other Indigenous Amazonian people as "*the image*

of an ideal life "(Tuesta, et al 2008) and is described by Shawi as helpful for supressing thirst and hunger. Cassava is a climate-resilient crop, although it also has cyanuric components; cassava thus may reflect both an adaptive and maladaptive coping mechanism and further support and research are needed. Furthermore, fermented food can contain beneficial probiotics (Franz et al., 2014), which are currently the focus of clinical trials in Ghana as treatment for children with diarrhea (Lei et al., 2006). In Ecuador, initial findings suggest that the presence of important microbiota in traditionally-prepared *masato* provides health and immunity benefits for local Indigenous peoples (Colehour et al., 2014). Similarly, there are multiple other seasonal fruits and animal species (e.g. especially to alleviate anemic conditions) that may reflect climate-resilient local adaptations grounded in local knowledge. In addition to traditional foods, my thesis also highlights livelihood strategies (e.g. food sharing) and coping mechanisms, such as location of crops and homes to avoid the impacts of flooding or extreme weather events. Existing coping mechanisms will be critical in informing and underpinning successful and locally-relevant adaptation planning.

6.3.3 Highlighting the potential for intra-household double burden of malnutrition

My thesis contributes to policy discussions regarding options and implications of an emerging nutritional transition among Indigenous populations in the Amazon. Previous reports have highlighted rapid changes in the nutritional profile of Indigenous Amazonian peoples, likely associated with socioeconomic changes and urbanization (Hidalgo et al., 2014, Port Lourenço et al., 2008). Obesity and cardiovascular conditions already are prevalent among Indigenous Amazonian populations in Brazil and Ecuador (Almeida et al., 2016, Coimbra et al., 2013, Liebert et al., 2013), while in Peru only one study has documented high prevalence of obesity and hypertension among Ashaninkas (Romero et al., 2014). My dissertation detected that some

Shawi households had an overweight parent and a child with nutritional deficiency. The coexistence of underweight and overweight affecting children and adults living in same household is consistent with emerging research in Latin America indicating that severe household food insecurity was strongly associated with a household double burden of malnutrition (Gubert et al., 2017, Pérez-Escamilla, 2017). Efforts to prevent chronic health conditions associated with these trends require the development of program targets and the establishment of public health monitoring that recognize that members of food insecure Indigenous households could have differential nutritional profiles. Such information is critical to avoid policies or programs that erroneously assume all household members have the same nutritional profile, an assumption which could result in ineffective or maladaptive health outcomes. It is thus important to establish a baseline characterization of current prevalence of malnutrition and drivers of double burden. My thesis provides such baseline data for the Shawi in Peru, reflecting an important benchmark to monitor change and the impact of policy intervention in the context of an Amazonian nutritional transition.

6.3.4 Policy recommendations for national programming to aid Shawi communities

Chapter Four of this thesis developed specific recommendations to adapt Peruvian food and social programming to respond to Shawi perspectives and cultural values (See Box 4-1 and Box 4-2). Moreover, the fact that the diet consumed the day before and the food security of children were significantly associated with child stunting (See Chapter Three) point to food as a key modifiable determinant among Shawi (Marmot and Health, 2007). However, under conditions of intrahousehold double burden of malnutrition among Shawi participants, strategies aiming to improve food security will need to be cautious when combatting high child malnutrition in order

to avoid jeopardizing parenteral and community health by contributing to an increase in chronic health conditions.

6.3.5 Identification of entry points for climate adaptation

The results of this dissertation question the adequacy of current local food and economic strategies for improving the food security of Indigenous Amazonian people, especially in the context of climate change where new hazards will affect local food systems. In contrast, household and community adaptive capacity are crucial as food security coping strategies to respond to annual climate variability and extremes. These findings suggest that long-term adaptations must capitalize on local adaptive responses and available food system resources to respond to climatic stresses in the future. This means that community member voices need to be incorporated to implement effective adaptive strategies, especially to identify trade-offs and options to take advantage of future climatic conditions.

For example, the knowledge, promotion, and utilization of the forest food sub-system to respond to extreme climatic events when households experience extreme hunger will potentially require revision of environmental legislation on forest and biodiversity management. Options to make more economically valuable products from the farming food sub-system could improve access to financial resources, although this would need to be balanced with considerations about natural resources degradation.

6.4 Methodological contributions

6.4.1 Mixed methods approach to investigate food security

I used three methods to measure food security in Chapter Three (HFSSM, anthropometric indices, and hemoglobin test), combined with qualitative data collection, reflecting a mixed-method approach to the research questions in this thesis. This is in accordance with the recommendation of the FAO to generate a more "holistic understanding of food insecurity status" (FAO, 2013).

6.4.2 Consideration of intra-household variation.

The cross-sectional study in Chapter Three was based on household sampling to better understand the association between individual nutrition and household food security in the Peruvian context, where nutrition and food security interventions primarily focus on vulnerable population and prioritize specific household members (Acosta and Haddad, 2014, Alcázar, 2007). Inviting both parents and a child to participate in the cross-sectional study is a novel contribution to the literature as there has been negligible consideration of intra-household nutritional dynamics. This study design allowed my thesis to demonstrate that not only children but also adults were affected by malnutrition and, furthermore, that intra-household nutritional disparity was emerging.

6.4.3 Giving voice to Indigenous perspectives on food/social programming.

My use of qualitative methods to critically appraise Peruvian food programs is relatively novel for health research and policy in Peru, yet was important to highlight Indigenous perspectives and inform policy recommendations. Moreover, results from Chapter Four, which combine

quantitative and qualitative methods, contribute to the global discussion on the relevance of local diet and food preferences as determinants of the nutrition transition and food insecurity among vulnerable populations (FAO, 2017). In the last empirical chapter, I highlighted the importance of education for Shawi participants as a mechanism to diversify livelihoods, explaining the decision of many households to purchase school supplies instead of food with external money. Qualitative methods also documented the multiplicity of strategies, institutions, and knowledge that the Shawi people had to respond to the local climate variability and extremes. When combined with the results of my first empirical chapter — finding high levels of food insecurity and nutritional disparities — my qualitative findings indicate that to support Shawi food security in a changing climate multiple sectors will need to participate in the promotion of environmentally and socially sustainable adaptation pathways, while not jeopardizing existing local capacity to adapt.

6.4.4 Comparability with other reports about mechanism of climate change impacts on Indigenous food systems in the Peruvian Amazon

This thesis employed a contextual vulnerability approach, consistent with other research investigating climate change impacts on food security among Indigenous peoples. In doing so, my research provides opportunities to critically appraise similarities and differences compared to other studies conducted in the Peruvian context and globally. For example, the Shawi food system differs considerably from the Shipibo people in the Ucayali river due to very different geography, and thus types of food resources available; while the Shawi are located on high lands close to the headwater rives, the Shipibo live on low lands where seasonal flooding is part of annual climate variability (OGE, 2002, Huertas Castillo and Chanchari Lancha, 2011). Despite

these ecosystem differences, both Shawi and Shipibo have developed multiple adaptive mechanisms to access food in their environments and throughout the year (Sherman et al., 2015). Additionally, both populations have reported that climate variability and hydrological cycles strongly influence their availability and utilization of food. Social factors such as food sharing networks were reported as a key modifier that could decrease both Shawi and Shipibo vulnerability to food insecurity at critical times. Even when proximal drivers of food security differ among Indigenous populations, for example in terms of the type of ecosystem that they access, how they are expecting to diversify their livelihoods to improve their food security (e.g. educative desires), and the type of climatic exposure (e.g. seasonal community flooding), they share similar distal factors such as Peru's political economy, social exclusion, and high levels of income inequality that is reflected in low access to paid jobs (Sherman et al., 2015). My methods and findings thus contribute to the knowledge base for multiple geographies of climate change and food security among Indigenous people in Amazonia.

6.5 Limitations

6.5.1 Generalizability

While the place-based nature of this thesis implies that specific results are not generalizable to other populations, the general insights from this research — as outlined in the contributions above — are relevant to our understand of climate change vulnerability among Indigenous people in Amazonia and more broadly. The characteristics of climate change in particular, being a global exposure with manifestations and impacts at specific locations, implies that findings from this research are an important contribution to informing adaptation to climate change in Peru and in the Amazon region. In addition, the social and health disparities between Indigenous

and non-Indigenous populations have been observed throughout Latin-American and the rest of the world (Stephens et al., 2005, Stephens et al., 2006). This implies that findings from this dissertation, particularly those implicating the role of distal drivers in influencing local vulnerability, may provide insights for understandings of the social determinants of Indigenous vulnerability to climate change more broadly.

There are around 100 Shawi communities in Peru; for this thesis, I partnered with eleven communities from a total of nineteen along one river; the geographical access and cost (e.g. I would need to use a helicopter or private flight to save time and work on more distant communities) meant it would have been very difficult and costly to involve more communities in the context of the timeframe of a doctoral thesis. Shawi communities share similar social and cultural background, however, and have experienced a common historical colonization process (Ormaeche and Barclay, 2008, Fuentes, 1988). Research across other communities and rivers have found similar dependency of Shawi livelihoods on the natural environment (Ormaeche and Barclay, 2008, Huertas Castillo and Chanchari Lancha, 2011). Although those studies did not focus on food security or climate change, one study did report similarities in the food environment to those observed in my work; the *Juntos* and *Vaso de Leche* programs were also observed in other Shawi communities (Ormaeche and Barclay, 2008). Research has also noted that Shawi report perceiving alterations in the local climate (Huertas Castillo and Chanchari Lancha, 2011). I argue that my findings are broadly representative of the food security situation, food systems activities, and climate change vulnerability among Shawi as an ethnic group.

6.5.2 Instruments

In terms of my specific quantitative methods, I used standardized instruments to determine nutritional status, and a culturally-appropriate and adapted household food security questionnaire. In the case of diet composition, however, I created my own qualitative categories to divide food in three major groups (animal protein sources, carbohydrate-rich foods, and non-starchy vegetables) based on the diet reported by households. Although these categories followed general FAO recommendations (FAO and WHO, 2016), they differ from the conventional nutritional classifications reported in other studies (e.g. nutrient classifications). This was because I did not collect detailed information about types and amounts of food (e.g. 24-hour dietary recall) and because this research study was intended to be an initial characterization and description of the current diet that Shawi access. Similarly, I did not collect data on physical activity levels. These two variables — nutrient consumption and energy expenditure — will be essential, for example, to test the hypothesis that household members who receive governmental intervention are more vulnerable to chronic health conditions via alterations in their diet composition and /or reduced physical activity.

Results from the household food security instrument used in this thesis found minimal variability, and thus did not appropriately capture the range of Shawi experiences of food insecurity. In Uganda, this same instrument was re-designed to investigate the food security of Indigenous people because, like in this thesis, they did not find sufficient variation (Patterson et al., 2017). This represents a limitation to my measure of food insecurity at the household level and limits the potential monitoring of progress for this indicator. Because food security measures using questions could be influenced by expectations or other components of self-perception or priorities (Pinstrup-Andersen, 2009), anthropometry and micronutrient evaluations (e.g.

hemoglobin) are alternatives to evaluate and monitor progress on food security (FAO, 2002, Pinstrup-Andersen, 2009). It is also possible that Shawi notions of egalitarianism (Fuentes, 1988) influenced my finding that almost every household had similar reported food insecurity. Additionally, while I adapted the food security measure for the local culture and language (Appendix 1b), I avoided major modifications so as not to compromise comparability with food security among other populations.

6.6 Directions for further research

6.6.1 Education as a support mechanism for climate change adaptation

The role of education as a support mechanism for climate change adaptation requires further study in the context of Indigenous Amazonian peoples. For example, whether is possible to improve the access and quality of education so that households and communities could diversify their livelihoods and consequently communities would theoretically be more resilient. Given that children spend several hours at school, knowledge transmission and opportunities for extensive experience with traditional food system activities may decrease, and at the end of secondary studies educated youth may be less competent in their own language or know less about traditional activities and local climatic and environmental risks. Working with a population of low income settlements in El Salvador and Brazil, an investigator found that higher levels of formal education affected the likelihood of living in a risky area and that those with more education visualized more numerous options for recovery after a hazardous climatic event (Wamsler, 2011). However, this research also found that education worked as a mechanism for recovery only where formal employment was available. It suggested that improving access to education in and of itself will not guarantee that communities will be more prepared to respond to climatic risks. However, other investigators reported that, independent of income, level of

education and literacy rate were inversely associated with number of deaths from a disaster; this was attributed to the ability to seek and access information that governmental initiatives deliver (Adger et al., 2004). For the Shawi, this would translate into the causal expectation that education would improve their Spanish and thus facilitate better access to governmental aid. However, this assumes that the benefits of education will outweigh any potential losses in local and traditional knowledge about preparedness and response to risk.

6.6.2 Nutrition transition in a changing climatic context

Additional research might further investigate the mechanisms that underpin the nutritional transition in the context of a changing climate (Chapter Three). In particular, I would prioritize a focus on whether socioeconomic and environmental transformations (Finer et al., 2008, UNEP, 2009) are interacting with more frequent climatic hazards reported in the Amazon region (Malhi et al., 2008, Marengo et al., 2013), directly or indirectly, to determine local food security and the emergence of chronic health conditions. For example, in Brazil researchers hypothesized that a governmental intervention has critically jeopardized local food security and adaptive capacity among the rural Amazonian population, eroding the practice of collective work and traditional division of labour by gender and age (Peperata, et al 2016). Even though this previous study did not include a climatic lens, researchers noted that non-significant improvements in child nutrition and food security of mothers was documented after a four-year period of Brazilian governmental intervention (Peperata, et al 2016). Longitudinal studies will be required to examine how climatic and non-climatic factors could interact to influence food security, nutrition, and health. In this context, a key research direction will be to investigate and co-develop opportunities for community-based participatory surveillance programming to monitor health, well-being, and key

indicators of climate exposure, sensitivity, and adaptive capacity. This particular research focus is already funded and will comprise a component of my post-doctoral work.

6.6.3 The role of traditional and ecological knowledge for climate change adaptation

The traditional and ecological knowledge of the Shawi Indigenous people to respond to food insecurity and climactic hazards, as reported in Chapter Five, deserves deeper investigation. Characterization of the nutritional content of traditional and modern foods to identify key foods that could contribute to improved nutrition and/or food security in the short and long-term of Shawi could inform the development of health, nutrition, and food security adaptive responses. To this end, I will investigate over the next few years the potential to develop regional (e.g. Amazonian Peru) facilities for nutritional laboratory analysis, with a focus on Indigenous and traditional foods. At the same time, Shawi knowledge about climate variability and risks and their associations with annual food availability and access could be incorporated into the local risk management system for nutrition security of Shawi communities.

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8 APPENDICES

Appendix 1a: Characteristics of the eleven Shawi communities included and questionnaires

	Families with children up to 5 **years**		Description	
Community name	Total	Invited to participate (% accepted)	Geographical access from the closest city	Services
a[1]	10	excluded	2.0 hr road plus 6 hr on foot	Primary
b[1]	6	excluded	2.0 hr road plus 1.5 hr on foot	Primary
c[1]	6	excluded	2.0 hr road plus 1.5hr on foot	Primary
d[1]	6	excluded	2.0 hr road plus 2.5 hr on foot	Primary
e[1]	5	excluded	2.0 hr road plus 2.0 hr on foot	Primary
f[1]	5	excluded	2.0 hr road plus 2hr on foot	Primary
g[1]	4	excluded	2.0 hr road plus 1.45 hr on foot	None
h[2]	4	excluded	2.0 hr road plus 3 hr on foot	Primary
i	50	47 (94)	2.0 hr road plus 5 hr on foot	kindergarten, primary, and health post
j	40	36 (90)	1.7 hr road	kindergarten, primary and secondary
k	24	22 (92)	1.5 hr road	kindergarten, primary
l	19	18 (95)	2.0 hr road	kindergarten, primary and health post
m	14	12 (86)	1.0 hr road plus 45 min on foot	kindergarten, primary
n	12	12 (100)	1.5 hr road plus 20 min on foot	kindergarten, primary
o	11	10 (91)	1.0 hr road	kindergarten, primary and health post
p	11	10 (91)	1.3 hr road	kindergarten
q	9	8 (89)	2.0 hr road plus 1hr on foot	none
r	8	8 (100)	2.0 hr road plus 30 min on foot	none
s	6	5 (83)	1.0 hr road plus 20 min on foot	kindergarten
Total participating	204	188 (92)		

excluded for distance > 5hr walking

[1]excluded for few households with children ≤ 5y

[2]rejected to participate

INDIVIDUAL SURVEY FOR THE FATHER or the male caregiver of the child

The following questions are to be answered by the father or the male caregiver of the child. The questions are related to your work, your habits, your trips and your health. Age of participant: _____years.

1. How far did you get in your studies?
- □ No formal education (cannot read or write)
- □ No formal education (can read or write)
- □ Pre-school education
- □ Incomplete primary education
- □ Complete primary education
- □ Incomplete secondary education
- □ Complete secondary education
- □ Some type of higher education
- □ Doesn't know
- □ Refused

2. How many years did you study? (write down the total number of years that she attended school, an institute or university)

……

3. Do you currently have a paid job?
- □ Yes (1)
- □ No (0)
- □ Doesn't know(.)
- □ Refused(.)

4. What type of job do you have?
- □ Full time
- □ Part time
- □ Occasional
- □ Seasonal
- □ Doesn't know
- □ Refused

5. During what time of the year do you have this job?
- □ Summer
- □ Winter
- □ All year long
- □ Some months in the year
- □ Doesn't know
- □ Refused

6. What job is this?
- □ Teacher
- □ Mason
- □ Worker
- □ Artisan
- □ Other (specify) …….

Regarding the activities, you performed over the last two weeks:

7. Did you fish?
Yes No

8. What for?
- □ Just for consumption at home
- □ For consumption at home and for sale
- □ Just for sale
- □ For gifts or exchange
- □ Other…….(write down)
- □ Doesn't know / Refused

9. Did you engage in farming?
Yes No

10. What for?
- □ Just for consumption at home
- □ For consumption at home and for sale
- □ Just for sale
- □ For gifts or exchange
- □ Other…….(write down)
- □ Doesn't know / Refused

11. Did you raise animals?
Yes No

12. What for?
- □ Just for consumption at home
- □ For consumption at home and for sale
- □ Just for sale
- □ For gifts or exchange
- □ Other…….(write down)
- □ Doesn't know / Refused

13. Did you do handcraft?
Yes No

14. What for?
- □ Only for my home
- □ For my home and for sale
- □ Just for sale
- □ For gifts or exchange
- □ Other…….(write down)
- □ Doesn't know / Refused

15. Did you hunt?
- Yes
- No

16. What for?
- Just for consumption at home
- For consumption at home and for sale
- Just for sale
- For gifts or exchange
- Other…….(write down)
- Doesn't know
- Refused

17. Did you collect medicinal plants?
- Yes
- No

18. What for?
- Just for consumption at home
- For consumption at home and for sale
- Just for sale
- For gifts or exchange
- Other…….(write down)
- Doesn't know
- Refused

19. Have you traveled outside your community?
- Yes
- No

20. Where did you go?

……..……

21. **What for?**

……

22. How many nights did you spend out of your community?

……..

23. Did you sleep last night under a mosquito net?
- Yes
- No

24. Was that mosquito net impregnated or treated to kill mosquitoes?
- Yes
- No

25. **Do you drink alcohol?**
- Yes
- No

26. **How often do you drink alcohol?**
- Once a week
- Once a month
- Occasionally
- Doesn't know
- Refused

27. **How much do you drink?**
- I never get drunk (a little)
- Until I get drunk (heavily)
- Doesn't know
- Refused

28. **Do you smoke? (we mean cigarettes)**
- Yes
- No

29. **How often do you smoke?**
- Once a week
- Once a month
- Occasionally
- Doesn't know
- Refused

30. **How much you smoke?**
- Once cigarrete a time (a little)
- More than one cigarette a time (a lot)
- Doesn't know
- Refused

31. **Do you use any drug? (we mean cocaine, or marihuana or other)**
- Yes
- No

32. **How often do you use that drug?**
- Once a week
- Once a month
- Occasionally
- Doesn't know
- Refused

33. Thinking in general about your life. How happy are you?
- Very sad
- A little sad
- OK
- A little happy
- Very happy

34. Do you identify yourself with the community?
- Much
- Strongly
- Kind of weakly
- Very weakly

INDIVIDUAL SURVEY FOR THE MOTHER or the female caregiver of the child

The following questions are to be answered by the mother. The questions are related to your work, your habits, your trips and your health. Age of participant: _____years.

35. How far did you get in your studies?

- ☐ No formal education (cannot read or write)
- ☐ No formal education (can read or write)
- ☐ Pre-school education
- ☐ Incomplete primary education
- ☐ Complete primary education
- ☐ Incomplete secondary education
- ☐ Complete secondary education
- ☐ Some type of higher education
- ☐ Doesn't know
- ☐ Refused

36. How many years did you study? (write down the total number of years that she attended school, an institute or university)

……

37. Do you currently have a paid job?

- ☐ Yes (1)
- ☐ No (0)
- ☐ Doesn't know(.)
- ☐ Refused(.)

38. What type of job do you have?

- ☐ Full time
- ☐ Part time
- ☐ Occasional
- ☐ Seasonal
- ☐ Doesn't know
- ☐ Refused

39. During what time of the year do you have this job?

- ☐ Summer
- ☐ Winter
- ☐ All year long
- ☐ Some months in the year
- ☐ Doesn't know
- ☐ Refused

40. What job is this?

- ☐ Teacher
- ☐ Mason
- ☐ Worker
- ☐ Artisan
- ☐ Other (specify) …….

Regarding the activities, you performed over the last two weeks:

41. Did you fish?

Yes No

42. What for?

- ☐ Just for consumption at home
- ☐ For consumption at home and for sale
- ☐ Just for sale
- ☐ For gifts or exchange
- ☐ Other…….(write down)
- ☐ Doesn't know / Refused

43. Did you engage in farming?

Yes No

44. What for?

- ☐ Just for consumption at home
- ☐ For consumption at home and for sale
- ☐ Just for sale
- ☐ For gifts or exchange
- ☐ Other…….(write down)
- ☐ Doesn't know / Refused

45. Did you raise animals?

Yes No

46. What for?

- ☐ Just for consumption at home
- ☐ For consumption at home and for sale
- ☐ Just for sale
- ☐ For gifts or exchange
- ☐ Other…….(write down)
- ☐ Doesn't know / Refused

47. Did you do handcraft?

Yes No

48. What for?

- ☐ Only for my home
- ☐ For my home and for sale
- ☐ Just for sale
- ☐ For gifts or exchange
- ☐ Other…….(write down)
- ☐ Doesn't know / Refused

49. **Did you hunt?**
- Yes
- No

50. **What for?**
- Just for consumption at home
- For consumption at home and for sale
- Just for sale
- For gifts or exchange
- Other…….(write down)
- Doesn't know
- Refused

51. **Did you collect medicinal plants?**
- Yes
- No

52. **What for?**
- Just for consumption at home
- For consumption at home and for sale
- Just for sale
- For gifts or exchange
- Other…….(write down)
- Doesn't know
- Refused

53. **Have you traveled outside your community?**
- Yes
- No

54. **Where did you go?**

……..……

55. **What for?**

…….

56. **How many nights did you spend out of your community?**

……..

57. **Did you sleep last night under a mosquito net?**
- Yes
- No

58. **Was that mosquito net impregnated or treated to kill mosquitoes?**
- Yes
- No

59. **Do you drink alcohol?**
- Yes
- No

60. **How often do you drink alcohol?**
- Once a week
- Once a month
- Occasionally
- Doesn't know
- Refused

61. **How much do you drink?**
- I never get drunk (a little)
- Until I get drunk (heavily)
- Doesn't know
- Refused

62. **Do you smoke? (we mean cigarettes)**
- Yes
- No

63. **How often do you smoke?**
- Once a week
- Once a month
- Occasionally
- Doesn't know
- Refused

64. **How much you smoke?**
- Once cigarrete a time (a little)
- More than one cigarette a time (a lot)
- Doesn't know
- Refused

65. **Do you use any drug? (we mean cocaine, or marihuana or other)**
- Yes
- No

66. **How often do you use that drug?**
- Once a week
- Once a month
- Occasionally
- Doesn't know
- Refused

67. **Thinking in general about your life. How happy are you?**
- Very sad
- A little sad
- OK
- A little happy
- Very happy

68. **Do you identify yourself with the community?**
- Much
- Strongly
- Kind of weakly
- Very weakly

INDIVIDUAL SURVEY REGARDING THE CHILD

The following questions are to be answered by the mother, father or any of the child's caretakers. The questions are related to the child's habits, trips and health.

69. Who is answering this survey on the child?

- ☐ The child's male caretaker
- ☐ The child's female caretaker

70. The child's male caretaker who answered the previous survey in page _____ is

- ☐ The father
- ☐ The grandfather
- ☐ The uncle
- ☐ Other ……..(specify)

71. The child's female caretaker who answered the previous survey in page _____is

- ☐ The mother
- ☐ The grandmother
- ☐ The aunt
- ☐ Other ……..(specify)

72. Date of birth of the child

_____day_____month_____year

73. **Age** ……

74. How far did the child get in his/her studies?

- ☐ No formal education (cannot read or write)
- ☐ No formal education (can read or write)
- ☐ Pre-school
- ☐ Incomplete primary education
- ☐ Doesn't know
- ☐ Refused

75. How many years did the child study? (write down the total number of years he/she attended school, an institute or university)

……

76. What number of child is this child (the older, second, third, etc.) write down

……..

Regarding the activities performed by the child in the last two weeks:

77. Has the child traveled outside his/her community?

- ☐ Yes
- ☐ No

78. Where did he/she go?

……..……

79. **What for?**

…….

80. How many nights he/she spent outside his/her community?

……..

81. Did the child sleep last night under a mosquito net?

- ☐ Yes
- ☐ No

82. Was that mosquito net impregnated or treated to kill mosquitoes?

- ☐ Yes
- ☐ No

Regarding the feeding of the child:

83. Until when did he/she breastfeed?

……months/years of age

84. When did you start giving him/her food?

…… months/years of age

85. What was the first food you gave the child?

……

86. At what age did the child start drinking 'mazato' (fermented cassava drink)?

…… months/years of age

87. **Who is the person in charge of preparing the food for you and your family?**

- The father
- The mother
- The grandfather
- The grandmother
- Another member of the family like an uncle, an aunt, etc.

88. **Age of the person who prepares the food for this family _____**

Thinking about the food you had yesterday, could you tell me:

89. **What did you eat? ……..**

……..

90. **How did you get the food or the meal? Check all that apply**

- **You bought it (specify what type of food did you buy)**

  ……
- **You brought it from your small farm (specify what type of food did you bring from your small farm)**

  ……
- **You caught it by fishing (specify what type of food did you caught)**

  ……
- **You collected it from the woods (specify what type of food did you collect)**

  ……
- **You hunted it (specify what type of food did you hunt)**

  ……
- **The food was donated (specify what type of food did you receive as a donation)**

  ……
- **Some other form of getting food (specify what type of food)**

  ……

91. **In the last month, have you been worried about that the food for you and your family would run out before you could find more**

- Many times (1),
- sometimes (1),
- Never (0),
- Don't know (.),
- No response(.)

92. **In the last month, how often food that you had, didn´t last enough time and you couldn't find more**

- Many times (1),
- sometimes (1),
- Never (0),
- Don't know (.),
- No response(.)

93. **In the last month, have you had enough different foods to eat well?**

- Many times (0),
- sometimes (1),
- Never (1),
- Don't know (.),
- No response(.)

94. **In the last month, you or someone else adult in your home had have to eat less or stop to eat because there was not too much food at home?**

- Yes (1)
- No (0)
- Don't know (.),
- No response(.)

95. **In the last month, how often did it happen?**

- almost every day (1),
- few days (1),
- only 1 or 2 days (0),
- don´t know (.),
- no response(.)

96. **In the last month, did you or other adults in your home feel that they lacked food because there was not enough food at home?**

- Yes (1)
- No (0)
- Don't know (.),
- No response(.)

97. **In the last month, did you or other adults in your home stay hungry but didn´t eat because there wasn´t enough food at food?**

- Yes (1)
- No (0)
- Don't know (.),

102. **In the last month, have you had enough different food to feed children well**

- Many times (0),
- sometimes (1),
- Never (1),
- Don't know (.),
- No response(.)

103. **In the last month, did you happen that your children didn´t eat enough because you couldn't find enough food??**

- Many times (1),
- sometimes (1),
- Never (0),
- Don't know (.),
- No response(.)

104. In the last month, did you give children less food because there was not enough food at home?

- Many times (1),

- No response(.)

98. In the last month, did someone notice that you were skinnier or did you see other adults in your home get skinnier because there wasn´t enough food at food?

- Yes (1)
- No (0)
- Don't know (.),
- No response(.)

99. In the last month did you or someone else adult in your home stay without food for a whole day because there was not much food at home?

- Si (1)
- No (0)
- No sabe(.)
- No responde(.)

100. In the last month, how often did it happen?

- almost every day (1),
- few days (1),
- only 1 or 2 days (0),
- don´t know (.),
- no response(.)

Following questions are about your children

101. In the last month did you happen that you had to give children others foods because food ran out at home and it was hard to find good food??

- Many times (1),
- sometimes (1),
- Never (0),
- Don't know (.),
- No response(.)

- sometimes (1),
- Never (0),
- Don't know (.),
- No response(.)

105. In the last month did any children skip a meal because there was not enough food at home?

- Yes (1)
- No (0)
- Don't know (.),
- No response(.)

106. In the last month, how often did it happen?

- almost every day (1),
- few days (1),
- only 1 or 2 days (0),
- don´t know (.),
- no response(.)

107. In the last month, did any of your children feel hungry but he/she didn´t eat because there was not food at home?

- Yes (1)
- No (0)
- Don't know (.),
- No response(.)

108. In the last month, did any of your children stay without food for a whole day because there was not much food at home?

- Yes (1)
- No (0)
- Don't know (.),
- No response(.)

Appendix 1b: Adaptation and codification of the (HFSSM)

Adaptation

The HFSSM questionnaire was adapted to the Shawi indigenous language and to local food security interpretation as part of a previous investigation aimed to characterize the vulnerability of Indigenous Health to climate Change, by working with remote populations (see http://ihacc.ca). Adaptation process have included translation to Spanish and to Shawi language. First the HFSSM questionnaire was translated into Spanish by one of the authors (CZ). The first Spanish version was presented to one female and one male fully Shawi bilingual teachers (the experts in Shawi bilingual education in the Loreto region) whom read carefully each question and answer alternatives in order to provided insights on appropriate wording in local Spanish to be understand for Shawi people who are bilingual. Teachers also made suggestions to regarding on the food security of local communities. For example, they heave recommended to avoid the use of money within questions since Shawi in this territory still practice self-production for getting food and access to cash incomes was very low. The second Spanish version was then presented to the field Shawi research assistants in order to answer each question and to verify whether the language and objective of each food security item was appropriate for a typical Shawi households. Eight research assistance belonged to three different communities have facilitated the fieldwork. They have been recommended by local authorities for their high literacy in Spanish and to be highly bilingual Spanish-Shawi. The final adapted writing Spanish version was orally standardized with the most fluently bilingual research assistant verifying that questions were properly applied. A Shawi writing version of the questionnaire was created for monitoring and informative purposes (See Table 1). The questionnaire was piloted using Shawi language in two communities twice prior to full data collection.

The final adapted version included the following main modifications respect to the original HFSSM:

1. Questions were adapted to ask explicitly for the food situation of adults and children who lives in the visited house.
2. Period of recall was suggested to modify to one month instead of one year, because food security might vary over the year and participants declared that one month is a more realistic period to remember how food situation was in each household.

3. In this context most families rely on own food production therefore, questions were adapted to ask for "find", "get" or "enough food at home" instead of "buy" or "enough money for food"
4. Children question referred as "***low***-cost food to feed the children" was modify for "others foods because food ran out at home and it was hard to find good food".
5. "Balanced meals" was suggested to change by "enough different foods to eat well? where fish or game meat was named as the most scare item.
6. According with Shawi research assistants an ideal high food security situation generally implies that household members had access to either fish or game in addition to cassava or plantain, while when they referred to the worst food security situation or "do not eat the whole day" means that they only had masato (cassava beverage) along the day for "*calm hungry*".

Codification

Responses received a value of 1 or 0 depending on whether it was a positive or negative food security condition respectively. Answers "yes", "many times", "sometimes", "almost every day" or "few days" were positive, whereas responses "no", "never" and "only one or two days" were coded as negative. Only for questions 3 and 12, the response "many times" was negative and "never" was positive. (See Table 2 for adapted version and codes). A direct imputation method was applied to nonresponse items under the premise that a household that affirms an item will, in general, have affirmed all less severe items and a household that denies an item will, in general, deny all more severe items.

Table 1. Food security questions applied, answers and codification: Original HFSSM, Spanish and Shawi adapted versions

	Standard HFSSM questions	HFSSM Original alternatives (code)	Back translations of the locally adapted Spanish questions	Back translations of the locally Spanish alternatives (code)	Spanish questions	Spanish answers (code)	Shawi questions	Shawi answers
1	"I *worried whether our food would run out* before we got money to buy more."	Often (1), Sometimes (1), Never (0), Don't know (.), No response(.)	In the last month, have you been worried about that the food for you and your family would run out before you could find more	Many times (1), sometimes (1), Never (0), Don't know (.), No response(.)	En el último mes ¿alguna vez has estado preocupado que la comida para ti y tu familia se termine antes que puedas encontrar más?	Muchas veces (1), algunas veces (1), nunca (0), No sabe (.), No responde(.)	Isu yuhki paninke anaruterant a kusharu pawaterink e ku ana kenayatasu we?	Nakun inauran Anataweri inauran ku pawaninwe ku nituterinwe Ku ya shawiriwe
2	"The *food that we bought just didn't last*, and we didn't have money to get more."	Often (1), Sometimes (1), Never (0), Don't know (.), No response(.)	In the last month, how often food that you had, didn´t last enough time and you couldn't find more	Many times (1), sometimes (1), Never (0), Don't know (.), No response(.)	En el último mes ¿con qué frecuencia la comida que tenían no duró lo suficiente y no pudieron encontrar más?	Muchas veces (1), algunas veces (1), nunca (0), No sabe (.), No responde(.)	Isu yuhki paninke kusharu manansu ku wakiterinke nwe	Nakun inauran Anataweri inauran ku pawaninwe ku nituterinwe Ku ya shawiriwe

3	"We *couldn't afford to eat balanced meals."*	Often (1), Sometimes (1), Never (0), Don't know (.), No response(.)	In the last month, have you had enough different foods to eat well?	Many times (0), sometimes (1), Never (1), Don't know (.), No response(.)	.En el último mes ¿han tenido suficientes alimentos diferentes para comer bien?	Muchas veces (0), algunas veces (1), nunca (1), No sabe (.), No responde(.)	Isu yuhki paninke naku kusharu nisha nisha yaweterin nuya kushatamar e	Nakun inauran Anataweri inauran ku pawaninwe ku nituterinwe ku ya shawiriwe
4	In the last 12 months, did *you or other adults* in your household ever *cut the size of your meals or skip meals* because there wasn't enough money for food?	yes (1), no (0), don´t know (.), no response(.)	In the last month, you or someone else adult in your home had have to eat less or stop to eat because there was not too much food at home?	yes (1), no (0), don´t know (.), no response(.)	En el último mes ¿tu u otra persona mayor en tu casa han tenido que comer menos cantidad o dejar de comer porque no había mucha comida en la casa?	si (1), no (0), no sabe(.), no responde(.)	Isu yuhki paninke kema peinenke pupian pupian kanama ku akete kusharu yawerinwe nitun	Inauchi Ku ku nituterinwe Ku ya shawiriwe
5	How often did this happen	almost every month, (1), some months but not every month (1), only one or	In the last month, how often did it happen?	almost every day (1), few days (1), only 1 or 2 days (0), don´t know (.), no response(.)	En el último mes ¿Qué tan seguido pasó esto?	casi todos los días (1), solo algunos días (1), sólo 1 or 2 días (0), no sabe(.), no responde (.)	Isu yuhki paninke ¿uhpuruchit a inauchin ninama kahtutaweri ku	Yaipitaweriun chin(1) anataweri uchin(1) Katu taweriuchin(0) Ku nituterinwe(.)

		two months (0), don´t know (.), no response(.)						Ku ya shawiriwe(.)
6	In the last 12 months, did you ever *eat less than you felt you should* because there wasn't enough money to buy food?	yes (1), no (0), don´t know (.), no response(.)	In the last month, did you or other adults in your home feel that they lacked food because there was not enough food at home?	yes (1), no (0), don´t know (.), no response(.)	En el último mes ¿tu u otra persona adulta en tu casa sintió que le faltó comida porque no había mucha comida en la casa?	si (1), no (0), no sabe (.), no responde(.)	Isu yuhki paninke kema peinenke kusharu pawuanterin kema yunkirana ku yawerinwenitun	Inauchin(1) Ku(0) ku nituterinwe(.) Ku ya shawiriwe(.)
7	In the last 12 months, were you ever *hungry but didn't eat* because you couldn't afford enough food?	yes (1), no (0), don´t know (.), no response(.)	In the last month, did you or other adults in your home stay hungry but didn´t eat because there wasn´t enough food at food?	yes (1), no (0), don´t know (.), no response(.)	En el último mes ¿tu u otra persona mayor en tu casa se quedó con hambre pero no comió porque no había mucha comida en casa?	si (1), no (0), no sabe(.), no responde(.)	Isu yuhki paninke kema peinenke tanawiranawe ku kushateramawe ku kusharu yawerinwenitun	Inauchin(1) Ku(0) ku nituterinwe(.) Ku ya shawiriwe(.)
8	Sometimes people lose weight because	yes (1), no (0), don´t know (.),	In the last month, did someone notice that you	yes (1), no (0), don´t know (.), no response(.)	En el último mes ¿Te han visto enflaquecer o	si (1), no (0), no sabe (.), no responde(.)	Isu yuhki paninke nininen shintenan,	Inauchin(1) Ku(0) ku nituterinwe(.)

	they don't have enough to eat. In the last 12 months, did you *lose weight* because there wasn't enough food?	no response(.)	were skinnier or did you see other adults in your home get skinnier because there wasn´t enough food at food?		tu has visto enflaquecer a alguna persona adulta en tu casa porque no había mucha comida en casa?		kema ninan anake peineke shintenin ku kushatatuna we ku nakun kusharu yawerinwe nitun peike	Ku ya shawiriwe(.)
9	In the last 12 months, did *you or other adults* in your household ever *not eat for a whole day* because there wasn't enough money for food?	yes (1), no (0), don´t know (.), no response(.)	In the last month did you or someone else adult in your home stay without food for a whole day because there was not much food at home?	yes (1), no (0), don´t know (.), no response(.)	En el último mes ¿Tú u otra persona adulta en tu casa se quedó sin comer por un día completo porque no había mucha comida?	si (1), no (0), no sabe (.), no responde(.)	Isu yuhki paninke kema peinenke ku anateranta, ana taweriraw e kushaterin we ku kusharu yawerinwe nitun	Inauchin(1) Ku(0) ku nituterinwe(.) Ku ya shawiriwe(.)
10	How often did this happen	almost every month, (1), some months but not every	In the last month, how often did it happen?	almost every day (1), few days (1), only 1 or 2 days (0), don´t know (.), no response(.)	En el último mes ¿qué tan seguido pasó esto?	casi todos los días (1), sólo algunos días (1), sólo 1 o 2 días (0), no	Isu yuhki paninke ¿upuruhuch inta isuchin ninin?	Yaipi taweriunchin(1) anataweri uchin(1) Katu taweriuchin(0)

		month (1), only one or two months (0), don´t know (.), no response(.)				sabe (.), no responde(.)		Ku nituterinwe(.) Ku ya shawiriwe(.)
11	"*We relied on only a few kinds of low-cost food to feed the children* because we were running out of money to buy food."	Often (1), Sometimes (1), Never (0), Don't know (.), No response(.)	In the last month did you happen that you had to give children others foods because food ran out at home and it was hard to find good food?	Many times (1), sometimes (1), Never (0), Don't know (.), No response(.)	En el último mes ¿le ha pasado que tuvo que darle a los niños otros alimentos porque se acabo la comida en casa y era difícil encontrar comida buena?	Muchas veces (1), Algunas veces (1), Nunca (0), No sabe (.), No responde(.)	Isu yuhki paninke anaruterant a wawashane n keteran manin kushainteran ta kusharu pawuanink eran	Nakun inauran (1) Anataweri inauran(1) ku pawaninwe(0) ku nituterinwe(.) ku ya shawiriwe(.)
12	"We *couldn't feed the children a balanced meal* because we couldn't afford that."	Often (1), Sometimes (1), Never (0), Don't know (.), No response(.)	In the last month, have you had enough different food to feed children well	Many times (0), sometimes (1), Never (1), Don't know (.), No response(.)	En el último mes ¿han tenido suficientes alimentos diferentes para que los niños coman bien?	Muchas veces (0), algunas veces (1), Nunca (1), No sabe (.), No responde(.)	Isu yuhki paninke naku kusharu nisha nisha yaweterink e wawarusa nuya kushata kaisumare	Nakun inauran (0) Anataweri inauran(1) ku pawaninwe(1) ku nituterinwe(.) ku ya shawiriwe(.)
13	"The *children*	Often (1), Sometimes	In the last month, did you	Many times (1), sometimes	En el último mes ¿te ha	Muchas veces (1),	Isu yuhki paninke	Nakun inauran (1)

	were not eating enough because we just couldn't afford enough food."	(1), Never (0), Don't know (.), No response(.)	happen that your children didn´t eat enough because you couldn't find enough food?	(1), Never (0), Don't know (.), No response(.)	pasado que tus hijos no comieron lo suficiente porque no encontraste mucha comida?	algunas veces (1), nunca (0), no sabe (.), No responde(.)	wawarusa ku nuya kushatuwi we ku kusharu nakun kenanawe nitun	Anataweri inauran(0) ku pawaninwe(0) ku nituterinwe(.) ku ya shawiriwe
14	In the last 12 months, did you ever *cut the size of any of the children's meals* because there wasn't enough money for food?	Often (1), Sometimes (1), Never (0), Don't know (.), No response(.)	In the last month, did you give children less food because there was not enough food at home?	Many times (1), sometimes (1), Never (0), Don't know (.), No response(.)	En el último mes ¿le diste menos comida a los niños porque no había mucha comida en casa?	Muchas veces (1), algunas veces (1), nunca (0), no sabe (.), No responde(.)	Isu yuhki paninke wawarusa pupian pupian kusharu keteran ku kusharu nakun yawerinwe nitun	Nakun inauran (1) Anataweri inauran(0) ku pawaninwe(0) ku nituterinwe(.) ku ya shawiriwe(.)
15	In the last 12 months, did any of the *children ever skip meals* because there wasn't	yes (1), no (0), don´t know (.), no response(.)	In the last month did any children skip a meal because there was not enough food at home?	yes (1), no (0), don´t know (.), no response(.)	En el último mes alguno de los niños se quedó sin comer en algún momento porque no había mucha comida en casa?	si (1), no (0), no sabe (.), no responde(.)	Isu yuhki paninke anaken wawarusa ku kushatupiw e ku kusharu yawerinwe nitun	Inapuchin(1) Ku(0) ku nituterinwe(.) Ku ya shawiriwe(.)

	enough money for food?							
16	How often did this happen	almost every month, (1), some months but not every month (1), only one or two months (0), don´t know (.), no response(.)	In the last month, how often did it happen?	almost every day (1), few days (1), only 1 or 2 days (0), don´t know (.), no response(.)	En el último mes ¿Qué tan seguido pasó esto?	casi todos los días (1), sólo algunos días (1), sólo 1 o 2 días (0), no sabe(.), no responde(.)	Isu yuhki paninke ¿unpurupuc hinta inapuchin ninan?	Yaipi taweriunchin(1) anataweri puchin(1) Katu taweriuchin(0) Ku nituterinwe(.) Ku ya shawiriwe(.)
17	In the last 12 months, were the *children ever hungry* but you just couldn't afford more food?	yes (1), no (0), don´t know (.), no response(.)	In the last month, did any of your children feel hungry but he/she didn´t eat because there was not food at home	yes (1), no (0), don´t know (.), no response(.)	En el último mes ¿algunos días, alguno de sus niños estuvo con hambre, pero no había comida en casa	si (1), no (0), no sabe(.), no responde(.)	Isu yuhki paninke ¿anaken teranta wawashane n tanawiriwe ku kusharu yawerinwe nitun ku kushaterin we	Inapuchin(1) Ku(0) ku nituterinwe(.) Ku ya shawiriwe(.)
18	In the last 12 months, did any of the *children ever not eat for a whole*	yes (1), no (0), don´t know (.), no response(.)	In the last month, did any of your children stay without food for a whole	yes (1), no (0), don´t know (.), no response(.)	En el último mes ¿alguno de sus niños se quedó sin comer un día completo	si (1), no (0), no sabe(.), no responde(.)	Isu yuhki paninke ¿anaken teranta wawashane n ku	Inapuchin(1) Ku(0) ku nituterinwe(.) Ku ya shawiriwe(.)

	day because there wasn't enough money for food?		day because there was not much food at home?		porque no había comida en la casa?		kushaterin we ana tawerira ku kusharu yarerinwe nitun.	

Appendix 2: Household Questionnaire and interview guide

Head of household survey

Dear Sir, we work for a Program called Indigenous Health and Adaptation to Climate Change. We are conducting a research project to determine the living conditions and health of the population in relation to the changes in nature and climate. This information will help us devise projects that help communities cope with the climate change that is happening worldwide.
You can participate by answering the questions that we will ask next.
At the end of the study we will present the results so that you and your authorities are aware of them. If you have questions, we will answer them and we will also write them down to know what you think.

1. **What type of fuel is mainly used in your home to cook?**
   - Firewood
   - Kerosene
   - Electricity
   - Gas
   - Other (write down)_____
   - Doesn't know
   - Refused

2. **Is the house elevated? (built on a platform)**
   - Yes
   - No

3. **What material is your house made of?**
   - Roof _____
   - Walls _____
   - Floor _____

4. **How many windows do you have at your house?**
   - None
   - One
   - Two
   - More than two
   - Doesn't know
   - Refused

5. **Does someone in the family have? Check all that apply**
   - cell phone?
   - satellite phone?
   - radio?
   - electricity?
   - electric generator?
   - hunting weapon?
   - large metal pot?
   - mud pot?
   - bicycle?
   - motorcar or motorcycle?
   - car or truck?
   - boat?
   - motor?
   - small canoe?
   - large canoe?
   - other type of vehicle or means of transportation?
   - blankets to cover when it is cold?
   - None of these , Doesn't know , Refused

6. **In your family, do you raise any animal?**
   - Yes
   - No

7. **¿Do you raise hens or chicken?**
   - Yes_____(write down how many)
   - No

8. **Do you raise ducks?**
   - Yes_____(write down how many)
   - No

9. **Do you raise pigs?**
   - Yes_____(write down how many)
   - No

10. **Do you raise cattle?**
    - Yes_____(write down how many)
    - No

11. **Do you have dogs?**
    - Yes_____(write down how many)
    - No

12. **Do you have cats?**
    - Yes_____(write down how many)
    - No

13. **Other types of animals? (write down which other classes of animals there are in this house, like parrots, turtles, white-lipped peccary, monkeys and write down the type)**
    ……

14. **Is there a small farm in your community?**
    - Yes_____ (write down how many)
    - No
    - Doesn't know
    - Refused

15. **Is the small farm owned by you or by the community?**
    - Owned by him/her
    - Owned by the community
    - Doesn't know
    - Refused , Other ……

16. **Head of household name**
_____

17. The head of household is:
- The father
- The mother
- The grandfather
- The grandmother
- Another family member like an uncle, an aunt, etc.

18. **Head of household age** _____

19. Age of the head of household couple _____

20. Individual head of household code
_____

21. Does the head of household agree to participate?
- Yes
- No

22. Why doesn't he/she want to participate?
- Not interested in the survey
- Doesn't have time to participate
- Doesn't like research projects
- Other reason

23. Is the head of household a single mother or father?
- Yes
- No

24. What is the civil status of the head of household?
- Single
- Married
- Live-in partner
- Widow(er)
- Other

25. How many people, including you, live in this house?
Adults 18 and older _____
Minors 12 to 18 years old_____
Children 6 to 11 years old_____
Children 0 to 5 years old _____
- Refused
- Doesn't know

26. In the last five years, has someone from your family died?
- Yes_____(write down the number of deceased)
- No

27. The person who died more recently was
- A child
- An adult

28. **In how many spaces or parts is your house divided?**
_____

29. Write down how many of these spaces are used to
- Cook_____
- Sleep_____
- Raise animals_____
- For other purposes _____

30. Where is the kitchen located?
- Inside the house
- Separately, outside the house

31. **The land where your house has been built is owned by you or by the community?**

- Owned by him/her
- Owned by the community
- Doesn't know
- Refused
- Other ……

……

32. **Do you have any property like a small farm or land in another place? The land where your house is built is owned by you or by the community? (check all that apply)**

- Yes, in another native community
- Yes, in Yurimaguas
- Yes, in another place
- No
- Doesn't know
- Refused
- Other ……

……

33. **Do you have relatives who are working in another place and send you money or products to eat? (check all that apply)**

- Yes, they send money
- Yes, they send food
- No
- Doesn't know
- Refused
- Other ……

34. **Does someone from your family receive food from the government, from any program or institution?**

- Yes _____(write down the name of the institution or program)
- No

35. **What type of food does he/she receive?**

……..

36. **When was the last time that this person received this food? (write down the date)**

…….....

37. **Does your family receive economic support from the government, from any program or any other institution?**

- Yes _____(write down the name of the institution or program)
- No

38. **What type of support does it receive?**

……..

39. **When was the last time it received this support? (write down the date)**

……

40. **In the last year, has someone sprayed or fumigated the walls of your house to kill mosquitoes?**

- Yes
- No

41. **In what moth did they fumigate? (write down the month)**

……

42. **¿Do you have mosquito nets in your house?**

- Yes
- No

43. **How many mosquito nets do you have? (write down the number)**

……

44. **Generally, how many people sleep under each mosquito net? (write down the number)**

……..

45. **How many of these mosquito nets came treated or impregnated to kill mosquitoes? (write down the number)**

……..

46. **Last night, how many mosquito nets did you use? (write down the number)**

……..

47. **Where do you get or from where you bring water to drink, mainly?**
- River
- Lagoon (cocha)
- Ravine
- Well excavated inside the house
- Well excavated outside the house
- Spring water
- Rain water
- Other (write down which one) ……

  ……
- Doesn't know
- Refused

48. **If the abovementioned water source is not available, where would you get or from where would you bring water to drink?**
- River
- Lagoon (cocha)
- Ravine
- Well excavated inside the house
- Well excavated outside the house
- Spring water
- Rain water
- Other (write down which one) ……

  ……
- Doesn´t know
- Refused

49. **What do you think of the water you drink?**
- Really bad
- Bad
- Fair
- Good
- Very good
- Doesn't know
- Refused

50. **Before drinking the water, do you add or do something?**
- Yes
- No

51. **What do you add or do?**
- Boil or cook
- Filter
- UV radiation
- Add chemical substances like chlorine
- Buy purified water
- Let it rest
- Other
- Doesn't know
- Refused

52. **Where do you mainly relieve yourself?**
- Bathroom with sewage connection
- Covered latrine
- Uncovered latrine
- In the woods
- In the river
- Any other facility
- Doesn't know
- Refused

53. **Who uses this place?**
- It's just for my family
- We share it with people from other families
- Community
- Doesn't know
- Refused

54. **Do you have a special place to wash your hands at your house?**
- Yes
- No

55. **So far, do you have any question or comment?**

……

……..

……..

Characteristics of participants in the qualitative interviews

	Community			Age
	A	B	Total	
	n	n	N	mean (min/max)
Women	6	3	9	36.7 (19, 60)
Men	5	4	9	37.7 (30, 46)
Elders	2	2	4	66.0 (53, 76)
Teachers	1	1	2	50.0 (50,50)

Appendix 3. Interview guidelines

Semi-structured interviews	
Objective: To characterize practices for getting food throughout the year and how they are related to food availability, access and utilization	**Participants**: Key informants; Male and female, elderly

General questions

Greetings, I would like to talk with you today about your community and about food. I am going to ask you about food in your community in the present, in the past and in the future. This interview will take approximately 45 minutes. Do you accept to talk with me?

1. Availability

What do you do to obtain your food? Is it the same throughout the year?

Do you share your food? Which foods?

Do you barter your food? What type of food and for what kind of goods?

Do you sell your food? How often? To whom? What do you usually buy with that money?

Do you have domestic animals like chickens, pigs or cows? How do you feed these animals?

Do you use domestic animals as food? Which animals? Under what circumstances?

Do you buy food? What food do you buy?

2. Access

During which part of the year do you eat well? What are factors that make this time a good time for getting food?

During which part of the year do you not eat well? What are factors that make this time a bad time for getting food? How do you deal with this?

What places are important for getting your food?

What kind of difficulties do you have to obtain your food?

What kind of food do you get in the community and what kind of food do you get in Yurimaguas?

3. Utilization

What food do you prefer?

What food do you consider is better for your health/ child/ pregnant women/elderly?

What food do you consider is worse for your health/ child/ pregnant women/elderly? Explain

How do you store and preserve your food?

How do you prepare your food?

4. Coping strategies

Do you remember a time when there was a severe scarcity of food for you and your family? Can you describe what happened?

What did you do to get food?

Do you remember a time when there was an abundance of food for you and your family? Can you describe what happened?

What would you do if someday your food production was damaged by drought/ flooding?

Transect-walks	
Objective: To explore crop production practices and constraints by accompanying participants to their lands	**Participants**: Key informants; Male and female, elderly

General questions

Greetings, I would like to talk with you today about your crops and farming practice. I would like to join you today to your land to better register your impressions and opinions. This interview will take approximately 45 minutes. Do you accept to talk and walk with me?

5. Time allocation

How many hours do you work in average?

Could you please describe, what kind of crops do you have in your land?

What is the most difficult time during the day for working your land? and why? Could you explain please?

What is the easiest time during the day for working your land? and why? Could you explain please?

Is there a time/month when you work in your land less hours than usual? and why? Could you explain please?

Is there a time/month when you work in your land more hours than usual? and why? Could you explain please?

In the past. Did people work the same than now in their land? and why? Could you explain please?

What are consequences of that change on your crop production?

Appendix 4. Approved letters and Consent forms

McGill University
ETHICS REVIEW
RENEWAL REQUEST/STUDY CLOSURE FORM

Continuing review of research involving humans requires, at a minimum, the submission of an annual status report to the REB. This form must be completed to request renewal of ethics approval. If a renewal is not received before the expiry date, the project is not considered to be approved and no further research activity may be conducted. When a project has been completed, this form can also be used to officially close the study. To avoid expired approvals and, in the case of funded projects, the freezing of funds, this form should be returned 2-3 weeks before the current approval expires.

REB File #: 497-0514
Project Title: Vulnerability of Shawi indigenous people to food insecurity and identification of adaptation opportunities to climate change
Principal Investigator: Claudia-Carol Zavaleta
Email: Claudia.zavaleta@mail.mcgill.ca carolzavaleta2009@gmail.com
Faculty Supervisor (if PI is a student): Prof. Lea Berrang-Ford

1. Were there any significant changes made to this research project that have any ethical implications that have not already been reported to the REB? ____YES X NO
   If yes, complete an amendment form indicating these changes and attach to this form.

2. Are there any ethical concerns that arose during the course of this research? ___ YES __X_ NO
   If yes, please describe.

3. Have any participants experienced any unanticipated issues or adverse events in connection with this research project? ___ YES X NO
   If yes, please describe.

4. Is this a funded study? X YES ___ NO
   If yes, list the agency name and project title and the Principal Investigator of the award if not yourself. This information is necessary to ensure compliance with agency requirements and that there is no interruption in funds.
   IDRC doctoral award; IDRC,SSHRC,CIHR and NSERC – IHACC
5. Does this project require REB approval from another Institution/Board? X YES ___ NO
   If yes, and the project is continuing, attach a copy of the current approval.

Principal Investigator Signature: _____ _Date: _14 July 2015_____

Faculty Supervisor Signature: _____ _____ Date:___14 July 2015_____
(if PI is a student)

____ Check here if the **study is to be closed** and continuing ethics approval is no longer required. A study can be closed when all data collection has been completed and there will be no further contact with participants.

_X Check here if this is a **request for renewal** of ethics approval.

Submit by email to lynda.mcneil@mcgill.ca. REB Office: James Administration Building, 845 Sherbrooke Street West suite 429, Mtl., QC H3A0G4; tel: 514-398-6831/6193; fax: 514-398-4644;www.mcgill.ca/research/researchers/compliance/human
(December 2014)

UNIVERSIDAD PERUANA
CAYETANO HEREDIA
Vicerrectorado de Investigación
Dirección Universitaria de Investigación
Ciencia y Tecnología - DUICT

CONSTANCIA

El Presidente del Comité Institucional de Ética (CIE) de la Universidad Peruana Cayetano Heredia hace constar que el comité de ética aprobó la **ENMIENDA/MODIFICACIÓN** del proyecto de investigación señalado a continuación.

Título del Proyecto	**: "Evaluación en salud en comunidades indígenas amazónicas en el contexto del cambio climático: Enfermedades transmisibles por vectores, enfermedades gastrointestinales y seguridad alimentaria".**
Código de inscripción	**: 59472**
Investigador principal	**: Dr. Alejandro Llanos Cuentas**

La **enmienda/modificación** corresponde a los siguientes documentos:

- ✓ **Protocolo de Salud indígena,** versión 3 de fecha 13 de mayo del 2014
- ✓ **Consentimiento informado para el jefe de comunidad**, versión de fecha 2 de enero 2012, enmienda 13 mayo 2014.
- ✓ **Consentimiento informado para el participante**, versión de fecha 1 de enero 2012, enmienda 13 mayo 2014.
- ✓ **Consentimiento informado para el jefe de familia**, versión de fecha 2 de enero 2012, enmienda 13 mayo 2014 v3.
- ✓ **Consentimiento Informado Individual,** versión 2 de fecha 22 de mayo del 2014.
- ✓ **Consentimiento Informado Comunitario,** versión 2 de fecha 22 de mayo del 2014.
- ✓ **Consentimiento Informado para uso de fotografía,** versión 2 de fecha 22 de mayo del 2014
- ✓ **Permiso del Padre para participación de un menor,** versión 11 – 2010
- ✓ **Asentimiento Informado Individual,** versión 11 – 2010

Lima, 27 de mayo del 2014

COMITÉ INSTITUCIONAL DE ÉTICA-CIE
UNIVERSIDAD PERUANA CAYETANO HEREDIA
DUICT

Lic. Rosa Vaiz Bonifaz
Presidenta (e)
Comité Institucional de Ética en Investigación

/lpr

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