



THE UNIVERSITY OF QUEENSLAND
AUSTRALIA

Living with drought: a study of spatial mobility in semi-arid Northeast Brazil

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BA(Hons)

*A thesis submitted for the degree of Doctor of Philosophy at
The University of Queensland in 2015*

School of Geography, Planning and Environmental Management

Abstract

This thesis examines spatial mobility in relation to livelihood portfolios and capital assets among rural households during the 2010-2013 drought in semi-arid Northeast Brazil. Spatial mobility is a strategy adopted by rural households to respond to the impacts of climatic events in marginal regions around the globe. Permanent and seasonal forms of migration have been widely documented in the African Sahel and in Southeast Asia, but less attention has been given to South America. Moreover, little consideration has been given to the way climatic events impact on local forms of temporary mobility, including diurnal activity patterns and circular mobility.

The distinctive socioeconomic and physical context of Northeast Brazil provides a unique setting to explore these relationships. On the one hand, the settlement pattern provides greater spatial choice. On the other hand, a robust welfare system reduces vulnerability to external stressors such as climatic events. At the same time, semi-arid Northeast Brazil suffers from cyclical droughts, including an intense and prolonged drought for the majority of 2010-2013. Such slow-onset climatic events represent a major threat to marginal communities relying on rain-fed agricultural systems. This study presents an empirical account of the impacts of the recent drought on spatial mobility and livelihood strategies in three rural localities in the State of Ceará. The methodology is multifaceted including, analysis of aggregate regional data on migration and climate, a survey of rural households, key-informant interviews, and the application of a new toolkit designed to capture the space-time signature of local circulation patterns. Nested within a regional case-study, these data were complemented by a macro approach which examines the broad socioeconomic and climatological context of the region.

A robust conceptual model was developed to guide the research, situating household livelihood strategies in a framework defined by access to five broad groups of assets, within the wider socioeconomic and physical context, and tracing changes in the spatiotemporal dimensions of mobility resulting from the drought. At the aggregate level, the study uses census data and indirect estimates to link population dynamics to climatic events in the Northeast Region and in the State of Ceará. At the micro level, the study couples an intensive survey with field observation to examine household access to five forms of capital which mediate livelihood strategies among smallholder farmers. Analysis revealed four distinctive types of households, which differed in asset endowment and livelihood strategies: welfare-dependent, mixed livelihood, non-farming and commercial livestock-oriented.

Differences between the four types were reflected in the way they were impacted by climatic events, and in the strategies employed to respond to the hardship.

The study also sought to compare household perceptions of changes in the local climate against scientific climatological data. Respondents showed clear awareness of the 2010-2013 drought but a poor understanding of the true dynamics of climate variability in the region. It also sought to establish the significance of climatic events among other external factors impacting livelihoods by examining perceptions of community issues. Respondents ranked climate variability and drought below other factors such as crime, access to credit and markets, unemployment and poverty. However, the recent drought appears to have exacerbated these problems which suggest that climatic events impact indirectly as well as directly on everyday aspects of residents' lives and livelihoods.

The study employed conventional techniques to capture permanent and seasonal migration, but developed a new toolkit (MISTIC - Mobility in Space and Time among Individuals and Communities) to measure more nuanced variations in temporary mobility and local circulation. The toolkit captured both production- and consumption-related mobility using a participant-centred approach that identified duration, frequency and spatial patterns. The findings revealed that permanent and seasonal migration were both prevalent among households, but differed in rationale, composition and destinations. Permanent moves were selective of young adults motivated primarily by employment opportunities rather than being a response to drought. Permanent migration was mainly rural-urban. Seasonal migrants were predominantly mature males engaged in off- and non-farm work in response to climate variability, and generated more diverse flows, especially to rural destinations. However, the greatest impact of the 2010-2013 drought was on diurnal and circular mobility, with customary patterns of production- and consumption-related activities shifting markedly in intensity, timing and spatial distribution. The two household types with fewer assets, Welfare-dependent and Mixed-livelihood, recorded the most significant changes, with fewer and shorter trips to fetch water from local dams, visit distant relatives, and attend farmers' markets. However, access to social capital gained importance for all household types increasing trips associated to friends and religious activities.

The findings revealed that the welfare system in Brazil, compared to other countries, has direct implications on livelihoods, and on the movement of individuals who could otherwise have engaged in seasonal or permanent migration due to climatic events. As a result, in

contrast to findings elsewhere, shifts in local mobility became a more prevalent response to the drought.

Declaration by author

This thesis is composed of my original work, and contains no material previously published or written by another person except where due reference has been made in the text. I have clearly stated the contribution by others to jointly-authored works that I have included in my thesis.

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Publications during candidature

Peer-reviewed papers

1. Safra de Campos, R, Bell, M, Charles-Edwards, E 2014, Collecting and analysing data on climate-related local mobility: the MISTIC toolkit (submitted)

Conference papers

2. Safra de Campos, R, Bell, M, Charles-Edwards, E, McNamara, K 2015, Living with drought: Understanding the role of mobility in livelihood strategies to cope with climatic variability. Paper presented to the 8th International Conference on Population Geographies, Brisbane, Australia

3. Safra de Campos, R, Bell, M and Charles-Edwards, E, McNamara, K 2014, Living with drought: Understanding the role of mobility in livelihood strategies to cope with climatic variability. Paper presented to the 17th Biennial of the Australian Population Association, Hobart, Australia

Publications included in this thesis

Publication 1 was partially incorporated in Chapter 9. Safra de Campos, R (candidate) was responsible for 60% of conception and design, 100% of analysis and interpretation of data and 60% of drafting and writing. Bell, M was responsible for 30% of conception and design and 30% of drafting and writing. Charles-Edwards, E was responsible for 10% of conception and design and 10% of drafting and writing

Contributions by others to the thesis

Professor Martin Bell and Dr Elin Charles Edwards had input in the conception and design of the project, interpretation of data analysis and critically revised previous drafts of the thesis. Dr Karen McNamara contributed to the organisation of Chapter 4 and critically revised the final drafts of Chapters 1, 2, 4 and 10 of the thesis.

Statement of parts of the thesis submitted to qualify for the award of another degree

None.

Acknowledgements

I would like to express my special appreciation and thanks to my supervisors Professors Martin Bell and Dr Elin Charles-Edwards, whose guidance and support have been fundamental in all phases of this journey. I am also grateful to Dr Karen McNamara for her contributions in the early stages of this thesis. I would like to thank my colleagues at the Queensland Centre for Population Research and the School of Geography, Planning and Environmental Management for their advice and support during this project.

I wish to thank the University of Queensland and the School of Geography, Planning and Environmental Management for providing me with financial support necessary to complete my PhD studies in a timely manner. This support allowed me to attend important conferences and workshops where I was able to disseminate my work and engage with my peers.

I want to mention my deepest gratitude to the 90 families in rural Irauçuba whose participation in the household survey was fundamental to the completion of this thesis. Without their time and input this work would not have been possible.

Thank you also to my mother Lourdes for her guidance and counsel, as well as her endless support throughout all stages of my life. You have always been a light to me when all other lights go out. In addition I would like to thank my father Gidalberto, my uncle Alceu and Mr Renato Tancini for their support and encouragement. I am also thankful to my parents-in-law, Kristen, Brooke and Tim, for their love.

My gratitude goes to my dear friends Tiago, Diogo, Thiago, Eliel and Jose Carlos for their always present emotional support. The distance may have separated us but true friendship carries on irrespective of distance. I would also like to thank Philipp and Christabel for their support and friendship. May we remain close friends for as long as time allows.

Finally, I would like to thank my dear wife Felicia who has provided unconditional love and support in good and bad times. We met halfway into my PhD journey and since then she has been the most caring and warmest companion during this endeavour. Thank you for your unshakable patience and understanding.

Keywords

spatial mobility, livelihoods, climatic events, northeast brazil, data collection, measuring migration

Australian and New Zealand Standard Research Classifications (ANZSRC)

ANZSRC code: 160303, Migration, 70%

ANZSRC code: 050204, Environmental Impact Assessment, 30%

Fields of Research (FoR) Classification

FoR code: 1604, Human Geography, 75%

FoR code: 1603, Demography, 25%

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Abbreviations

| | |
|---------|--|
| ANOVA | Analysis of variance |
| DFID | Department of International Development |
| EMBRAPA | Brazilian Agricultural Research Corporation |
| FUNCEME | Foundation for Meteorological and Hydrological Resources of the State of Ceará |
| IBGE | Brazilian Institute of Geography and Statistics |
| IPCC | Intergovernmental Panel on Climate Change |
| ITCZ | Intertropical Convergence Zone |
| MISTIC | Mobility in Space and Time among Individuals and Communities |
| NEB | Northeast Brazil |
| NELM | New Economics of Labour Migration |
| PRA | Participatory Rural Appraisal |
| SLA | Sustainable Livelihood Approach |
| UNFFC | United Nations Framework Convention on Climate Change |
| USA | United States of America |

Chapter 1. Introduction

1.1 Background

In their First Assessment Report the Intergovernmental Panel on Climate Change (IPCC) identified migration and displacement as potentially one of the most complex and threatening effects of climate change (IPCC 1990). Seventeen years later Wilbanks et al. (2007) argues that estimates of environmental migrant totals and direction of flows are still, at best, guesswork, with considerable variability in projected numbers. This reflects the naivety of methods used to generate such estimates which are commonly based on the size of the population in at-risk regions and on the assumption of migration as a last-resort response with all individuals responding to the same stimuli in the same way. The resultant estimates of environmentally-induced migrants range from 250 million (Myers 1993, 2005) to one billion people (Christian Aid 2007), although other studies suggest that future impact of climate change will lead to only minor population movements (Tacoli 2009). Greater consensus exists regarding the spatial distribution of environmental migrants, with the majority of movement predicted to occur within the borders of developing nations (Laczko and Agharzam 2009).

Despite growing recognition of the potential scale of environmentally-driven migration, there is no agreement as to what constitutes an environmental migrant. As of yet there is only a limited understanding of the mechanisms that prompt environmentally-related population movement. Moreover, a wide range of mobility patterns may result from environmental change, and there is little recognition of the role that temporary mobility may play in the livelihood strategies of vulnerable populations subject to environmental shocks (Brown 2007; De Haas 2007; Hampshire and Randall 1999). In addition, limited attention has been paid to migrant destination in the context of climatic and other environmental stressors (Findlay 2011).

Past studies of environmentally-induced migration have instead focused on push and pull factors (Davis 1963; Myers and Kent 1995) that contribute to the decision to migrate permanently, focusing on the role of population structure and composition (Bilsborrow 2002; Donner and Rodriguez 2008), and how the decision to migrate varies across and within households in the same community (Martin et al 2014; Wolpert 1966). Research has also examined the impact of different environmental stressors on migration, categorising these as either 'sudden-onset' (Belcher and Bates 1983; Frey and Bates 2006; Paul 2005) or

'slow-onset' (Apeldoorn 1981; Findley 1994; McGranaham et al. 2007; Mortimore 1989). Most studies of environmentally-induced migration have been concentrated in Africa (Afifi 2008; Gila et al. 2007; Linenga et al. 2012; Marchiori et al. 2008; Mertz et al. 2009; Stal 2008, Van der Geest 2009), Asia (Dunn 2008; Murali and Afifi 2011; Zhang 2008) and in the Pacific (Barnett 2001; Connell and Conway 2000; Locke 2009; Mortreux and Barnett 2009). Much less attention has been given to other parts of the world, including locations such as semi-arid Northeast Brazil where climate change is predicted to intensify existing vulnerability to drought (Wanget et al. 2004). Northeast Brazil represents a markedly different setting from the regions mentioned above both in respect to policy and governance, as well as in cultural, socioeconomic and physical characteristics. These differences present a significantly altered context within which the environment-mobility nexus plays out.

Past approaches investigating linkages between climatic events and migration had often been based on static push and pull frameworks, ignoring the complex interplay between a wide range of drivers and responses in this relationship. Current studies acknowledge the multi-causality associated with migration, and also recognize the notion that mobility is a strategy to diversify livelihoods and supplement household income in response to environmental stress (Black et al. 2011; Brown 2007). Migration can reduce consumption, provide access to remittances, and enhance household resilience to external shocks (Hampshire and Randall 1999; Mortimore and Adams 2001). However, research is yet to find ways to capture and measure changes in temporary mobility patterns in the context of severe climatic events.

This thesis seeks to make contributions to knowledge with respect to the way in which discrete types of mobility (permanent migration, seasonal moves, and local diurnal mobility) form part of rural livelihoods strategies in semi-arid Northeast Brazil. It also aims to identify the factors which underpin the variability among several dimensions of this mobility, including shifts in the composition, purpose, spatial pattern, frequency, duration and seasonality of moves. This study thus endeavours to move beyond the conventional dichotomy of 'movers' and 'stayers' in order to establish a more encompassing framework. It does so through the development of a conceptual model that addresses the multifaceted characteristic of spatial mobility in the context of a climatic event. This model guides the development and application of a robust methodology to capture the relationship between spatial mobility, household livelihoods and climatic events.

1.2 Spatial mobility linked to rural livelihoods diversification strategies

This thesis utilises the Sustainable Livelihoods Approach (SLA) as the key organising framework. Rural income diversification has received increasing attention over recent decades (Reardon et al. 1992; Reardon and Tellegen 1997; De Haas 2007). It is defined as “an expansion of rural dwellers’ income sources away from farm labour” (Bryceson 1999, p. 172), and encompasses several strategies including self-employment, dependence on remittances and welfare payments, and non-farm work.

Recent studies focusing on rural household diversification strategies have investigated remote ecologically vulnerable regions where potential harvest failure predispose rural populations to incorporate a range of non-agricultural activities like handcrafts and trade in their livelihood strategies (Hampshire and Randall 1999). Anticipating shortfalls, households concentrate their efforts into a range of income-earning activities that offset the risk of agricultural production failure (Brujin and van Dijk 1997; De Haas 2007). Spatial mobility is one strategy available to households vulnerable to unexpected climatic oscillations. Involvement in non-agricultural activities may comprise discrete forms of mobility, from daily commuting to temporary relocation to urban or industrial centres, or to more permanent resettlement in other localities where work is available. The forms of mobility available to household members are linked to the availability of endogenous resources (social, physical, financial, human and natural capital) as well as to the exogenous structural context (for example, economic recession, political isolation or war) and the social and governance institutional framework (for example, cultural norms, laws, regulations and policies).

The extent of seasonal mobility from rural drought prone regions to areas of irrigated agriculture or urban centres are rarely captured in national statistics (Tacoli 2009). However, Henry, Schoumaker and Beauchemin (2004) concluded that rainfall variability triggered circular movement both from rural-to-urban as well as from rural-to-rural areas in Burkina Faso. Remittances and earnings from off- and non-farm labour have been found to play a major role in livelihood diversification strategies in Africa (Tiffen 2003) and Asia (Hoang, Dang and Tacoli 2005).

Despite the acknowledged potential of migration as an adaptive response and livelihood diversification strategy (Brown 2007; Chambers and Conway 1992; Hampshire and Randall 1999) there is little empirical evidence capturing and interpreting the spatiotemporal dynamics of mobility linked to livelihoods, and the shifts in the frequency, purpose,

composition, seasonality and spatial pattern in response to severe climatic events. This thesis seeks to contribute to knowledge with respect to the linkages between the environment and mobility by including the SLA and a suite of techniques derived from migration studies into its methodology to help discriminate the key factors that mediate this relationship.

1.3 Thesis aim and objectives

The overall aim of this thesis is to develop a critical understanding of human spatial mobility, encompassing both temporary and permanent moves that form part of household livelihood strategies and response to severe climatic events in marginal areas of semi-arid Northeast Brazil. Semi-arid Northeast Brazil is an ideal setting for studying the impact of climate events on mobility and household livelihood strategies, having recently experienced an intense and prolonged drought over the period of 2010-2013 (Gutiérrez et al. 2014). In this context, this research is guided by a series of objectives, which seek to:

1. Develop a conceptual model linking spatial mobility to rural livelihoods strategies in the context of severe climatic events

Conceptual models developed to further understand the environment-migration nexus have been theoretically incomplete. In the face of a climatic event, a variety of mobility actions are available to households. The investment required for long-distance travel may inhibit migration, but household members might have access to other forms of spatial responses that form the full spectrum of mobility. Previous models have been limited by an incomplete assessment of the range of external factors impacting on household vulnerability to environmental stressors, including differences in household resources and the institutional frameworks. As a result, conceptual models have painted an incomplete picture of the range of spatiotemporal forms of mobility in response to climatic events. The model presented in this study endeavours to capture the way in which the exogenous context (socioeconomic and environmental) interacts with social and institutional frameworks (cultural norms, laws, regulations and policies), and household resources to shape mobility in response to a severe drought in semi-arid Northeast Brazil.

2. Establish the socioeconomic and climatic context of contemporary mobility in semi-arid Northeast Brazil

The relationship between the environment and spatial mobility is complex and multifaceted.

In this objective, the factors underpinning the socioeconomic characteristics, and the nature, pattern and geographic distribution of the settlements in the region, will be explored. Supplementing these analyses, this objective also seeks to examine the climatological characteristics which determine the occurrence of cyclical droughts and rainfall variability. This is the starting point of a systematic investigation of the structural setting that creates marginal conditions for livelihoods in rural semi-arid Northeast Brazil. At the end of this phase, this study will have established the contextual characteristics that shape migration patterns in the region and in the study area in particular.

3. Identify the characteristics of households that shape livelihoods in rural semi-arid Northeast Brazil

The conceptual model developed in the first objective is the key organizing framework for this objective. Building on the findings of the second objective, this objective seeks to articulate the relationship between spatial mobility and livelihoods strategies. Distinct forms of mobility are triggered by external factors and processes endogenous to household livelihood strategies. These processes include sources of subsistence, income and the internal dynamic of households. At the end of this phase this study will have established a clear picture of the impact of climatic events in the context of livelihood strategies, access to capital assets and perceptions of socioeconomic and environmental factors which affect the lives of the inhabitants of the study area.

4. Determine the variation of mobility behaviour before and after the occurrence of a severe climatic event

Migration is widely recognised as a response of last resort to climate events, but livelihood strategies around the world draw on a variety of mobility actions characterized by spatial and temporal variations. One possible impact of a climatic event on household livelihood strategies is a shift in purpose, spatial pattern, frequency, composition, or seasonality of mobility associated with income-generating activities and other customary undertakings. The final objective of this thesis seeks to capture and measure spatial mobility behaviour and changes in patterns in the context of a severe climatic event (the 2010-2013 drought). Information is sought not only with respect to how climate events impact on the spatial signature, timing and purpose of mobility in the study area, but also how the characteristics of this impact influence different clusters of rural inhabitants. At the end of this stage, this research will identify and assess the spatiotemporal shifts in permanent migration, seasonal

moves and local diurnal mobility. It will also investigate the significance of five forms of capital assets and livelihood strategies in mediating mobility responses to climatic events.

1.4 Geographic setting: Semi-arid Northeast Brazil

Northeast Brazil encompasses the states of Maranhão, Piauí, Ceará, Rio Grande do Norte, Paraíba, Pernambuco, Alagoas, Sergipe and Bahia (Figure 1.1). This region covers almost 20% of the landmass of the country and over a quarter of Brazil's 190 million residents (IBGE 2010). Approximately half of the most vulnerable inhabitants of the country live in NEB (IBGE 2010). Land concentration characterised by *latifundios* (large plantations), backward political setting, stalled economic development, and environmental problems such as cyclical droughts and rainfall variability are recurrent features of the area. The socioeconomic aspects of the Northeast society are controlled by an economic elite which has a sphere of influence which touches, institutional structures, the police, the judicial system, and the politics. The Catholic Church is also an important feature of the socio-political economy of the region (Kenny 2002). At the 2010 census, the Northeast's GDP accounted for about 13% of the country's GDP. In contrast, the four states in the Southeast region, which occupy only 11% of the total land area, accounted for around 60% of Brazilian GDP (IBGE 2010). The livelihood of its rural population is heavily reliant on rain-fed subsistence agriculture and livestock activities, with limited opportunities to engage in full time non-farm work.

Northeast Brazil has been characterized as an area of outflow of population from the earliest official records on migration in the country. Explanations for this phenomenon are based on environmental causes (cyclical droughts and rainfall uncertainty), low quality of life (as revealed through demographic indicators such as infant mortality) and the poor economic dynamism of the region (Yap 1975, Kenny 2002). Destination choices among out-migrants are commonly framed in terms of improved access to services and better prospect of finding waged jobs in large urban areas (Yap 1975; Perz 2000). Because of the combination of these factors, Northeast Brazil presents a unique location for the study of the relationship between climatic events and spatial mobility (Finan and Nelson 2001; Marengo 2008).

Except for the Atlantic coastal line, Northeast Brazil is characterized by a semi-arid environment with high spatiotemporal rainfall variability and frequent drought, with only occasional flooding in the coastal zones (Marengo 2008). Semi-arid zones are defined as areas where rainfall is between 200 and 800 mm per year, and the year-to-year variability is relatively large, at 20%-30% of the annual mean (Rasmusson 1987). Legally, the semi-

arid area in Brazil (shaded area in Fig. 1) is characterised as a region with mean annual rainfall less than or equal to 800 mm (Silveira et al. 2007).

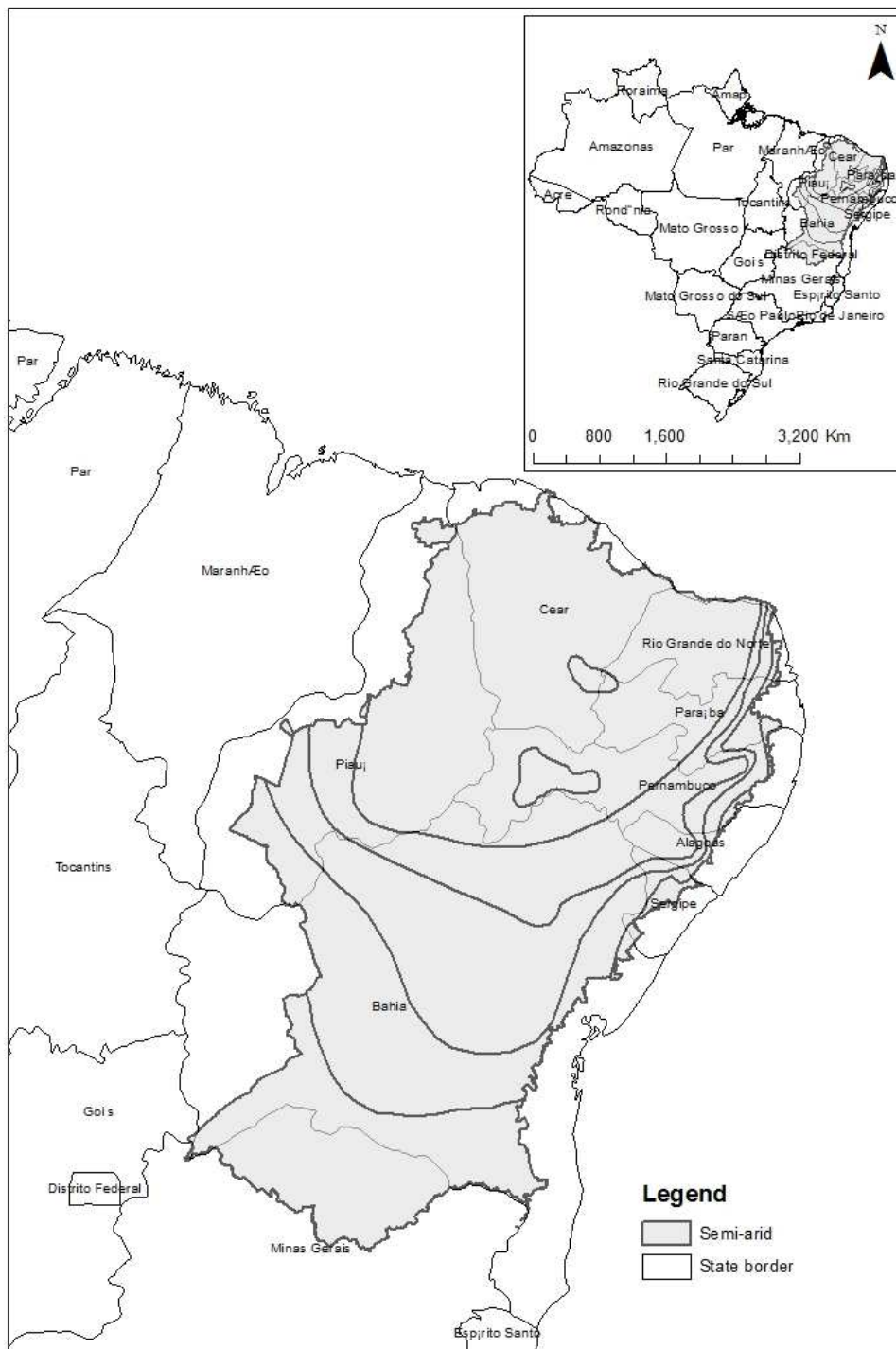


Figure 1.1 Semi-arid Northeast Brazil (IBGE, 2010)

The population of semi-arid Northeast Brazil, particularly smallholder farmers, sharecroppers, pastoralists and rural inhabitants are extremely vulnerable to the impacts of climate variability, which often compromise fragile livelihood systems (Finan and Nelson 2001; Marengo 2008). In this region, a historic succession of droughts has become a common phenomenon in the lives of its inhabitants (Kenny 2002), and “drought mitigation

policies have been mostly ineffective in reducing vulnerability for the majority of the population” (Araujo 2000, pp. 16). For these reasons, internal migration has historically been one of the strategies employed by individuals and families to escape drought effects and its resulting poverty (Brooks 1971).

Given the frequency of drought and lack of economic development in the area, there has been no cohort of *sertanejos* (traditional inhabitants of semi-arid Northeast) who has reached old age without having experienced some form of displacement during their lifetime (Mello 1964; Siegel 1971; Finan and Nelson 2001). Migration in response to the pervasive effects of climate variability and poverty created a cultural group named *viuvas da seca* (drought widows) (Brooks 1971). Previous studies reported that, upon leaving their communities during a hardship, the *retirantes*, (traditional semi-arid Northeast migrants) usually become inexpensive sources of labor in large metropolitan areas of the country (de Melo, Tereso and Abrahão 2010; Greenfield 1992).

1.5 Thesis structure

An understanding of the previous body of scientific knowledge and background is fundamental to appreciate the contribution of this research. Chapter 2 discusses the relevant literature and identifies knowledge gaps and other shortcomings in existing approaches. Chapter 3 outlines the methodological strategy employed to address the four objectives of this study. It describes the multifaceted approach, the data sources and the blend of techniques used in the analysis of the data. Instead of relying on a single strategy of analysis, this research integrates quantitative and qualitative techniques to interrogate the data at micro- and macro-level of analysis. Chapter 4 examines previous conceptual models in the environment-migration research, and sets out a new model, which expands on the relationship between structural socioeconomic factors and internal household characteristics in the context of climatic events, linking these two scales with key spatiotemporal dimensions of mobility. Using the conceptual model as a backdrop to guide interpretation, Chapter 5 begins the substantive analysis of this thesis. In tackling the second objective set out in 1.3, it investigates the aggregate links between macro socioeconomic and climatological factors which shape spatial mobility in Northeast Brazil. Guided by the micro level established in the conceptual model, Chapter 6 focuses on the third objective of this study. It examines household access to capital assets and livelihood strategies using the sustainable livelihoods framework to guide the analysis. Chapter 7 establishes the significance of climatic events among other external factors impacting livelihoods by

examining household perceptions of socioeconomic and environmental issues, and changes in the local climate. Chapter 8 focuses on addressing the fourth objective by investigating the characteristics and patterns of permanent out-migration and seasonal moves in the study sites and using qualitative tools reports shifts in mobility dynamics of rural households in the context of climate events. Chapter 9 investigates local diurnal and circular mobility in the study sites using a new toolkit constructed for this research to capture customary mobility associated with production- and consumption-related activities and the shifts brought about by the 2010-2013 drought. Chapter 10 concludes the thesis with a summary of the main findings. This chapter is framed around the four objectives of the research and the four domains of theory, methodology, substantive knowledge and policy. The concluding chapter also discusses limitations of the study and suggests potential paths for future research on the environment-migration nexus.

Chapter 2. A review of literature on the environment-mobility nexus

2.1 Introduction

Increasing concerns about the growing environmental problems have augmented the interest of the scientific community and policy makers on the linkages between population movements and the environment (Hugo 1996; Morrissey and House 2009; Myers 1993; Suhrke 1994). Since the early 1980s when global warming and climate change came to the forefront of media campaigns and international politics, the predictable scale of their impacts has been broadly disputed. Scientific publications on global climate change and environmental hazards have of late expanded beyond the debate surrounding the scientific basis of change to include substantial consideration of the impacts of current and future climate scenarios upon environments and societies worldwide.

One of the many impacts discussed within the literature is the potential for increased flows of migrants from areas severely affected by climatic events and other environmental stressors to destinations of relative economic and environmental prosperity. Despite the absence of an established global framework to measure the impact of climate change on societies, there is general agreement that many regions of the planet are losing their capacity to sustain a stable environment due to a combination of climate-related hazards and anthropogenic interaction such as erratic rainfall patterns, prolonged dry seasons, droughts, degradation of agricultural lands, desertification, more frequent floods and water pollution (Stocker et al. 2013). Born out of this debate, a new field of research has been established that investigates the existence, the scale and more recently the context of these flows of 'environmental migrants'.

While these studies have contributed valuable insights into the relationship between the environment and spatial mobility, what has been lacking is comprehensive research examining the shifts in intensity, timing, spatial pattern, composition and purpose in mobility behaviour brought about by climate events. Mobility in semi-arid Northeast Brazil is widely recognised as a livelihood response to the climate uncertainties in the region (Finam and Nelson 2001; Kenny 2002), but capturing, measuring and interpreting the spatial and temporal dynamics of this mosaic at individual, household and community levels represents a serious challenge to scholarship. Consideration of the dynamics of spatial mobility within livelihood strategies as a response to climate events is critical to gaining a better understanding of the environment-migration nexus.

As a first step towards addressing this deficiency, this chapter reviews prior research examining the relationship between the environment and human spatial mobility to outline gaps in knowledge and shortcomings in analytical approaches. To do so, this chapter reviews previous studies on migration, climate change and conceptual connections between the two categories. Section 2.2 is the starting point of this literature review and it examines key theories of migration. Section 2.3 provides an overview of climate change scenarios. Section 2.4 explores recent findings on temporary mobility studies and argues about its validity in the study of environmental migration outcomes. Section 2.5 reviews the changing definitions associated with environmentally-driven migration. Section 2.6 reviews the substantive knowledge on four broad areas of research on the subject, framing the discussion on the type of environment event, and interrogates the existing empirical data on the relationship between environmental change, climatic events and mobility. Section 2.7 explores methodological approaches within the literature. Section 2.8 identifies some of the deficiencies and knowledge gaps in the literature, and offers concluding remarks.

2.2 A review of key theories of migration

Outlining the linkages between environmental change and stressors on migration is a challenge that involves research from a range of scholarly disciplines. Drawing from these multiple disciplines requires researchers to integrate a variety of frameworks, methods and models from existing disciplines investigating the phenomenon. Early models examining migration were largely descriptive. On the one hand, these models did not provide formal analysis of the range of factors behind migration decisions. On the other hand, they provided useful insights that would be integrated into more rigorous research exploring the complexity of migration behaviour (Greenwood 1993). An early example is that of Ravenstein (1885), who, based on empirical observations within the UK, suggested a series of analyses regarding the phenomenon. These frameworks, known as gravity models, indicate that significant factors driving migration flows are the population sizes in places of origin and destination, and the distance between them (Ravenstein 1885). In this case, migration tends to be proportionally related to population sizes within the pertinent populations and inversely related to their distance apart. Most migrants move short distances from smaller towns to nearby large cities (Greenwood 1993). A gravity models are based on a simple economic notion that traversing distance involve costs that rise as the distance increases. This concept, known as the “friction effect” of distance underpins many economic theories.

One existing migration framework that seeks to bridge this gap is the macro theory of

neoclassical economics. The fundamental concept of this theory is based on the notion that migration is primarily triggered by regional disparities in the supply and demand of labour. The prospect of higher salaries in wealthier countries attracts people from developing and least-developed countries (Skeldon 2003). The same interpretation can be extrapolated with regard to places of origin and destination in internal mobility. As a result, the proportion of the labour force available in sending areas will decline, and salaries in these regions are expected to increase. At the other end of the spectrum, the workforce in receiving areas will increase and salaries are expected to fall. Labour migration will carry on until balance in the supply and demand of labour in origin and destination areas is attained.

These formal economic models of migration decisions originated from the Hicks-Sjaastad model, which suggested that migration is an investment which has the potential to increase the productivity of human resources (Sjaastad 1962). The model argues that people migrate across locations if the long term benefits of living in the new setting offset the costs of migration. In the model, if w_i and c_i denote the wages and cost of living in place of origin i , correspondingly, then a person will choose to migrate from location i to place of destination j if:

$$\sum_{t=0}^T \frac{(w_{jt} - c_{jt}) - (w_{it} - c_{it})}{(1 + r)^t} > C_{ij}$$

where c_{ij} are the costs of migrating from location i to place of destination j .

Several significant contributions follow from this model. First, the model indicates that young individuals will be more likely to migrate than more mature people, given that their discounted stream of benefits from migrating is more likely to offset migration expenses. Second, if a larger distance between place of origin i and place of destination j infers greater costs of moving then migration will be more likely between locations that are geographically closer to one another. Third, as a result of migration, salary differential between locations should be increasing and conversely the cost of moving differential should be decreasing.

Todaro (1969) introduced a revision to the Hicks-Sjaastad model based on the high rates of rural to urban migration in developing countries despite the fact that urban unemployment in these countries is high. In his model, Todaro (1969) suggested that migration choices are a function of anticipated value of income and costs associated with the journey in each

location. In his assessment, for example, rural migrants might have expectations about the time they will have to spend searching for a wage job should they decide to move to an urban area. If the projected wait to become part of the labour force is long, then the salary will need to be high in comparison to the rural wage in order to compensate for the waiting time. Harris and Todaro (1970) applied this model to economies with two main sectors, rural and urban. They argue that urban minimum wages are comparatively higher than rural minimum wages and that difference induce rural migration despite high levels of urban unemployment (Harris and Todaro 1970). Most relevant for this current study is the fact that environmental stressors such as climatic events can trigger mobility if they result in decreased wages or income due to changes in agricultural and livestock production, or in other economic activities.

Two migration theories that emphasise the intrinsic demand for labour in contemporary societies, as opposed to decisions made at the individual level, are the Dual Labour Market and the World Systems (Massey et al. 1993). The fundamental concept behind the former is that population movement is not triggered by push factors in origin regions. Instead, attraction factors at destination, predominantly the demand for external workers to complement the labour market, are the main cause. The internal dynamic of this theory reflects structural inflation, motivational difficulties, economic differentiation and the demographic characteristics of labour supply (Massey et al. 1993). The World Systems theory, predominantly based on work by Wallerstein (1974) suggests that multinational firms from developed capitalist societies, using developing countries as sources for inexpensive resources, land, labour and unexplored consumer markets, caused unequal economic development. As a result, a great volume of migration flows to developed countries ensued (Massey et al. 1993).

Other theories examining migration argue that migration is greatly aided by people's access to networks in receiving areas. These networks facilitate migrant transition into a new society by minimising costs and risks. It is also important to note the increase in the volume of undocumented migration during the course of the 20st century (Boyle, Halfacree and Robinson 2014). Furthermore, it has been widely acknowledged that migration processes have the capacity to change socioeconomic conditions in origin areas because they alter income distribution and other key capital assets, resulting in changes in the structure, context and social meaning of work. These characteristics influence migration decision-making process, and are identified as the cumulative causation of migration (Massey et al. 1993).

The micro theory of neoclassical economics is an opposing theory, which, contrary to the macro theory, suggests that migration is associated with the decision made by individual actors to maximise their income according to their skills and qualifications (Massey et al. 1993). The underpinning principle of this theory is that individuals assess the potential outcome of moving to another area by taking into consideration its potential benefits, such as better salaries, and diversified labour markets, and frame it against its drawbacks, including the financial costs associated with the journey, and the cultural and emotional costs associated with the adaptation to a different society (Massey et al. 1993).

The New Economics of Labour Migration (NELM), unlike the neoclassical economics system discussed above, frames migration as a collective decision made by actors such as households and families. This theoretical framework argues that desired migration outcome includes both the maximisation of individual profit, as well as the minimisation of loss of household overall income associated with crop failure, volatility of markets or economic recession. Considerations regarding the spreading of risk are particularly relevant in societies not supported by reliable insurance systems and welfare programmes provided by the spheres of government (Stark and Bloom 1985).

The theories discussed above conceptualise migration employing approaches that can be complementary or contradictory (Bakewell 2010; Massey et al. 1993). Despite the production of substantive conceptual frameworks, the development of an encompassing theory is yet to be achieved (Massey et al. 1993). These multiple theories explaining migration drivers and decisions have been the source of much debate because researchers often need to employ a range of approaches and frameworks to fit their study designs. Despite this limitation, it is important to note that scholars have reservations about the practicality of a single, encompassing theory, because of the multi-causal nature, and the range of intertwined factors associated with the phenomenon (Bakewell 2010).

Bakewell (2010) argues that there is a significant divide between existing migration theories. These theories revolve around the macro-economic state level; and the micro level, based on human agency. There are frameworks which also endeavour to combine both the aggregate and the individual level in order to understand migration decisions and patterns (Bakewell 2010). There is also a fourth approach, proposed by Faist (2000), which argues for the inclusion of the meso-level, constituted mainly of migration networks and institutions, in the analysis of migration behaviour.

Migration analyses can also be represented by conceptual models seeking to identify potential drivers and intervening obstacles that exist between the place of origin and the place of destination. In his seminal work, Lee (1966) acknowledged the effects of push and pull reasons existent in sending and receiving areas and identifies the presence of obstacles preventing migration. Lee's model (Figure 2.1) offers a valuable insight into the numerous feedbacks between sending and receiving areas but does not account for the specific perceptions of individuals and families or the institutional sphere of influence that might help them overcome the prevailing hindrances identified in the model.

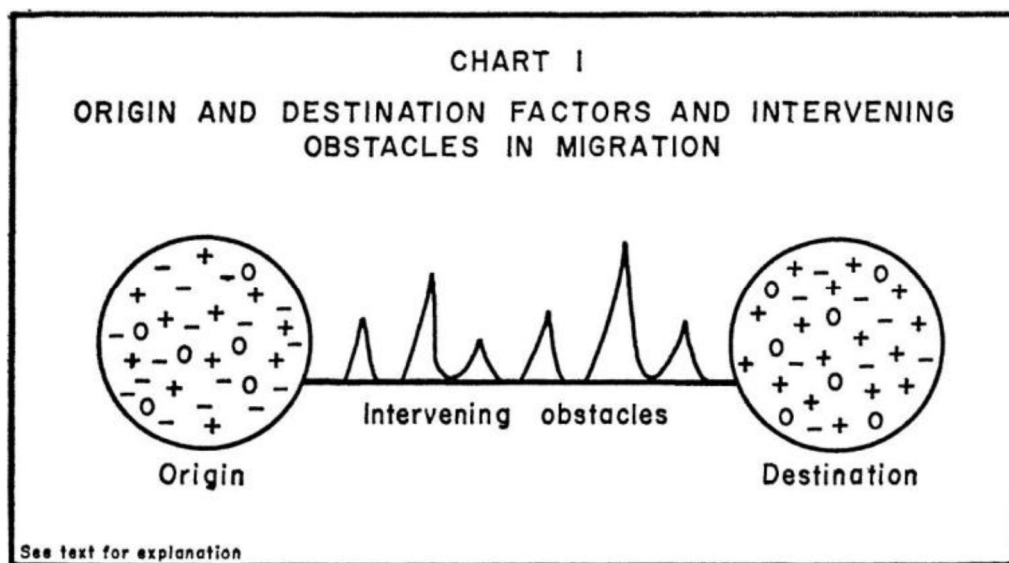


Figure 2.1 Conceptual Model of Intervening Obstacles (Lee, 1966)

A characteristic that all these theories have in common is that the role of environmental factors in migration decisions has been largely overlooked. This gap in knowledge is associated with the fact that contemporary migration theories are predominantly focussed on investigating international migration (King and Skeldon 2010, Massey et al. 1993). The omission of environmental aspects in existing theories limits understanding of their impact on economic processes at the structural and the micro levels of analysis. Moreover, it is important to note that climatic events and other environmental hazards have affected and will continue to impact, both directly and as a catalyst, the movement of population both internally and internationally.

Because of the potential effects of climate change, academics and policy-makers demonstrate increased concern over the environment-migration nexus (Black et al. 2008;

Piguet and Pecoud 2011). Existing studies oppose the notion of a direct association between environmental factors and spatial mobility, except for extreme life-threatening events such as tsunamis, earthquakes and cyclones. What these studies have in common is the notion that migration is highly context-specific, complex, and is driven by multiple aspects, including socioeconomic, political and environmental factors.

Despite the lack of an encompassing theoretical framework investigating the environment-migration nexus, the volume of empirical research is growing. However, Tacoli (2011) warned of the “high level of uncertainty regarding the locally-specific impacts of climate change and the lack of comprehensive data on migration” (2011, p. 5). These are the two key obstacles that prevent advancing the knowledge into the environment-migration nexus.

In addressing the limitation signalled above, Tacoli (2011) discussed empirical findings derived from a cross-national research, which included in Tanzania, Senegal and Bolivia. The study investigated the impacts of a range of environmental stressors on spatial mobility in different political, cultural and socioeconomic settings. The type of hazards included soil erosion, salinization, desertification and droughts. The findings indicate that mobility in response to climatic events and other environmental hazards should not be analysed in isolation from socioeconomic, cultural and political factors in the context of people's livelihood. As a result, the author argues that migration, in the context of environmental stressors, ought to be investigated as a form of livelihood diversification strategy (Tacoli 2011). Consistent with the conceptualisation of climatic events as a risk, and mobility as one potential response, - thereby framing those affected as ‘adaptive agents’ (Ransan-Cooper et al. 2015) - the following section examines the potential impacts of climate change, and links with rural livelihood strategies. These events may have severe consequences on a global scale, but more importantly, they might have severe impacts on individual and household livelihoods.

2.3 A review of temporary mobility in the context of livelihood strategies

Recent studies have postulated that one of the impacts of climate change will be a marked increase in the volume of out-migration from impacted areas of the world (Myers 2005). However, the types of migration that might ensue have not been explicitly investigated but rather derived from estimates that lack concrete empirical experience. In fact, most environmentally-related migration is likely to be internal, covering short-distances, and temporary (Laczko and Aghazarm 2009) or seasonal (Hampshire and Randall 1999)

Research on temporary mobility gained relevance in the developing world where it was examined as a habitual process and an adaptation to changes brought about during the colonial eras (Chapman and Prothero 1983). Inversely, in the developed world, research has been structured unsystematically, focusing on different types of movement (Bell and Ward 2000). One of the most commonly employed definitions suggest that temporary mobility is any form of territorial movement that does not entail in a permanent change of residence (Bell and Ward 2000). This definition comprises a multitude of movements over space and time undertaken for a range of purposes that include work, leisure, education, health and consumption.

Zelinsky (1971) associated temporary mobility to farming, social visits and religious activities and projected a substantive growth in the diversity and complexity of circulatory movements in modern societies. Contemporary work on temporary mobility has been gaining traction within academics and policy circles, with the majority of studies focusing on tourist flows, students' circulatory patterns and commuting for a range of purposes (Bell and Ward 2000, Hall 2005, Muller 2004). Temporary moves can be measured according to nine different dimensions (Bell 2004). Five of these – movement intensity, duration, frequency, seasonality and periodicity - relate to the temporal dimensions, while the remaining four – distance, direction, connectivity and impact – are concerned with the spatial aspects. These dimensions are interwoven and affect one another interchangeably. For example, the purpose of journey causes fluctuations in intensity and geography of temporary moves. The frequency and composition of movers vary according to the characteristics of populations and reflect the strength of networks and connectedness of places.

Most relevant for this research is the role of nuanced forms of temporary mobility within livelihood strategies in marginal areas of developing countries. Rural livelihoods are becoming increasingly multi-locational due to a range of factors the include climate uncertainty, privatisation of land and the rapid change in economic scenarios. Empirical research revealed increased circular mobility patterns, including daily and weekly commuting, between rural and urban areas in Indonesia and Ethiopia, with rural localities supplying most of the personnel working in civil construction (Hugo 2003). In Vietnam, for example, the lifting of restriction of movement and development of new markets expanded the number of migrants from uplands to lowlands to supply labour to service the growing export-oriented agricultural economy of the country (De Brauw and Harigaya 2007). Research in India revealed that seasonal mobility as a livelihood strategy is an important

process in attempting to escape poverty. Gupta and Mitra (2002), investigating migrant labour in Delhi slums argue that, with experience and support from networks, migrants are likely to amass higher earnings in regular jobs. Authors such as Deshingkar and Start (2003) argue that migration streams in both farm and off-farm work have allowed lower cast individuals to find new opportunities to generate income and escape poverty.

The empirical evidence compiled by these studies revealed that seasonal migration and other forms of temporary moves have become an important part of livelihood strategies in rural areas of developing countries. These moves provide a route to livelihood diversification into off-farm and non-farm work which helps to spread risks associated with external factors impacting on agricultural activities. Data collected across 1300 households in rural parts of India show that temporary migration rates are significantly high. On average, almost 47% of the households surveyed had at least one member absent. In several Andhra Pradesh villages, a drought-prone state, 78% of the households declared that a member was temporarily absent (Deshingkar and Start 2003).

Aside from travelling to find wage work, rural people are now more mobile for a variety of reasons that include health and education, social, environmental and political factors. What emerges from this new reality is a spatially differentiated mobility system, with its dimensions varying across regions (Charles-Edwards, Bell and Brown 2011). Therefore, it is important that this study moves across the full spectrum of spatial mobility. Capturing the dimensions of mobility, and the changes brought about by climate events, is one of the single most significant contributions that this research aims to make.

2.4 Sketching the changing definitions of environmentally-driven mobility

As previous sections illustrated, when studying migration it is important to take into account the range of factors that can lead a person to leave their homeland, and the range of mobility responses to seek new and improved opportunities elsewhere (Castles 2002). These can include avoiding armed conflicts, political unrest, ethnic persecution, environmental degradation, natural hazards, colonial contact, poor quality of life; while at the same time include searching for separated family members, education opportunities and superior job prospects which could promote upward social mobility. Castles (2002) argues that migration drivers involve a complex multitude of factors including economic, social, political and cultural, and that the environment is closely linked to them. This assessment corroborates the notion that environmental factors do not destabilize human security alone. Limited

economic development, the range of government support to community, capacity to access credit and markets, social cohesion and political instability are equally important in decision-making processes (Castles 2002; Carr 2005).

The mounting scientific and political interest in the consequences of environmental change and climate events is yet to resolve the issue of what exactly constitutes an environmentally provoked move, and how to define it (Morrisey and House 2009). The impacts of environmental stressors on human mobility have been conceptualised in recent decades, generating much controversial terminology within the literature, with the terms 'environmental migrant' and 'environmental refugee' being interchangeably used in the process (Morrisey 2009).

The denomination 'environmental refugee' was introduced by Lester Brown in the 1970s (Kniverton et al. 2008), but echoed strongly in 1985 in a United Nations Environmental Programme (UNEP) report by El-Hinnawi, where the author defined environmental refugees as "people who have been forced to leave their traditional habitat, temporarily or permanently, because of a marked environmental disruption that jeopardised their existence and/or seriously affected the quality of their life" (El-Hinnawi 1985, p.4). This definition was challenged by several authors who contested the political, legal and theoretical perspectives derived from the term 'environmental refugee' (Bates 2002; Black 2001; Castles 2002; Shurke 1994). Castles (2002), in particular, argues that the term is simplistic, misleading and deterministic because it suggests a mono-causality that rarely exists in practice, except when a sudden-onset event occurs in a region (for example, earthquakes, cyclones and tsunamis).

The cases of El Salvador, Haiti, the Sahel and Bangladesh, examined by Lonergan (1998) underline the significance of a multi-causality approach in any conceptualisation about the environment-migration nexus. An overabundance of processes had been responsible for displacement and migration in an intricate blend of socioeconomic, cultural, and political factors. Similar context was observed in the cases of North Korea and Sudan, where individuals were forced to abandon their homeland for multiple reasons, including human induced disasters and governmental and international structural factors (Lonergan 1998).

Because of the complex nature of migration, Lazcko and Agharzam (2009) and Castles (2002) argued that the label 'environmental refugee' lacks any legal definition under existing international law and its use can potentially undermine current refugee protection schemes

based on cross-border movement. Furthermore, Bates (2002) argued that the term 'refugee' carries a cultural component that has enabled racist and anti-immigration perspectives in several countries. The author suggested the denomination can depoliticise the other factors (war, political persecution, civil unrest, economic downfall, loss of civil rights) that often force people to seek asylum under the condition of 'refugees' (Bates 2002). Hugo (1996) argued that environmental stressors are a driver of involuntary mobility and should be recognised politically and scientifically as such. Instead, the author suggested the adoption of the concept 'environmental migrants' (Hugo 1996). The International Organisation for Migration (IOM) proposed an alternative to the term 'environmental refugee' and defined environmental migrants as:

“persons or groups of persons who, for reasons of sudden or progressive changes in the environment that adversely affect their lives or living conditions, are obliged to have to leave their habitual homes, or choose to do so, either temporarily or permanently, and who move either within their territory or abroad” (IOM 2007, p. 1).

This definition was aimed at being more comprehensive and less deterministic, but it still provides limited perspective on the multitude of factors that drive migration. It is the incidence of these multiple factors that indicate that the nexus between environmental change and spatial mobility should not be investigated under linear assumptions.

2.5 A review of climate change scenarios

An increase number of studies have sought to examine the complexity of the environment - migration nexus. Yet, limited attention has been placed in the analysis of the full range of mobility responses to climatic events and other environmental hazards. Furthermore, conceptual models have generally failed to incorporate temporary forms of mobility within rural livelihood strategies as a form to diversifying income and reducing consumption (DaVanzo 1981; Gardner 1981).

Climatic events can have different magnitudes. They can manifest worldwide, but it is at the local level, particularly in marginal communities, where these stressors can have a direct impact on people's livelihoods. Climatic events such as drought affect households in various forms, both directly by destroying key assets including material belongings, and natural resources on which people rely for their subsistence and livelihood. The impact can also be indirect, as a threat multiplier (Hampshire and Randall 1999). The frequency and intensity

of these events is predicted to increase under climate change scenarios. The consequences of climate change are discussed below.

The global average temperature increased by 0.6°C in the last century, while the warmest years on record have all occurred since 1990 (Stocker et al. 2013). Current climatological models expect an average increase in the global temperature of 1.1°C to 4.8°C by 2100 relative to the 1980-1999 period (Stocker et al. 2013). The projections for mid-21st Century suggest that the amplitude of the intensity of the warming rate will be contingent largely on the prevalent scenario (high emission, medium emission or aggressive mitigation). The variation in temperature is projected to be between 0.9°C and 2.3°C (Stocker et al. 2013). The projected differences between the scenarios may become even more prominent by late 21st Century with global temperature increase reaching up to 5.4°C (Stocker et al. 2013). The geographical patterns of climate change reveal that more substantial changes in temperature are projected to occur over land in the Northern Hemisphere. A less intense increase in temperatures is projected to occur over the southern oceans. Moreover, the IPCC projected with a great degree of confidence that heat waves will become more intense, and will occur more frequently. Conversely, cold spells are projected to decline significantly, including substantial reduction in the number of frost days (Stocker et al. 2013).

The 2013 IPCC Physical Science report suggested that global sea levels are projected to rise by 20 cm to 60 cm until the end of the 21st century, with current rise already reaching 19 cm (Stocker et al. 2013). The IPCC report also projected greater rainfall variability on a global scale. High latitudes and tropical regions will experience increased precipitation. Moreover, rainfall is projected to decline in subtropical regions. As a consequence, already dry areas might experience less rainfall, whereas traditionally wet areas might experience an increase in rainfall totals (Stocker et al. 2013). According to the IPCC report, this precipitation reduction in dry regions is likely to be permanent. The report also projected increases in sea surface temperatures, resulting in more intense cyclones (Stocker et al. 2013).

Climate projections for Northeast Brazil for the 21st century indicate a strong likelihood of amplified temperatures and reduced precipitation, causing increased aridity of the region (Marengo et al. 2009). These predicted changes in the climate of Northeast Brazil also increase the likelihood of droughts caused by the amplified effects of climate uncertainty in the semi-arid region. Furthermore, the IPCC projects that the annual distribution of precipitation is expected to alter drastically, resulting in progressively long intervals without

rain, followed by short and highly unpredictable wet seasons in the region (Stocker et al. 2013). In contrast, intense and frequent precipitation occurrences have been projected for Northeast Brazil Atlantic coast, which might result in increased risk of floods in densely populated urban centres.

Internal and external processes are identified by the IPCC as forces producing changes to the climate. Internal variations of the climate are caused by atmospheric processes. These comprise changes in the precipitation regime, temperature, and the frequency and strength of climatic events. The variability, in turn, is prompted by natural internal processes within the atmosphere, or by variations in natural or anthropogenic external factors. Natural processes include changes to solar radiation and volcanic activity, while anthropogenic factors include the emission of greenhouse gases into the atmosphere (Stocker et al. 2013)

For the aim of this research, it is imperative to differentiate the terms *climate variability* and *climate change*. The former affects the range and frequency of shocks that society absorbs or to which it adjusts; the latter alters the resource base (Parry and Carter 1985). The United Nations Framework Convention on Climate Change (UNFCCC) and the IPCC define climate variability as “variations in the mean state and other statistics (such as standard deviations, the occurrence of extremes, etc.) of the climate on all temporal and spatial scales beyond that of individual weather events” (UNFCCC 2001, p. 788-789). It is relevant; however, to stress that as a result of climate change, the amplitude of climate variability-related events are expected to increase worldwide (OCHA-IDMC 2009).

2.6 Substantive empirical knowledge: Assessing the evidence

The previous sections of this literature review have examined key theories of migration, explored climate change scenarios and scrutinised the intricacy of the environment-migration nexus with regard to definitions while also assessing conceptual issues within broader migration theories. Methodologically, the challenge of current and future impacts of climatic events and other environmental hazards on mobility is complex, and the outcome of research has been fragmented (Morrissey and House 2009). A significant problem when studying issues relating to climate change is how and under what conditions ‘change’ is defined, and what impacts it will bring about.

As a result, it will remain challenging to identify migration in response to climate change-induced stressors simply because the assumption that individuals were living under a

different set of average climatic conditions has to be presumed (Hugo 1996; McLeman and Smit 2006; Morrisey and House 2009). As such, empirical studies investigating the environment-migration nexus have focused on localised studies of events which are related to the potential impacts projected under future climate change scenarios including drought, storm surges, increased aridity and sea-level rise, or specific cases of sudden-onset environmental hazards such as earthquakes, tornadoes and cyclones. Current studies have also investigated existing extreme environmental events that occurred in several areas of the globe, and their impacts on migration flows.

Research on the subject can be broadly divided into four groups: migration and sudden-onset events; migration and slow-onset events; secondary effects following impacts on migration; policy, planning and governance issues in relation to environment-migration nexus (IOM 2007). Differentiating the climatic stressors is as important as assessing the various approaches employed in the investigation of the environment-migration nexus. This section of the literature review will examine in detail the empirical evidence on each of the groups.

2.6.1 Migration and Sudden-onset events

Environmentally-related migration flows and characteristics can be related to the speed to which ecological hazards happen. Sudden-onset events are frequently related to last-resort or distress migration where large contingents of people are forced to move from their current location at short notice (Brown and McLeman 2013). Examples of sudden-onset events include cyclones, tornadoes, earthquakes, tsunamis, storm-surges and bush fires. Floods are classified in this category but the conditions leading to their occurrence are known amongst public authorities and policy-makers.

Although the link between warmer oceans and frequency of storms and cyclones remains inconclusive, the science of climate change argues that more frequent and intense events may occur in a scenario where the oceanic waters are warmer (Stocker et al. 2013). There is also general agreement that sea-level rise will potentially increase storm surge damage in coastal cities across the globe (Stocker et al. 2013). This section will look into studies that have investigated migration flows generated by sudden-onset events.

In research on the impacts of Hurricane David in the Dominican Republic in 1979, Belcher and Bates (1983) argued that absolute damage in certain areas was an effective indicator

of mobility. Their study concluded that residential mobility was high in areas where the infrastructure was left intact but damage to housing structures was significant. Temporary short-distance moves were also identified in areas partly destroyed by the hurricane because affected households moved within the same or neighboring districts to live with family and friends. Belcher and Bates (1983) found that out-migration rates were high in areas that suffered great damage or were completely destroyed. Households in these areas could not rely on emergency-relief services and had to seek assistance in refugee camps set up by the authorities. Their study also examined the role of livelihoods and found the intention to remain in their pre-hurricane community, regardless of the damage to dwellings, was higher if the level of impact on livelihoods was less extensive. The distance of moves was intimately linked to the estimated recovery time until economic activities could be resumed (Belcher and Bates 1983)

The hurricane Katrina that hit New Orleans in 2005 was the subject of a study by Frey and Singer (2006). The authors found that areas impacted by the hurricane experienced great population fluctuation. The U.S census data indicated that the majority of long-distance permanent out-migrants comprised poor households headed by black females who did not own property or vehicles. In their case, the study found that there was no incentive to return to their previous areas of residence after the floods in New Orleans subsided. On the other hand, wealthier and more mobile households were more likely to return to the city (Frey and Singer 2006)

In the case of 2004 tornadoes that hit the North and Central areas of Bangladesh, Paul (2005) identified that, on the one hand, the event had little impact on out-migration figures in the affected areas. On the other hand, it increased in-migration rates of artisans, builders and contractors to help with the reconstruction effort. Surveys and interviews used in his research found that people believed they received adequate support in the form of relief goods, and were promised financial support to help rebuilding their homes. The study also identified that cyclical mobility was employed by people going to relief centres in the area to collect goods and seek medical assistance (Paul 2005).

Two studies have focused on the impacts of earthquakes on migration flows. In both cases, the sudden-onset hazard had a secondary degree of relevance in driving migration flows. Osterling (1979) examined the event that hit Peru in 1970 whereas Belcher and Bates (1983) analysed the 1976 earthquake in Guatemala. In the first case, economic downturn and the failure of government to address the consequences of the event triggered high volumes of

out-migration. Osterling's (1979) interviews revealed that people did not indicate that the earthquake was the main reason to move, but rather the absence of jobs and subsequent exacerbation of poverty. Belcher and Bates (1983) research concluded that in the two subsequent years almost 90% of the out-migrants had returned home. It was found that ownership of land and property was the main factor behind the distance and duration of the move. Property and land owners returned in order to initiate the reconstruction of their property and resume livelihood activities in their place of origin.

Most of the literature on flooding and migration has come from the flood plains and deltas of South Asia. Kayastha and Yadava (1985) and Haque and Zaman (1989) have studied India and Bangladesh respectively and found that eroded riverbanks have triggered out-migration in both countries. In the former study, Kayastha and Yadava (1985), through the use of questionnaires and interviews, concluded that population mobility was generated through a complex of relationships between flooding of farmlands and destruction of household assets. Temporary mobility over short distances in search of shelter and jobs was the strategy employed by low-skilled less-educated people. On the other hand, Kayastha and Yadava (1985) found that permanent moves away from flood plains were undertaken by households that had both crops and property destroyed.

Haque and Zaman's (1989) study in the Brahmaputra-Jamuna River area in Bangladesh found that erosion of floodplain areas following flooding of the delta region triggered different forms of out-migration. Short-distance mobility occurred with households that owned property and believed that their lands would reemerge. Poor vulnerable households moved short-distances due to the prohibitive costs of travel, and also the fear of being included in resettlement programs (Haque and Zaman 1989). Their research found that community networks carry significant value in the region and people did not want to move outside their administrative region.

Globally, rapid-onset environmental hazards affect all people living in a region, regardless of wealth and income class, however research on the subject has shown that more economically vulnerable households are likely to migrate permanently (Morissey and House 2009). The studies also made evident that governance responses influence mobility characteristics as much as exposure level. Provision of emergency-relief and access to basic services is a significant part of the set of factors that influence the decision to stay or migrate.

2.6.2 Migration and Slow-onset events

Slow-onset hazards do not emerge from one single event, but instead happen gradually over time with different intensity and are based on a confluence of factors (OCHA/IDMC 2009). This group of environmental hazards includes droughts, desertification, increased aridity, sea-level rise and land degradation among others. The occurrence of these events over time can have tragic outcomes for vulnerable households that fail to cope. However, many households have developed alternatives to diversify their livelihoods and adjust to the new circumstances. Temporary forms of spatial mobility are amongst the strategies employed by affected households in many regions of the world.

A number of studies have investigated the relationship between droughts and migration in the Sahel region of Africa (Morrissey 2009). Climate uncertainty has always been part of life of the inhabitants of the semi-arid portions of the region, and extensive study on nomadic pastoralists and sedentary farmers have examined the role of migration as an adaptation strategy (Brown 2007). Research has also examined the linkages between climate shocks, livelihoods and mobility in the Sahel (Findley 1994; Henry, Schoumaker and Beauchemin 2004).

Apeldoorn (1981) through in-depth interviews with political authorities and policy-makers in Northern Nigeria, found that droughts triggered long-distance permanent migration from rural areas to urban centres. Existing migratory patterns were also impacted by the phenomenon. Whole households journeyed across the country motivated by survival instead of economic betterment. The regular pattern of single household members staying at the destination place for a predetermined period changed drastically in areas affected by drought.

Mortimore (1989), investigating the 1970s droughts in West Africa, found that the event triggered increased levels of out-migration, but contrary to Apeldoorn's (1981) study, the movements were of a more temporary nature. Mortimore (1989) argued that the cyclical aspect of mobility allowed people to manage unpredictable fluctuations of rural and urban economic development without cutting ties with the original community they belonged to.

Findley's (1994) study of the 1983-1985 droughts that hit Mali found that households employed temporary mobility to cope with the event. Through questionnaires and interviews, migration characteristics were revealed as seasonal and undertaken by both males and females. Findley (1994) also investigated the destination of the flows, contrasting regional,

cross-border and intercontinental moves. She found that assets, level of formal education attained and existing networks proved to be crucial in determining the distance of the move. International migration was only available for households that possessed all three aforementioned elements, making it a viable option for only a number of people. On the other hand, her study found an increase in temporary regional moves in order to diversify income flows and reduce household consumption (Findley 1994).

Work debating the multi-causal nature of migration in environmentally degraded areas has mainly focused on the Sahel. Ezra and Kiros (2001) examining drought-prone areas of Ethiopia found that economic downturn was commonly mentioned as the main reason to move. Through questionnaires, the authors were able to associate more intense dry years to loss of productivity and food insecurity. Meze-Hauksen (2000) explored similar issues in a study of a drought in Tigray, Ethiopia. The research found that climate shocks played a secondary role in driving migration in the region. The impact of droughts on livelihoods and economic processes undermined the productive capacity of households leading to an economic downturn that pushed them out of the region. Meze-Hauksen (2000) termed climate shocks as a 'second order' driver of migration, due to the underlying capacity to impact macro-economic structures of a region.

Other findings contradicting the role of slow-onset climate shocks in forcing migration found that ethnicity and economic activity were also important factors. Hampshire and Randall (1999) argue that migratory characteristics in times of climate hardship of Rimaiibe populations in Burkina Faso differ from those of Fulbe ethnicity. The former group has developed a suite of strategies to diversify their livelihoods when drought hits the region. Preemptive circular mobility of one or more members to urban centres help households generate income to endure climate vagaries. On the other hand, the latter group mostly comprised of pastoralists only employs mobility as a survival strategy, with the outcome always depending on natural fluctuations of climate (Hampshire and Randall 1999).

A study by Henry et al. (2004) on desertification and land degradation impact on migration in Burkina Faso; found that people living in degraded areas were less inclined to migrate. Working with rainfall and land degradation data, the author and colleagues were able to examine the quality of the land and subsequently compare the results with the productivity outputs. Their analysis found that people living in more degraded areas did not have the financial capacity to invest in migration as a livelihood diversification strategy, opting to focus

their efforts on other alternatives. On the other side of the spectrum, people in less degraded areas migrated more often (Henry et al. 2004).

Sea-level rise has also received attention from researchers investigating the environment-migration nexus, however due to the lack of empirical examples to draw from, their studies have been based on the estimated impact on coast cities and small island states. McGranham et al. (2007) observed that low elevation coastal zones represent 2% of the earth's surface but give shelter to 10% of its population. From this position, their study argues that the impact of sea-level rise will affect large urban centres displacing large numbers of people. Poorer nations and cities with reduced adaptive capacity will suffer the highest degree of impact (McGranham et al. 2007).

2.6.3 The environment, migration and conflicts

Another dimension of the impacts of climatic events and other environmental hazards on human mobility acknowledged by the literature comes in the form of conflict over resources. Several authors have argued that climate-related migration can induce and intensify conflict in areas receiving migrants (Homer-Dixon 1999; Lee 1997; Swain 1996). The findings of these studies suggest that future impacts of climate events on natural resources can result in violent conflicts over access and ownership of freshwater and agricultural lands, which could trigger movement of large contingents of vulnerable people. Current research defines four broad channels which may trigger conflict – competition, ethnic tension, distrust and existing fault lines (Homer-Dixon 1999; Reuveny 2007).

Sudden-onset and slow-onset environmental hazards can create the conditions in which migration becomes a potential outcome (Hugo 1996). Some events will be regional and governments might be able to provide the adequate responses to them. On the other hand, certain hazards have the potential to impact large areas and create more permanent consequences (Reuveny 2007). In this case some societies and communities might be forced to move internally or across-borders seeking refugee status or trying to improve their quality of life. The arrival of environmental migrants might promote competition over resources with the native population, particularly in less developing regions of the world (Lee 2001). Other potential outcomes described by Reuveny (2007) relate to ethnic tension. The new influxes might ignite long-standing ethnic disputes which increases the risk of conflict.

The literature on the subject gives several examples of cases where the arrival of migrants

triggered conflicts with native populations. In a review of cases linking environmental problems, migration and conflicts, Reuveny (2007) found that 19 both international and regional areas of the world have experienced some form of unrest provoked by the arrival of migrants. Droughts, land degradation and water scarcity were the recurrent environmental drivers, whereas ethnic tension, competition over resources and border dispute were the most common conflicts (Black et al. 2011; Reuveny 2007).

The Sahelian countries in Africa and the Northeast and Amazon regions of Brazil are amongst the distinctive places in which migration triggered forms of conflict (Kenny 2002; Reuveny 2007). During the 1970s and 1980s droughts and famines in the Sahel, 10 million people migrated within the region, triggering unrest in receiving areas due to competition over resources (Reuveny 2007). In the case of the Brazilian regions the authors argue that drought, land degradation and deforestation were amongst the factors that drove eight million to move, causing clashes between landowners, sharecroppers and squatters (Kenny 2002; Reuveny 2007).

Empirical studies in Somalia and Burundi, countries which have been involved in armed conflict and civil war, while also being impacted by droughts, investigated the linkages between climatic events, conflict, and migration (Kolmannskog 2009). In Somalia, a combination of drought, land concentration, unplanned population growth, and an unstable political scenario, which led to civil war, impacted the livelihood of pastoralists, causing disruptions to their traditional migratory patterns. As a result, various sectors of the population were confined to areas where their capacity to maintain their traditional livelihood was compromised. As a result, many lost their livestock and opted to migrate to the large urban centres to look for work. In Burundi, small farmers predominantly dedicated to subsistence constitute the majority of the population. In that country, major problems derive from the combination of climate uncertainty with scarcity of productive agricultural land. As a consequence, violent conflicts over remaining productive lands have occurred. Mobility has historically been part of the livelihood portfolio of families in Burundi. However, due to these conflicts, people have become too poor, lacking the resources to employ migration as an adaptation strategy. Kolmannskog (2009) argues that the relationship between severe climatic events, such as droughts, conflict, and mobility is multifaceted. As a result, comprehensive policy responses to address these issues are difficult to conceptualise.

Beyond the potential impact on migration flows, climate change might bring a multitude of secondary impacts in areas receiving environmental migrants. Sudden-onset hazards like

cyclones, tornadoes and earthquakes have the potential to displace large numbers of people over a short period of time, providing a scenario for potential conflicts (Homer-Dixon 1999; Reuveny 2007). Scholars agree that marginal areas in less developed countries are more vulnerable to the impact of increased flows of migrants, and therefore have called for better policy alternatives to the issue (Homer-Dixon 1999; Reuveny 2007).

2.6.4 Policy, planning and governance issues in relation to the environment-migration nexus

In marginal areas of developing nations where farming is usually the most important form of subsistence, decreased production due to environmental change may result in the loss of livelihood, forcing native populations to migrate in search of wage work or governmental assistance (Swain 1996). The influx of migrants from neighboring regions coupled with demand for food and public services and competition in the labour market may pit states against community groups, and community groups against other community groups (Reuveny 2007; Swain 1996).

Although scholars are still debating the validity of an environmentally-driven category of migrants, existing empirical research signals that climate shocks and environmental change have an impact on migration flows (Hugo 1996; Morrissey 2009; Warner et al. 2010). Studies now have turned their attention to the outcomes of these new flows and the extent to which institutional arrangements and official policies will be able to manage the issue. Warner et al. (2010) argue that governance related to institutions and policies guide the relationship between many actors over different spheres of power. Currently there are many international agreements, norms and principles that guide governance on human mobility. Warner (2010) suggests that they fall within two broad groups: the management of humanitarian crises, and the management of economic migrants. The former is based on the 1951 United Nations convention and on the 1967 Protocol on the Status of Refugees which offers comprehensive guidelines for the refugee status but do not include environmental factors. The latter is aimed at protecting the right of migrant workers against acts of racism and xenophobia. The 1990 United Nations Convention on Protection of all Migrant Workers and Members of their Families is a well-established document, but not all member states have signed onto it (Warner et al. 2010). Current institutional frameworks provide few incentives for governments in restructuring policies for migration and environmental change (McNamara 2007; Reuveny 2007; Warner et al. 2010).

The literature has explored the topic of governance and environmentally driven migration on

several occasions where case studies were the source of empirical evidence. In Mozambique, Stal (2009) explored governance responses to repeated flooding that affected over one million people in the Zambezi River valley. The households impacted lost property, livelihoods and had their access to sanitation, drinkable water and health services cut off. Public authorities' response in this case, came in the form of emergency relief assistance and resettlement programs (Stal 2009). The study indicates that the resettlement program did not build resilience to subsequent hazards as people were relocated to drought-prone areas of the country. The findings indicate that many people in fact opted to return to the flood plains area in search of more fertile soils for agriculture (Stal 2009).

A case study in the Mekong River Delta in Vietnam examined governance response to the cyclical floods that impact the area (Dun 2009). The Delta is home to approximately 18 million inhabitants and is responsible for a large percentage of the agriculture production of the country (Dun 2009). People depend on flood cycles to sustain their livelihoods, however, due to recent heavy monsoonal rains, flooding has become a major environmental stressor in the region (Dun 2009). Seasonal migration to urban centres, particularly to Ho Chi Minh City, has become a constant in people's lives. To counteract this fact, Vietnam's authorities have designed a program that offers alternatives to diversify livelihoods and has recently begun a resettlement program that aims to relocate households from areas close to eroded riverbanks (Dun 2009).

A slow-onset case of climate change impact was explored in a study of the Nile River Delta. Dasgupta et al. (2007) analysed institutional responses to desertification and the potential threat of sea-level rise in the area. Desertification is a slow-creeping issue that impacts productivity and creates conditions for erosion of arable lands (Dasgupta et al. 2007). In order to avoid unbalanced migration flows throughout the country, the Egyptian authorities sought to respond through an internal migration program designed to create a rural-to-rural migration streams in the direction of the edges of the Delta (Dasgupta et al. 2007). The relocation scheme allocated small land parcels, and is aimed at sharecroppers and small holder farmers. The study questioned the results of the program. Many migrants did not stay in the new areas due to lack of basic infrastructure and public facilities (Dasgupta et al. 2007).

Martin (2010) discussed the legal policies protecting environmentally-driven migrants, by examining current frameworks, such as the temporary scheme established in the United States of America in 1990. This policy provides protection to individuals who are living in

that country temporarily when their homeland is impacted by various forms of extreme situations, including armed conflict, political instability and a range of environmental hazards. Martin (2010) argues that the working definition present in the policy includes both slow-onset and sudden-onset forms of environmental hazards, and underlines that these hazards cause permanent or temporary impacts on affected areas, disrupting regular livelihoods and living conditions. The effectiveness of this mechanism as a protective policy for people impacted by climatic events and other environmental stressors is very limited. In that respect, Martin (2010) argues against the temporary nature of the scheme emphasising that some environmental hazards can impact the economic and political structures of countries for extended periods of time.

According to media reports, New Zealand and Tuvalu have been negotiating an international agreement, in which the former would settle potential migrants forced to leave the latter because of impacts derived from climate change. This tentative agreement resonated in the media, forcing New Zealand authorities to clarify that the negotiations had not been concluded (Stern 2006). Thus far, the majority of claims for non-binding policy agreements that protect people displaced by climatic events and other environmental hazards have not been successful worldwide (Stal and Warner 2009). Finland and Sweden are the only two countries that have specific immigration policies targeting environmentally displaced people (Martin 2010).

As seen in the review of the studies, lags in policy implementation remain an important and constant factor. Most responses have been reactive rather than preventive. Anticipatory capacity seems to be a concern amongst scholars, but the lack of pro-active actions from public authorities stem from the fact that the definition of an 'environmental refugee' or an 'environmental migrant' remains a debated issue (Warner 2010).

2.7 Methodological approaches within the literature

Studies of the population-environment nexus have generated some considerable variations in methods exploring the connection. The methods employed by these studies can be categorised into two broad groups that can be designated as macro and micro approaches. This section will examine them along with the data sets that are commonly used in the analysis.

Research within the macro approach has sought to explore associations between aggregate migration data and climate variables. Based on a plethora of environmental indicators and out-migration rates, this work has endeavoured to identify correlations between climate shocks and outmigration rates of a region. Ezra and Kiros (2001) employed this approach in a study in Ethiopia. Using rainfall data, land productive capacity and census data, the authors sought to examine the impact of a ten year period of extended dry seasons on out-migration rates. The findings indicate that people from certain areas were likely to move due to food insecurity issues. On the other hand, few migrants appeared to be moving due to climatic or economic reasons (Ezra and Kiros 2001). This proves to be one of the main limitations of this method as outcomes are only measured for geographical areas. Individual responses are hard to obtain, making it difficult to identify how regional impacts are felt by individuals according to livelihoods, gender or ethnicity.

Several studies have employed time series analysis to measure the degree of correlation between certain ecological indicators and migration (Kayastha and Yadava 1985; Kniverton et al. 2008; Meze-Hausken 2000). This approach was used in the work of Kniverton et al. (2008) on rainfall variability and outmigration in Mexico. The authors used 40-year precipitation data to infer that greater rainfall implied larger in-migration rates in the drought-prone states of Zacatecas and Durango, because agricultural fields became more productive. The study found that improved financial conditions propelled out-migration rates towards the United States of America (Kniverton et al. 2008). The conclusions were criticised by the scientific community because no control variables were used. One major limitation of time series analyses is that there is an absence of monthly or quarterly migration data for much of the world, confining its use to a handful of places.

Meze-Hausken (2000) investigated the relationship between land degradation and out-migration in Ethiopia. Her study used desertification and evapotranspiration indexes to analyse productive capacity of subsistence farming systems over a five year period. She identified a direct connection between famine and migration in certain regions, implying that climate shocks were a second order force in the situation. The study also found that two communities within the same region revealed different migration outcomes (Meze-Hausken 2000). A limiting factor of this approach is that the multi-dimensional nature of factors triggering migration, and the nature of mobility were not fully captured.

Another group of studies that have employed a macro approach have sought to establish the link between environment and migration through the analysis of climatic models and

research on local climate shocks. This body of work tries to identify the relationship between environmental change and migration and includes research on cyclones, drought, flooding, land degradation, desertification and sea-level rise as the major hazards impacting on people's livelihoods (Frey and Singer 2006; Haque and Zaman 1989; Paul 2005). There are also studies focusing on ongoing climate shocks in ecologically vulnerable areas to investigate the impact of environmental factors on migration (Apeldoorn 1981; Ezra 2001; Findley 1994; Hampshire and Randall 1999; Massey et al. 2010; Meze-Hausken 2000). Using existing data on rainfall, temperature, evapotranspiration, increased aridity and other ecological indicators this work explores slow-onset scenarios in the form of regional or case-studies and seeks to determine the extent to which environmental change causes loss of livelihood leading to migration as a potential outcome.

Research based on climate models in the vein of studies by Barnett and Adger (2003), McGranaghan et al. (2007) and Nicholls (1999, 2004) accepts that large scale environmental change will provoke migration. These studies tend to overlay projected changes in climate onto predicted population growth and current migration flows, and rely on aggregate data sets that cover large geographical areas. By using climate indicators such as rainfall data, global circulation models, aridisation indexes and satellite imagery, and migration data from national censuses and large longitudinal community surveys, researchers try to project the impact of climate change in areas of the world and link them to population growth and existing migration flows (Bilsborrow 2009; Ezra 2001; Findley 1994).

Nicholls, Hoozemans and Marchand (1999) investigated the potential change of coastal flooding patterns due to climate change. Using data from global atmospheric circulation models in conjunction with socioeconomic data from the World Bank, the author found that the major impact would most likely affect poor people living in floodplain areas. In an attempt to enrich the findings of the first study, the authors emphasised the significance of considering different development pathways as well as a range of socioeconomic factors impacting on people's decisions to adapt, cope or migrate (Nicholls, Hoozemans and Marchand 1999). The hypothesis generated by these models assumes that a percentage of people living in areas impacted by future change and degradation will migrate. On the other hand, the models are not able to capture either the multi-causal nature of migration or the fact that in some cases people's agency will result in pre-emptive responses to these impacts.

Micro level approaches focus at the individual rather than the aggregate level. One approach that has been employed in research on environmentally-driven migration is sample surveys. These studies are based on purposive surveys on migration behaviour and links to environmental change. Amongst other things, they look at the probability of an individual moving under certain conditions. In this approach, information on environmental variables is collected along with socioeconomic indicators in surveys administered to large or small samples of individuals or households. Surveys have been employed in a number of studies to obtain information on background, demographic composition, economic activities, income, community context, perceptions of environmental change and other socioeconomic indicators (Findley 1994; Massey et al. 2010; Warner 2010). Findley (1994) used two sets of survey data comprised of over 7.200 individuals and 320 households to assess whether the 1983-85 droughts in Mali increased migration rates. The primary data was then combined with climate data to relate the severity of drought to out-migration rates. The results showed a shift in migrant destinations and in patterns of circulation.

The difficulty of teasing out reasons why people move is a well-documented challenge in the literature regarding the environment migration nexus. Bilsborrow (2009) and Warner et al. (2010) comment on the importance of surveys unraveling the extent to which environmental change drives migration. One of the limitations of surveys on the subject is that they incompletely capture environmental change over time, as most instruments are designed to compare 'before' and 'after' situations. One alternative to this problem, argues Bilsborrow (2009), is to include questions about loss of productivity or assets and perceptions of change in climate and other environmental indicators. Pigué (2010) argues that surveys designed to capture life course events might also be a solution to overcome this issue.

Ethnographic methods have gained popularity in recent years as they provide richness of detail. A number of local case-studies have been conducted since 2005 (Warner, Afifi, Stal and Dun 2009; Oliver-Smith 2009). These micro studies combine field observations, interviews with key informants and small sample surveys in areas that have experienced environmental change or a climatic shock to test the impact on outmigration rates. For example, Dun (2009) employed this method in a study on the impacts of seasonal flooding in the Mekong River Delta, in Vietnam. Her research found that the events became more frequent and severe in magnitude, forcing some families to move during flood cycles. The author conducted in-depth interviews with families that were placed in the resettlement plan designed by the government, and migration flows that derived from them (Dun 2009). Such

research offers a valuable insight into people's perceptions of environmental change. It also provides understanding of the role of the environmental stressor in relation to mobility responses. Because of the richness of detail they provide, ethnographic studies are a fundamental aspect of studies investigating the environment-migration nexus. On the other hand, the small scale of sample sizes and area of study can limit generalization of the findings.

This review of the literature identified that macro and micro approaches have distinct advantages. Morrisey (2009) and Bilsborrow (2009) argue that macro approaches have sought to explore the connection between environmental factors and migration under certain circumstances, but they miss the richness of individual detail. On the other hand, micro approaches on the environment-migration nexus have been employed to capture the character of migration (forced or voluntary), and to explore the degree to which the environment acts as an underlying factor driving population movements (Bilsborrow 2009). However, small samples fail to produce generalisations that can be expanded to other parts of the world.

Seeking to maximise the potential outcomes of research, several studies have sought to combine qualitative and quantitative methods to further understanding on the environment-migration nexus (Grey 2009; Massey et al. 2010). Massey et al. (2010) combined both methods. In their study of environmental degradation and migration in a region of Nepal they connected indicators of perceived loss of environmental quality with outmigration rates. Land ownership, production capacity and distance to gather resources impacted on the odds of long-distance or short distance migration. Based on regional environmental indicators, local individual surveys and field observations, the findings of the study highlighted different characteristics of environmental impact and mobility preferences as well as the perceived effect of gender and level of income (Massey et al. 2010).

A multifaceted approach could be a solution to unravel the complexity of the environment-migration nexus as well as the multi-dimensional nature of mobility processes. The micro element could provide the in-depth understanding of the impact of environmental change on mobility responses. The study could be complemented by a macro approach that would examine the relative impact of environmental indicators and the strength of their linkage to migration responses (Bilsborrow 2009). The main challenges for research on environmental migration are, however, the difficulty of accounting for multiple factors driving mobility and intricacies of individual responses in the way people deal with the impacts of climate on their

livelihoods.

2.8 Concluding remarks and gaps in the field

The review of the literature on the environment-migration nexus points to significant gaps in theory. The one-dimensional perspective that is present in some early work is now being superseded in favour of a multi-causal approach that sees the environment as just one among other forces driving population movement. A number of theoretical frameworks have sought to capture the linkages between environmental change and migration. These conceptual models have encompassed the multi-causal nature of mobility while others have focused on adaptation strategies in which migration is one alternative among several others. However, the literature has yet to advance a framework that moves past the dichotomy of 'trapped populations' and 'movers', and recognises the variable duration, repetitive nature and seasonal variation, which form the full spectrum of mobility.

Migration has a multitude of complex drivers and people perceive and react to these conditions in different ways. Social, economic, cultural, political and environmental factors interact, overlap and interfere with one another, creating new mobility processes that have multiple outcomes in purpose, destination, periodicity and composition. There is a substantial body of literature on mobility that remains largely untapped in research on environmentally-driven migration. There is an opportunity to explore the nature of mobility through in-depth analysis of duration, composition, purpose, frequency and seasonality of moves. This is a gap that this current study endeavours to explore.

Another theoretical deficiency is that environmental migration remains largely focused on framing migration as a last resort solution rather than a normal part of people's lives (Bilsborrow 2009; Hugo 1996). Authors like Castles (2009) admit that mobility in the developed world is something 'desirable' regardless of any particular factor driving the phenomenon. Human mobility is an integral part of household livelihood strategies in some regions of the world and not a problem *per se*. In parts of the Sahel, households have been employing this strategy for decades, and emerging research is investigating the phenomenon (Brown 2007).

There is also a methodological gap that this study seeks to address. Previous works have focused on macro or micro approaches to investigate the environment-migration nexus. Given the complexity of the task ahead, this current study employs a multifaceted approach,

combining quantitative and qualitative techniques, bringing together the expanded dimension of the macro analysis with the richness of detail of the micro analysis.

Chapter 3. Methodological framework and research strategy

3.1 Introduction

This chapter discusses the research methods including data collection, data analysis and interpretation. These include an outline of the context of the study sites, the data sources and the ethics protocols. Additionally, this chapter highlights the field research process, challenges and difficulties, as well as the insights gained from the experience.

The literature review presented in Chapter 2 identified that existing empirical studies investigating the relationship between spatial mobility and the environment seem to be methodologically limited. These approaches often start by analysing climatic stressors and their impact on the migration patterns of individuals, households and communities. Qualitative studies explore this relationship by examining how different groups respond to climatic events, and to what extent migration is employed as part of these responses. Quantitative work, on the other hand, seeks to establish a meaningful statistical relationship between a climatic event and changes in the volume of migration. Both approaches provide valuable insights, but understanding of the environment-migration nexus is not yet conclusive. One reason is that many studies try to isolate climate stressors as a single factor influencing migratory behaviour. A second methodological limitation is that migration is a complex and multi-faceted phenomenon, and the fact that people respond differently to its various drivers.

To overcome these limitations, this research employs a multifaceted research strategy in an attempt to combine qualitative and quantitative methods with the objective of triangulating the information collected. The aim is to further critical understanding of the human mobility processes and characteristics that form part of household livelihood strategies and responses to climatic events in semi-arid Northeast Brazil. This approach endeavours to untangle the complexity of mobility processes. Primary data in the form of a household survey, key-informant interviews and the application of a toolkit designed to capture the nature and pattern of local circulation in the study area, aim to provide in-depth understanding of the impact of the 2010-2013 drought on spatial mobility. Nested within a regional case-study, these data are complemented by a macro approach which examines the socioeconomic and climatological context in which spatial mobility occurs in a rural setting in the state of Ceará.

This chapter is structured as follows. Section 3.2 describes the research strategy and provides a summary of data and methods employed in each stage of the research. Section 3.3 describes the sources of secondary data. Section 3.4 provides detailed information on the methods employed for the collection of field data. Section 3.5 discusses the study area selection and introduces the three study sites. Section 3.6 explores challenges and difficulties involved in the field work. Section 3.7 concludes the chapter.

3.2 Research strategy

As described in Chapter 1, the overall aim of this thesis is to further a critical understanding of the human mobility processes that form part of household livelihood strategies and the way these processes respond to climate shocks in marginal areas of Northeast Brazil. To achieve this aim, four core objectives were specified. These objectives are interconnected, but address specific aspects of the overall research aim. Table 3.1 summarises the overall research design, linking each objective to data and methods, and the following subsections describe these in detail.

Table 3.1 Outline of objectives and relevant methodological decisions underpinning this research

| Research objective | Aim | Methodology | Data |
|---|--|--|--|
| 1) To develop a conceptual model linking spatial mobility to rural livelihood strategies in the context of severe climatic events | <ul style="list-style-type: none"> a. Advance beyond the dichotomy of “movers” and “stayers” b. Incorporate mobility processes (i.e. temporary moves and local circulation) | <ul style="list-style-type: none"> a. Review of current theoretical frameworks | <ul style="list-style-type: none"> a. Five conceptual frameworks (Black et al., 2011; Gilbert & McLeman, 2010; Martin et al., 2014; McLeman & Smit, 2006; Perch-Nielsen et al., 2008) |
| 2) To establish the socioeconomic and climatic context of contemporary mobility in semi-arid Northeast Brazil | <ul style="list-style-type: none"> a. Identify the nature and pattern of settlements b. Examine the composition and spatial pattern of mobility c. Characterise the nature of climatic events in the region | <ul style="list-style-type: none"> a. Statistical analysis of secondary population data b. Analysis of climatic variables and the form and strength of the impact of climatic events in the study area | <ul style="list-style-type: none"> a. 2000 and 2010 Brazilian censuses b. Rainfall data (various time series) |
| 3) To identify the characteristics of households that shape livelihoods in rural semi-arid Northeast Brazil | <ul style="list-style-type: none"> a. Examine household composition, access to capital assets and livelihood strategies b. Examine household perceptions of socioeconomic and environmental issues | <ul style="list-style-type: none"> a. Case studies in three localities in semi-arid Northeast Brazil | <ul style="list-style-type: none"> a. Household survey of 90 households in three rural districts of the municipality of Irauçuba b. Key informant interviews c. Field observation |
| 4) To determine the variation in mobility behaviour before and after the occurrence of a severe climatic event | <ul style="list-style-type: none"> a. Examine the role of mobility within household livelihoods b. Investigate key dimensions of mobility for households and individuals in the study area c. Examine changes in local circulation brought about by climatic events | <ul style="list-style-type: none"> a. Case study b. Household survey c. MISTIC toolkit d. Participant observation | <ul style="list-style-type: none"> a. Survey of 90 households in three rural districts of the municipality of Irauçuba capturing seasonal and permanent migration b. 549 individual trajectories capturing local circulation in the study area |

3.2.1 Develop a conceptual model linking spatial mobility to rural livelihoods strategies in the context of severe climatic events

The development of a novel conceptual model was the first core objective of this study. The construction of this model aimed to overcome a limitation identified in the review of the literature. Previous models have provided useful insights into the relationship between the environment and migration, however, limited attention has been dedicated to conceptualising the broad spectrum of mobility behaviour associated with climatic and other environmental hazards. Moreover, the majority of conceptual models have largely bypassed the role of local circulation in mediating the impact of climatic events on livelihood strategies and the everyday life of communities. The literature suggests that temporary moves and local circulation are an integral component of rural livelihoods which are often employed as a pre-emptive mechanism to diversify income and reduce consumption during hardship (Da Vanzo 1981; Gardner 1981). Therefore, to address these issues, the following strategy was employed.

A rigorous set of criteria was employed in the selection of previous models which would be drawn upon in the construction of a model to guide the current research. First, the main focus of the models had to be on exploring population movement as a response to climatic hazards or other forms of environmental stress. Second, models should focus on the environmental processes which include slow-onset events such as droughts. It is important to note that in two models, the environmental stressor was not specified, but generally described as climate change. The most recent IPCC report (2013) suggests that slow- and sudden onset events will increase in both frequency and strength, therefore, conceptual models which focus on climate change were also selected.

Five main models were identified which met these criteria: McLeman and Smit (2006), Perch-Nielsen et al. (2008), Gilbert and McLeman (2010), Black et al. (2011) and Martin et al. (2014). These were reviewed and synthesized to integrate key features, specifically an exogenous context, institutional responses, and the capital assets which underpin the Sustainable Livelihood Approach (SLA), and the key dimensions of population movement. The resulting conceptual model is described in detail in Chapter 4.

3.2.2 Establish the socioeconomic and climatic context of contemporary mobility in semi-arid Northeast Brazil

The second objective connects directly to the conceptual framework and is the starting point for a systematic analysis of the broad socioeconomic and environmental characteristics of semi-arid Northeast Brazil, in which rural communities are embedded. At the macro scale, this study will examine the conditions of uneven economic development and climatic variability which were introduced in Chapter 1. Further questions develop from this. What is the composition of the population in the study area? What is the nature, strength and form of climatic events in the region? What is the pattern of spatial mobility in Northeast Brazil, and in the study area in particular?

To address these questions, the analysis of the regional context uses aggregate demographic and climatic data from public sources in Brazil. The type and sources of secondary data are discussed in detail in Section 3.4. To construct a profile of the climatic variability in the State of Ceará, where the study site is located, 100 years of precipitation data were analysed with regard to annual means and moving averages. The precipitation data also enabled investigation of the relationship between climate and agriculture. Data on subsistence crop production was used to infer the strength of rainfall variability in this relationship.

Different approaches were employed in the analysis of the population. First, the composition of the population in the study site was analysed with regard to sex and age structure. Second, to investigate current and previous patterns of regional migration, the analysis employed a suite of metrics aimed at computing the total of in-migrants and out-migrants and net-migration rates. This approach is commonly employed in migration studies (Boyle, Halfacree and Robinson 2014). Due to the limited data on intra-municipal population movement, the analysis of migration in the study site required an alternate strategy. Life table survival ratios were used as an indirect measure of net internal migration. The application of these methods of analysis is discussed in detail in Chapter 5.

3.2.3 Establish the characteristics of households that shape livelihoods in three localities in semi-arid Northeast Brazil

The third objective aimed to examine the internal dynamics of households in the study site in order to establish their composition, access to capital assets and livelihood strategies. A

second sub-objective sought to investigate household perceptions of local climate and socioeconomic issues. The aim was to assess the distribution of five types of capital generally recognised as forming the range of assets available to households and the communities, and to establish the way in which they mediate household livelihood strategies in the study area. This approach is based on the theoretical foundation of the Sustainable Livelihood Approach (SLA). The aim was to also to assess the relative importance of climatic events compared with other socioeconomic and environmental issues in the lives of households and communities.

In order to investigate the relationship between different forms of spatial mobility and the 2010-2013 drought in the study area, it was important to first establish key characteristics of households. To achieve these aims, field work was structured to systematically collect a range of primary data in the form of a household survey, key informant interviews and field observation. The sources and methods of data collection are discussed in detail in section 3.5.

Upon return from the field, questionnaire responses were coded (see appendix IV for the complete survey codebook) and the data were analysed using both Statistical Package for the Social Sciences (SPSS) v. 22 and Microsoft Excel. In the first round of analysis, household-level quantitative data were analysed using statistical techniques including measures of central tendency such as the mean, median and mode; measures of dispersion such as range, variance and standard deviation; and frequencies and percentages. Contingency tables have also been constructed to examine the frequency distribution of variables. To examine if there were statistically significant variation between households with regard to perceived climatic and socioeconomic issues, one-way analysis of variance tests were performed. ANOVA is a statistical technique employed to compare the means of three or more groups (Moore and McCabe 1989). Chi-square tests were employed to test the significance of association between variables collected in the field survey.

To differentiate households according to access to capital assets and main source of income, households were categorised into four groups according to their main source of income, access to capital assets and composition. This typology was obtained through cluster analysis. Cluster analysis is a research strategy for classifying agents into various discrete types by grouping entities which are similar, in order to maximise differences between groups (Romesburg 2004). This strategy is discussed in detail in Chapter 6.

3.2.4 Determine the nature of mobility behaviour among households and identify how this changed as a result of the 2010-2013 drought

The fourth objective aimed to examine the various forms of spatial mobility in the study area, and situate them in the context of the 2010-2013 drought. Permanent out-migration and seasonal migration data were collected in the household survey, but a systematic form to record data on customary local mobility before and during the drought required the development of a novel approach. The Mobility in Space and Time among Individuals and Communities (MISTIC) toolkit was designed to capture the spatiotemporal patterns of everyday mobility of household members. Based on key dimensions of spatial mobility, coupled with PRA techniques, this flexible, participant centred approach facilitated data recording and subsequent analysis. The theoretical foundation and the practical aspects of MISTIC are described in detail in Chapter 9. A suite of a metrics to compute the variance in key dimensions of mobility was employed. As a result, quantifiable estimates of frequency and length of time spent away from home were obtained and subsequently analysed in xy scatterplots. This approach enables the comparison of local circulation prior and during the 2010-2013 drought.

The overall research strategy integrated each objective within the principal aim of the study. Figure 3.1 maps the connections. The text in the top box describes the aim of the study, while the connectors link each objective described above back to the aim.

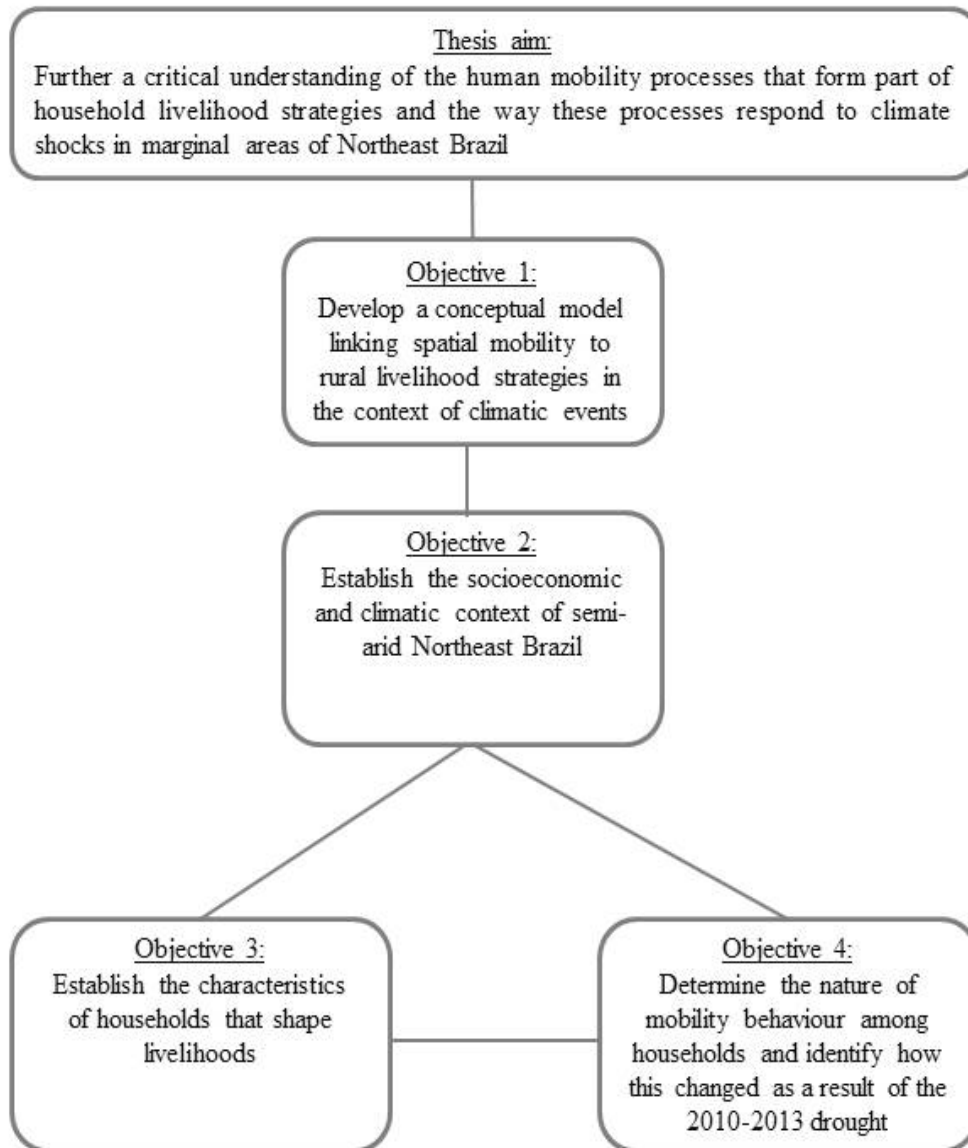


Figure 3.1 Research aim and core objectives

3.3 Secondary data sources

Aggregate public data were essential to the understanding of the broad regional climatic and socioeconomic contexts which form the core of the second objective of this study, described in subsection 3.2.2. Compared with other developing countries, Brazil is well served by both climatological and migration data. There are two main sources of data related to climate indicators: the National Institute for Space Research (INPE) which collects, analyses and distributes climate data at the national level; and the meteorological foundations located in each State, which have the same purpose, albeit at a regional and local level. All climate

data used in this study were acquired from Ceará's Foundation for Meteorological and Hydrological Resources (FUNCEME) and subsequently analysed to obtain the annual total, the mean, standard deviations and the coefficient of rainfall variability in the study area.

With regard to spatial mobility, the main source of data in Brazil is the decennial Brazilian Demographic Census, conducted by the Brazilian Institute of Geography and Statistics (IBGE). Concerning internal migration, the Brazilian census collects data in the form of a fixed date question. Interviewees are asked about their place of residence with regard to a specific date in the past, in this case five years preceding the census date. The census also captures mobility in the form of data recording place of birth and current place of residence.

The 2000 and 2010 Brazilian censuses were the main sources of origin and destination of migrants used in Chapter 5 to examine contemporary patterns of population movements in Northeast Brazil and in the state of Ceará. The major limitation of the census data is that, with the exception of questions on second homes, the data provides only a snapshot of temporary moves which are equal or longer than five years. No information is collected on circulatory movements that do not entail change of address. To overcome this limitation, the application of a household survey capturing the reasoning, purpose, duration, frequency, occupation at destination and other key features of spatial mobility was conducted in the study area. The design and application of the household questionnaire is discussed in detail in section 3.5.

3.4 Primary data collection

The empirical aspect of this study is based on a case study approach. This approach seeks to systematically obtain information about a social setting, event or group, which then enables the researcher to effectively understand how the focus of the study operates. Case study is not a data gathering technique, but a methodological approach which incorporates a range of data collection processes (Hammel, Dufour and Fourtin 1993). As a result, this research approach is supported by a suite of distinct qualitative and quantitative methods of analysis (Cassel and Symon 1994).

As presented in Section 3.2, objectives three and four required the collection of primary data. Consistent with the literature on the relationship between migration and the environment (Bilsborrow and Henry 2012; Jäger, Frühmann, Günberger and Vag 2009), a structured household survey coupled with key informant interviews and field observations were the key

strategies for primary data collection. As mentioned above, the application of a new toolkit designed for this research also featured in this stage of the research.

The structured household survey is a method which allows standardization across households and study sites. By incorporating variables at individual, household and community levels, this approach provides insight into both agency and structure of household livelihoods and access to capital assets (Chowdhury and Turner 2006). The study employed purposive sampling in selecting 30 heads of household in each of three districts. All households selected to participate in the survey were smallholders located in rural areas of the study site. Brazilian Law N°11.428 defines smallholding as land under 50 hectares and its adjacent living quarters for smallholder farming and stabling of animals. Purposive sampling involves criterion-based selection in which a particular setting, person, or event is selected deliberately in order to provide information for the researcher (Patton 2002). The purposive method generally involves smaller sample sizes than occur with large representative social surveys and reduced variability within the selected study group compared to the variability of random sampling (Flick 2009). Using the 2010 Brazilian census data, households in the three study sites were divided into two strata, rural and non-rural. To meet objectives three and four, only rural households were selected for the survey, which excluded households located in the main settlement of each district. Consistent with the literature (Fink 2003; Fowler Jr. 2013), a minimum sample of 10% of total rural households in the study area was designated in order to obtain meaningful results which could be generalised to the wider population at the 95% confidence level. Table 3.2 shows the sample size in all three survey sites.

Table 3.2 Sample selection and size

| District | # of rural households | # of sample households | Proportion (%) |
|----------|-----------------------|------------------------|----------------|
| Missi | 299 | 30 | 10 |
| Jua | 326 | 30 | 9.2 |
| Caxitore | 226 | 30 | 13.3 |
| Total | 851 | 90 | 10.5 |

3.4.1 Field work strategy

Before conducting field work, approval from the University of Queensland's Human Ethics Committee was obtained (protocol number 20130061). Field work was carried out between January-March 2014 in the rural districts of Missi, Jua and Caxitore, located in the municipality of Irauçuba, Ceará. Upon arrival, visits to each district were organised to identify the constituent rural communities. These initial visits also allowed the gatekeeper to introduce me to community leaders. These opportunities allowed me to describe the nature of the project and to begin the household listing operation for the survey. The key informant was then asked to list all residents in the communities so that a process to select sample households according to the study criteria could be performed. Once this stage was completed, application of the questionnaires commenced.

On average four interviews, which also included the application of the MISTIC toolkit, were performed daily. Details on the strategy employed in the application of the toolkit are described in detail in Chapter 9. Commuting to and from the rural districts provided a useful platform for field observation because it allowed me to broaden understanding of the study area with regard to daily livelihood activities, and the hardship brought about by the 2010-2013 drought as I too was affected by the limited availability of water and increased cost of foodstuff. As much as possible, I took up opportunities to participate in social events and engage in everyday activities performed by the residents of the study area. Patton (2002) argues that this directness provides a degree of validity to field-based research as it concentrates upon what people do, as opposed to what they report they do.

During my stay in rural Irauçuba, I attended several local community meetings. In a meeting in the district of Jua, I observed how residents, in spite of the impact of the 2010-2013 drought, were planning to combine efforts to provide food and entertainment to support the wedding of one member of the community (Figure 3.2). I tried to be aware of my physical surroundings and to take note of the way residents of the three study sites interacted with one another and with the environment that surrounds them. I always shared my meals in the study sites with research participants or was asked to join them, and generally tried to immerse myself in the local context. By directly observing daily household activities, valuable information which added richness of detail to the survey data was obtained.



Figure 3.2 Community meeting in the district of Jua

3.4.2 Key informant interviews

Key informant interviews were used to obtain access to important information about the impact of the 2010-2013 drought on the local economy and socioeconomic characteristics of rural Irauçuba that otherwise would be not available. Two key informant interviews were contacted before the field activity. Four other interviews were conducted during the field activity in January-March 2014. These included three interviews with municipal government staff and one interview with the director of an NGO working in the study area. The interviews with the municipal authorities generated information about the form and strength of the impact on the provision of essential frontline services, whereas the interview with the NGO representative generated information about the coping and adaptation strategies adopted by residents. It also provided crucial understanding of how the recurrent droughts impact on the livelihood of rural inhabitants in semi-arid regions of Northeast Brazil. It should be noted that two key informants also acted as gatekeepers to the surveyed communities, mediating the connection between researcher and interviewees for the duration of the field work.

3.4.3 Household questionnaire

The field survey was preceded by a pre-testing stage. The interviews were to be carried out in Portuguese, however the questionnaire was drafted in English. To ensure that the translation had been seamlessly completed, and that questions being asked accurately reflected the information required, an initial draft of the questionnaire was sent to three key informants for validation in October 2013. This exercise resulted in a few changes in the questionnaire in order to reduce the risk of both sampling and non-sampling errors, which include nonresponse rate and misunderstanding of questions (Flick 2009). The complete questionnaire used in the field survey is presented in Appendix III.

The structured questionnaire consisted of 115 questions divided into eight sections. The questions contained in the questionnaire were formulated to predominantly capture objective facts, thus increasing the reliability of the survey. However, Section H included questions requiring the respondent's own interpretations and experiences. This section aimed to ascertain the extent to which climatic events are perceived as an issue impacting households and communities, compared with other socioeconomic issues.

The aim of the household questionnaire was to collect data in a quantifiable format for analysis in standardised form. However, interviews provided an additional wealth of qualitative information. Respondents who wanted to provide additional information relevant to the discussion were encouraged to do so. These supplementary data were recorded as qualitative notes which have been translated from Portuguese to English with some adjustments made due to language and linguistic issues. The sections of the questionnaire are described below:

- Section A (Human Capital): This section sought to establish household membership and other relevant demographic characteristics including household size and composition in terms of sex, age and years of formal schooling.
- Section B (Physical Capital): This section comprised a series of questions seeking to establish land area and tenure, the type of activity performed on the farm, ownership of a range of consumer goods and housing characteristics.
- Section C (Financial Capital): This section sought to ascertain the main source of income, the existence of a savings account or monetary loans, and to obtain an estimate of the annual income of households.

- Section D (Social Capital): This section sought to establish the type, strength and form of social networks which households can call upon when hardship occurs.
- Section E (Natural Capital): This section sought to establish the overall quality of the natural environment surrounding households with regard to soils, vegetation and desertification.
- Section F (Livelihood Assessment): This section sought to collect information on recent changes in the productive capacity of the farm, and any changes in livelihood strategies. This section also collected data about the origin and the use of any borrowed money.
- Section G (Migration history and mobility of the household): The questionnaire sought to identify the current status of household members. Resident members were defined as those who identified their current home as their usual dwelling. Household heads identified the residential status of temporarily absent members engaged in seasonal migration. Former members of the household who had moved to live elsewhere in the past five years, and current members who had been absent over a continuous period in the six months prior to the survey, were classified as migrants.
- Section H (Perception of issues, changes in the local climate and form and strength of the impact of climatic events on households): This section sought to collect data on household perceptions and levels of concern about a range of issues. It also collected data specifically about perceptions of change in the local climate and the way in which climatic events impacted on the livelihood of households.

In the majority of interviews, the head of the household was interviewed (generally a male member except in single parent, divorced or widowed households). When the household head was not available, other household representatives were interviewed (such as the spouse of the household head) who had a thorough knowledge of household activities and decisions. Since there were no sensitive gender issues being analysed in this research, there was no reason to believe responses depended on whether male or female household members were interviewed, and responses provided by households did not appear to differ according to gender. Figure 3.3 shows the typical setting of the application of the household questionnaire



Figure 3.3 Interview with a household head in the district of Missi

It is important to briefly discuss the strategies that were implemented to minimise survey errors. Survey error assumes two distinct forms: sampling and non-sampling (Fowler Jr. 2002). The former occurs because the sample, which is a sub-set of the universe, does not exhibit the same characteristics as the universe. The latter is related to the impartiality of the researcher, or the respondent's capacity and disposition to answers the survey questions openly and in a truthful way.

This study aimed to examine the relationship between climatic events and spatial mobility in the specific context of smallholder rural households which mainly rely on rain-fed agricultural activities for subsistence. Therefore, it was vital that the selection of the sample included households which fitted the description above. Because of financial and time constraints, the decision to employ purposive sampling was made to ensure that only the target population would be selected, thus enabling a larger sample size to be surveyed (30 household in each of the three districts).

The strategy employed to minimise non-sampling error relates to the objectivity of the questions in the survey, framed so as to limit respondents' subjective interpretation or assessments. Notwithstanding the precaution cited above, this does not remove the risk of respondents not being in possession of the information or answering questions in an inaccurate or misleading way. To minimise this risk, respondents were asked at the start of

the interview to co-operate by answering questions accurately and truthfully, through a personal introduction in which the purpose of the survey was explained, it was also important to stress that the study had no involvement with any government or non-government institution. The questionnaire yielded few non-responses and these were recorded as such in the coding of the data.

3.5 Study area selection and description of field sites

The selection of three rural localities in the municipality of Irauçuba as the foci of the empirical element of this study was guided by two considerations. First, the location of the study area within semi-arid Northeast Brazil provided the opportunity to investigate the relationship between a slow-onset climatic event and spatial mobility in a novel socioeconomic and climatic context, as the majority of studies on this topic have focused on Africa and Southeast Asia. Rural Irauçuba had a range of characteristics that provided an ideal study site to investigate the four objectives presented in Chapter 1. These characteristics include the location in the hinterland of the state of Ceará, which has 92% of its territory within the semi-arid climatic zone. Moreover, in the study area in question, there is a clear predominance of smallholder traditional productive systems which include subsistence agriculture and a combination of non-farm and off farm activities which may entail the circulation of individuals (Sales 2003). All of these attributes fit within the aim of the study presented in Section 3.2.

Additionally, a range of indicators for Irauçuba reveal the environmental vulnerability of the municipality. For example, of the 184 municipalities in the state, Irauçuba has the highest index of degradation with 92% of its territory in areas susceptible to water shortages, desertification and loss of soil productive capacity (Sales 2003). Moreover, a study by Conti (2005) indicated that 67% of its rural areas are in the dreaded '*Diagonal Seca*' (Drought Diagonal), a region of Northeast Brazil which has historically recorded the lowest rainfall averages in the country. These characteristics are strongly associated with the occurrence of cyclical droughts and erratic rainfall patterns in the study area (Landim, Da Silva and Carvalho de Almeida 2011).

Second, considerable gaps in knowledge have been identified, including the limited understanding of local circulation and temporary forms of spatial mobility that do not entail a permanent change of residential address. Previous studies in Northeast Brazil have focused on estimating migration in the region under discrete climate change scenarios for

the 2025-2050 period (Barbieri et al. 2010) or on the number of migrants forced to emigrate from the semi-arid hinterland between 1960-1980 due cyclical droughts (Sanders 1991). There are various studies examining contemporary migration trends in Brazil, and in the Northeast in particular (Baptista, Campos and Rigotti 2012; Cunha 2004; Oliveira and Januzzi 2005). These studies provide useful insights into a range of aspects driving migration in Northeast Brazil, but there is little research about other forms of spatial mobility which are not captured in the national census. In addition, migration itself forms just one component in a broad spectrum of mobility behaviour. As a result, there is a severe under-reporting of local circulation, which may be employed by many people as a coping strategy in response to livelihood stress brought about by climate variability.

3.5.1 Description of the field sites (Jua, Missi and Caxitore)

The three rural districts selected for the application of the household survey are located in the semi-arid hinterland of the State of Ceará (Figure 3.4). The districts are located, approximately 30 kilometres from the urban centre of Irauçuba. Gravel roads connect the main settlement in Missi (Northwest), Jua (Southwest) and Caxitore (Southeast) to the urban centre and usually allow year-round transportation. Dirt roads connect smaller rural communities within each district, and they usually wash out if the rainfall is above the average during the rainy season, which occurs in January-April.

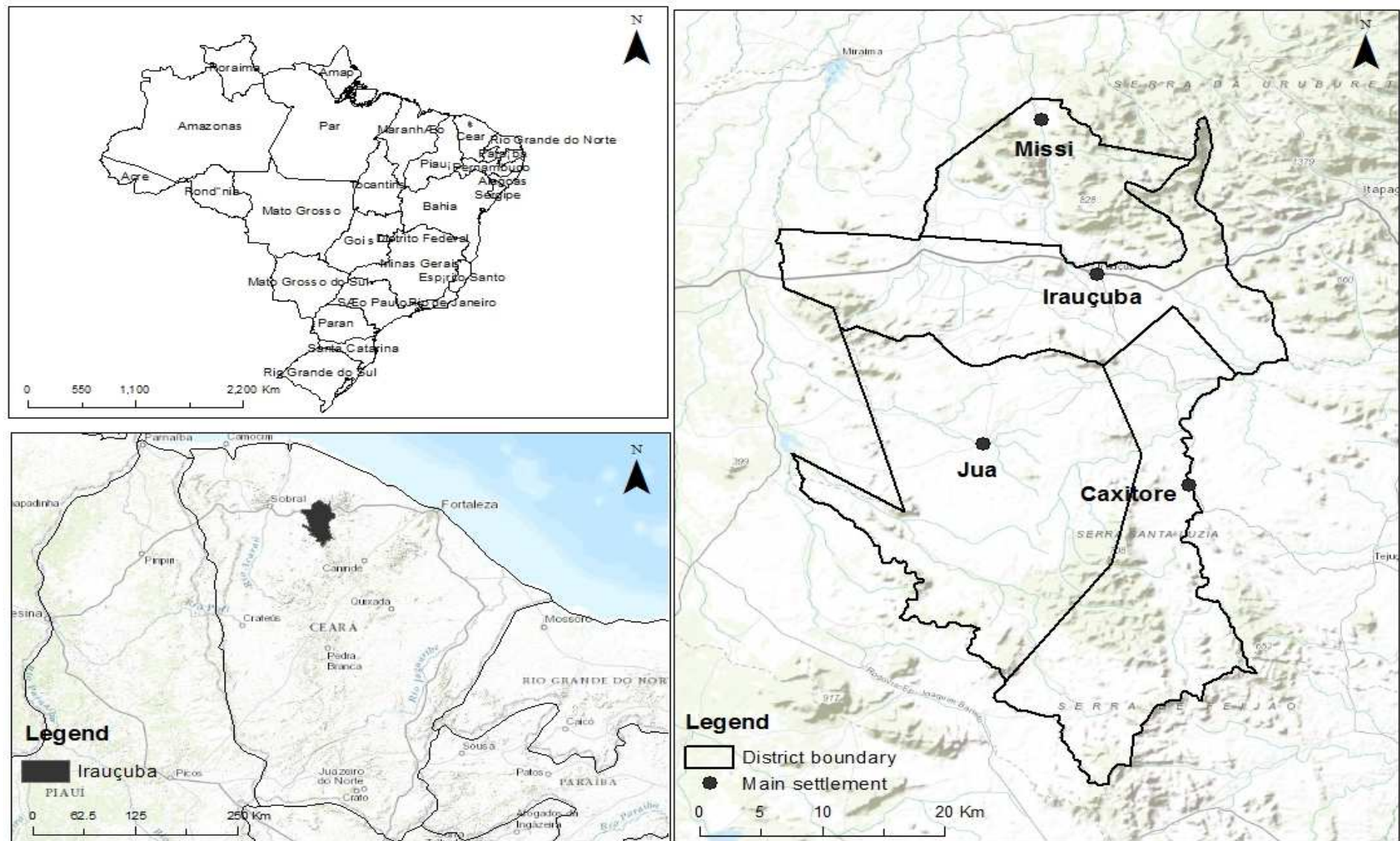


Figure 3.4 Study area and field sites

The topography of the study sites, with the exception of Missi, is characterised by lowlands with soils prone to desertification and loss of nutrients (Sales 2003). Annual rainfall averages and number of days with rain are spatially variable, but the three districts receive regular rainfall only between January-April (Landim, Da Silva and Carvalho de Almeida 2011). In this marginal environment, land use is dominated by subsistence agriculture and small-scale livestock keeping. Smallholder farms are sparsely distributed across the landscape, as shown in figure 3.5



Figure 3.5 Smallholder farms in Missi

The people in the study sites are poor, with low levels of complete primary education and vulnerable to the vagaries of climate common to this region of Northeast Brazil. To describe the population and rainfall characteristics of the three study sites, Table 3.3 presents values of selected measures from the 2010 Brazilian census and the Foundation for Meteorology and Hydraulic Resources for the State of Ceará.

Table 3.3 Demographic and precipitation indicators for the three research sites

| Demographic and precipitation indicators | Missi | Jua | Caxitore |
|---|-------|-------|----------|
| Distance from the municipal centre | 24 km | 25 km | 27 km |
| Total population (2010) | 4964 | 4251 | 1250 |
| Rural population (%) | 42.1 | 34.3 | 74.9 |
| Average size of household (2010) | 4.0 | 4.0 | 4.3 |
| Household heads with primary education (%) | 34.2 | 35.8 | 28.1 |
| Average monthly income <i>per capita</i> (US\$) | 93 | 84 | 57 |
| Mean annual rainfall (mm) | 635 | 531 | 427 |
| Mean annual days with rain | 40 | 36 | 19 |

Source: IBGE (2010), FUNCEME (2013)

Table 3.3 shows the approximate distance from the main settlement to the urban centre of the Irauçuba, where the majority of frontline services are provided. All three districts have their own main settlement area where local shops and primary schools are located. However, the city council, larger businesses and the only bank in the municipality are in the municipal centre. Of the three districts, Caxitore houses the largest proportion of rural population. Additionally, due to its location on the lee side of the *Uruburetama* Range, the district is impacted by rain shadow effect, which results in a low mean annual rainfall compared to the other two districts. Caxitore also has both the lowest proportion of household heads with primary education and the lowest monthly income *per capita* in the study area. Missi is the most populous district, with almost five thousand residents between its main settlement and the rural area. Precipitation in the district is the highest in the municipality both in terms of days with rain and mean annual rainfall due to its geographic location. Missi has the highest income per capita. Compared to the other two districts, the main features of Jua are the high proportion of household heads with primary education and the smaller proportion of rural residents.

3.6 Field experience: problems and challenges

Application of the questionnaire and the toolkit did not require the presence of an interpreter because I am a Brazilian national. However other challenges arose during the fieldwork. Unlike the household members interviewed, I came from a privileged background due to my formal education level and place of birth (São Paulo, which is the richest state of the federation). During field interviews and observations, I did not try to be inconspicuous, since such a thing was impossible in a place as rural Irauçuba, but I introduced myself as a doctoral student getting a degree from an Australian university. The presence of a local

gatekeeper minimised potential misunderstanding as to the purpose of my presence in the communities. In general, resident reactions were positive, and they helped me as much as they could. As I lived in the urban centre of Irauçuba for two months, some residents became used to seeing me in the area, and in turn I learned and practiced the local social custom.

The limited history of researchers interviewing residents in the area might help explain the lack of suspicion directed towards the field activity. A combination of curiosity, indifference, and a hope that that any direct improvements in their communities would result from their participation, were the types of reactions captured in the application of the questionnaire. In some parts of the three localities, this was the first academic research undertaken. Therefore, it was difficult to ascertain whether participants truly provided me with fully 'informed' consent as this relies on an understanding of the research products I was likely to produce.

The majority of household interviews occurred on residents' farms at a convenient time pre-arranged by the gatekeeper. The familiar setting allowed sufficient time for the interviews in between household duties. I administered the questionnaire and the MISTIC toolkit and recorded answers on the questionnaire sheet and in the supporting material included in the toolkit. As part of the commitment to ensure respect for research ethics, all household interviews began by the researcher introducing himself followed by a briefly explanation of the research objective. I also obtained oral consent in compliance with the research ethics in which I explained how the material collected in the interview would be protected for confidentiality, and only started the interview once oral consent was obtained. Participants were also informed that they were free to refuse to answer any question or interrupt the interview at any time. All visited households agreed to participate in the household questionnaire.

At the end of each interview I asked if the respondent wanted to review his answers or provide any additional information. There is a wealth of literature on this subject (Baxter and Eyles 1997; Christensen and James 2000) suggesting that communication has a fundamental place in the outcome of studies involving the application of questionnaires and interviews. Therefore, I tried to establish a cordial relationship with the interviewees, to minimise any bias which might have arisen as a result of the difference in age, clothes, formal education and physical appearance.

3.7 Conclusion

This chapter has described the research strategy and the details of the overall methodological approach taken to address the core objectives of this thesis. Starting with the overall research strategy, the data sources, methods of data collection and selection of the study area were discussed. A brief introductory description of the toolkit constructed for this study was also included in this chapter before a detailed discussion is presented in Chapter 9. Details were also provided with regard to the procedures employed in analysing the data and the strategies employed to address the limitations of this study. Lastly, this chapter reported the challenges encountered during the field work.

The majority of studies investigating the relationship between the environment and spatial mobility have been concerned with predicting the number of migrants and the general direction of flows, with limited attention to more nuanced forms of mobility or the context within which mobility occurs in rural areas impacted by an environmental hazard albeit notable efforts by Bayliss-Smith et al (1988) in examining the impacts of the cyclone Hazard on population movements in eastern Fiji. In this study, this framework is recast as one of quantifying and understanding the processes driving spatial mobility, not only with regard to movements of long duration, but also focusing on local circulation in the context of everyday livelihood activities. It also moves the setting from places in Africa, Southeast Asia, and the Pacific which have been the focus of the majority of studies, to semi-arid Northeast Brazil, a region afflicted by recurring droughts but with limited studies examining their relationship with multiple forms of spatial mobility.

Chapter 4. Conceptual model examining spatial mobility in the context of climatic events

4.1 Introduction

This thesis is founded on the premise that households can employ a variety of mobilities linked to livelihoods in the context of severe climate events, and there is a lack of a well formed theoretical construct within which to situate such dimensions. This chapter argues for a robust conceptual and methodological approach that moves beyond the dichotomy of trapped population or migrants. Such a framework should include the full spatial and temporal dimensions which form the full spectrum of mobility. Hence a conceptual model linking dimensions of mobility to rural livelihood strategies, and the exogenous factors, institutional responses and endogenous processes to households, is formulated in this chapter.

While in existing models migration is seen as a single event involving a permanent or lasting relocation, spatial mobility actually involves repetitive moves of variable duration and shifting seasonality, frequency and purpose. In developing the conceptual model for this study, existing models exploring the relationship between the environment and mobility were drawn upon to contribute to the final structure of the model presented in this chapter. Studies based on multiple drivers of migration argue that climatic events and other environmental factors might affect migration decisions in combination with a range of socioeconomic, cultural, demographic and political factors. This conceptualisation is a far more robust approach than the assumption of a linear relationship between the environment and migration. However, this approach does not effectively factor in the multiple spatial and temporal dimensions of mobility. To overcome these limitations, this study developed a new conceptual model which guides all subsequent stages of the research. This section discusses the theoretical foundations of the model and describes in detail the process of its creation.

This chapter is structured as follows. Section 4.2 systematically assesses and analyses previous models conceptualising the relationship between environmental stressors and migration. Section 4.3 assesses the Sustainable Livelihoods Approach and advocates for its validity in developing a robust conceptual model linking spatial mobility to livelihoods in the context of severe climate events. Section 4.4 presents a conceptual model that moves the discussion from migration as a problematic outcome of environmental change and climate events, towards an assessment of spatial mobility as an ongoing key element for

managing livelihood strategies in rural areas of the world. Section 4.5 concludes this chapter.

4.2 Towards a conceptual model: What do the current models say?

In research design, conceptual models serve two main purposes: to investigate cause-effect interactions; and to explore possible relationships between study variables (Ellis and Crookes 2004). Interest in the connection between environmental stressors and migration has grown significantly in recent decades, largely due to the increasing projections of climate change impacts and recurrent events due to climate variability (Bates 2002; Castles 2002). This growing concern has led to an extensive debate about the potential for climate change to increase existing conditions of climate variability in certain regions of the world, thus inducing population movement (Morrisey 2009; Tacoli 2009).

As a response, scholars have sought to develop conceptual frameworks to understand the dynamics of the environment-migration nexus (McLeman and Smit 2006; Perch-Nielsen et al. 2008; Gilbert and McLeman 2010; Black et al. 2011; Martin et al. 2014). However, research so far has not brought the complex nature of mobility to the forefront of analysis. Conceptual models capturing the social consequences of environmental events need to take into account the role of temporary mobility as an integral component of rural livelihoods, which are often employed as a pre-emptive mechanism to diversify income and reduce consumption (DaVanzo 1981; Gardner 1981). This thesis proposes an alternative framework which incorporates a specific focus on the multiple dimensions of spatial mobility linked to livelihoods in the context of climate events.

In this section, previous models are assessed and critiqued to determine their strengths and limitations, and to consider their possible applications to conceptualise the linkages between climate change, environmental stressors and mobility. Table 4.1 summarises the distinguishing features of five conceptual models and identifies key criterion against which the models are assessed.

Table 4.1 Summary of conceptual models exploring the environment-migration relationship

| Conceptual model | Main concept | Environmental migration process triggered by? | Unit of analysis | Outcome | Includes the role of spatial mobility in livelihood strategies? | Includes multiple dimensions of mobility? |
|--|--|---|------------------------|---|---|---|
| Model of migration in response to climate change (McLeman & Smit 2006) | Investigate population migration as a possible adaptive response to climate change | Not specified but generally described as climate change | Community / household | Migration is a choice mediated by broader societal processes and contexts in combination with capitals available | No | No |
| Model of influences of climate change on migration (Perch-Nielsen et al. 2008) | Explore the connections between climate change and migration through two environmental mechanisms | Slow-onset / sudden-onset | Impacted population | Migration is a choice along with a range of adaptation options | No | No |
| Conceptual diagram of rural household vulnerability (Gilbert and McLeman 2010) | Examine the extent to which access to capital assets influence households' ability to adapt to a severe environmental stress | Slow-onset | Household | Adaptive migration after <i>in situ</i> strategies have been exhausted | No | No |
| The drivers of migration (Black et al. 2011) | Identify the range of factors influencing migration decisions in the context of global environmental change | Not specified but generally described as climate change | Individual / household | Binary decision to migrate or stay taking into account individual and household characteristics along with intervening obstacles and facilitators | Yes | No |
| Climate-related model of migration decision making (Martin et al. 2014) | Explore behavioural aspects of migration decision-making in the context of climatic stressors | Slow-onset / sudden-onset | Individual | Migration decision mediated by a previous experiences, behavioural factors, norms, assets and perceptions combined with structural factors | Yes | No |

McLeman and Smit (2006) developed a model (Figure 4.1) in a study of migration as a potential adaptation strategy to the risks related with climate change. The model draws on theoretical insights from migration research, integrates the latest climate change science, and focusses on a range of aspects influencing people's vulnerability. The model is based on the broad hypothesis that climatic events influence some type of change in both the environmental and socioeconomic circumstances of a given community. The model provides a useful insight into the impact that inwards and outwards migration may have on communities.

McLeman and Smit's conceptual model initially examines the capacity of institutions to deploy essential policy corrections to secure the welfare of the inhabitants of a locality. If the institutions are unable to effectively manage the stressors, the obligation falls on individual households to employ responses that they judge most efficient. The range of options available to households and communities is a product of their assets. It is access to these capital assets that determine whether spatial mobility is a viable strategy among other potential responses.

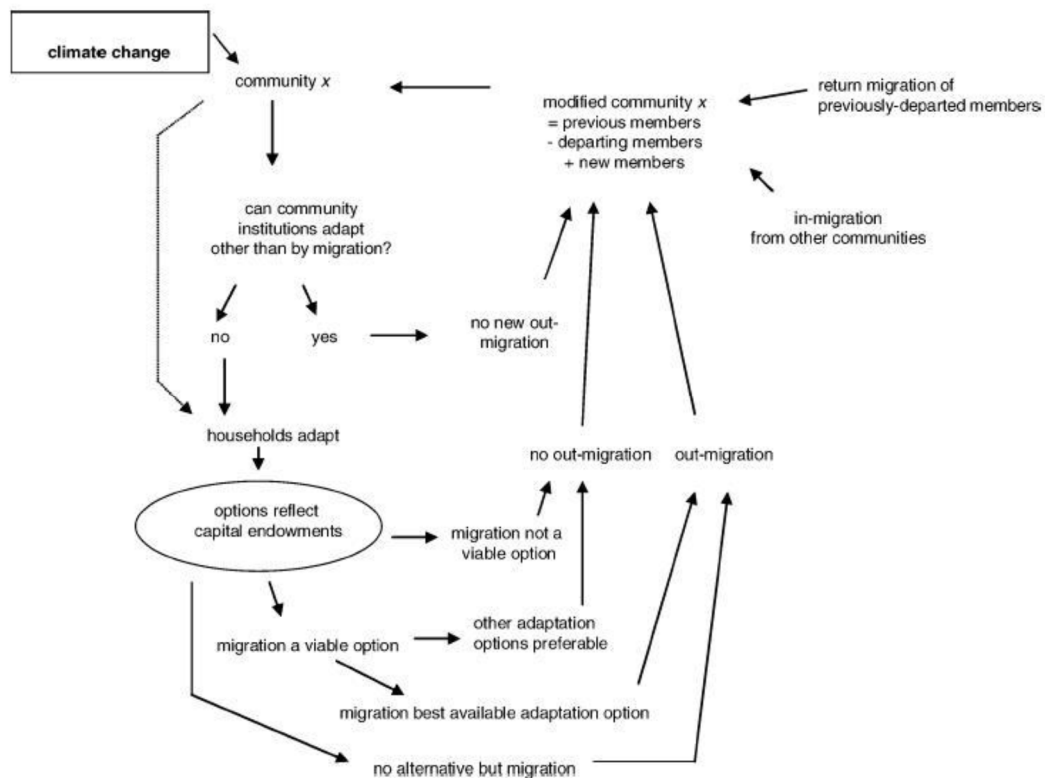


Figure 4.1: Conceptual model of migration as a response to environmental events related to climate change (McLeman and Smit 2006, p. 41)

McLeman and Smit's conceptualisation of spatial mobility as a response to climate change is a valuable analytical framework. By building on the notions of vulnerability, adaptive capacity and risk, as well as the incorporation of institutional responses in the context of migration outcomes, the authors conclude that one of the main challenges in developing a comprehensive conceptual model relates to the notion that a similar climatic event happening in the same area but at a different period may result in distinct outcomes (McLeman and Smit 2006). Therefore, it is essential to acknowledge the varying levels of adaptive capacity of impacted communities.

The household adaptation strategies identified in McLeman and Smit's model are determined by their assets and endowments. While recognising this issue, the model provides no further insight into how the association between endowments, adaptive capacity and natural capital impacts on the form of responses available to households. The model also does not expand on which endowments affect migration. On the one hand, case studies indicate that land owners and recipients of pensions and welfare cash-transfer programmes are less likely to migrate (Ashley and Carney 1999). On the other hand, a different stream of scholars argues that the opposite effect can be observed (Frey and Singer 2006). Drawing from the SLA framework (DIFD 2000), the alternative conceptual model proposed below includes five forms of capital assets (social, human, natural, physical and financial) associated with livelihood strategies, to shed light on the endogenous context of households that shapes adaptive behaviour, including spatial mobility.

McLeman and Smit's (2006) model has an obvious strength in that it identifies both community and institutional capacity to provide adaptive measures to impacted households. However, although the authors argue that wider socioeconomic circumstances impact on the adaptation strategies available to households, these aspects are not clearly incorporated in their model. The conceptual model developed in this thesis seeks to address this limitation by integrating the macro-level factors into the framework to create a more accurate representation of the complexity of factors in the environment-mobility nexus.

Building on the 'common sense' linkages that suggest climate change will potentially amplify the frequency and strength of environmental hazards causing destruction to land and houses, and thus forcing people to migrate, Perch-Nielsen et al. (2008) developed a conceptual model examining the relationship between two potential climate change outcomes and migration. This model detects ecological factors that can be impacted by future climate change and explores the extent to which direct and indirect effects may impact

on migration. One of the strengths of this model is that it identifies ‘push-factors’ associated with climate change. The first model explores flooding events, as they can be caused by increasing torrential rainfall, tropical cyclones and sea level rise (Figure 4.2). Perch-Nielsen et al. (2008) argued that direct effects such as loss of crops and livestock, damage to housing and essential infrastructure, and the spread of diseases and indirect effects such as reduced income, loss of land, reduced food availability and fewer work opportunities, are linked to a variety of adaptation measures including migration. These adaptation measures, in turn, are associated with the particular vulnerability levels of a society and the range of local, community and state level responses.

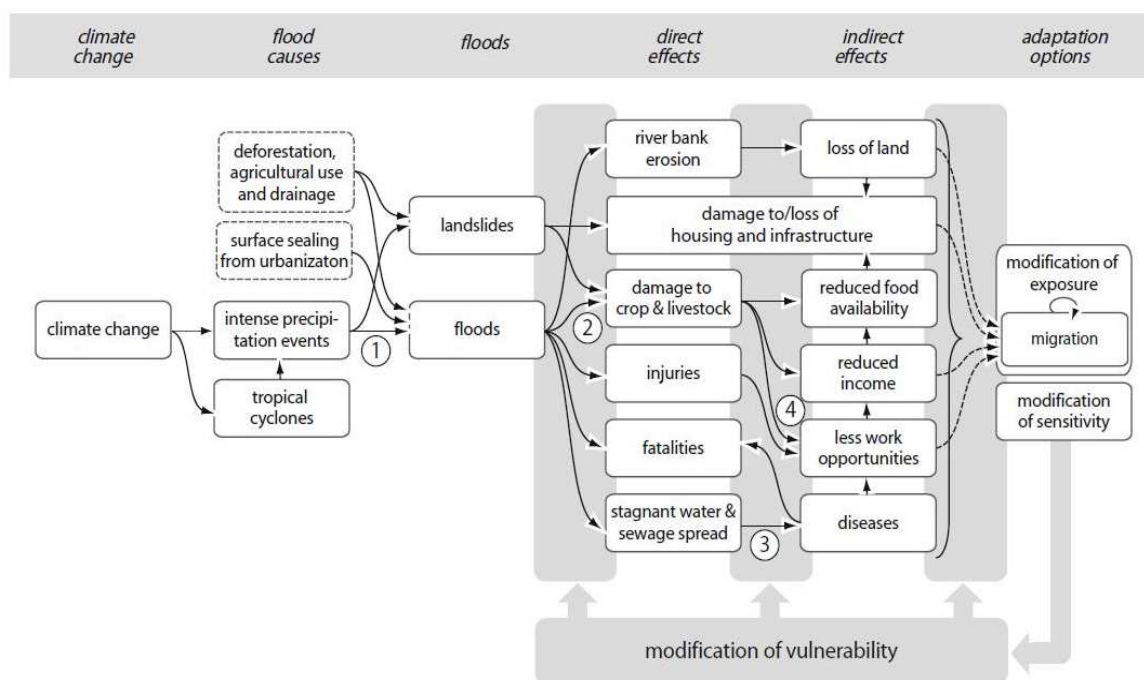


Figure 4.2: Model of influences of climate change on migration through flooding (Perch-Nielsen et al. 2008, p. 378)

The second conceptual model proposed by Perch-Nielsen et al. (2008) is a variation of the first model. It isolates sea level rise as the main environmental stressor due to its potential to cause loss of land and subsequent permanent out-migration (Figure 4.3). Examples of linkages between climate change and sea level rise given by the authors include erosion, salinization of freshwater and damage to infrastructure and buildings.

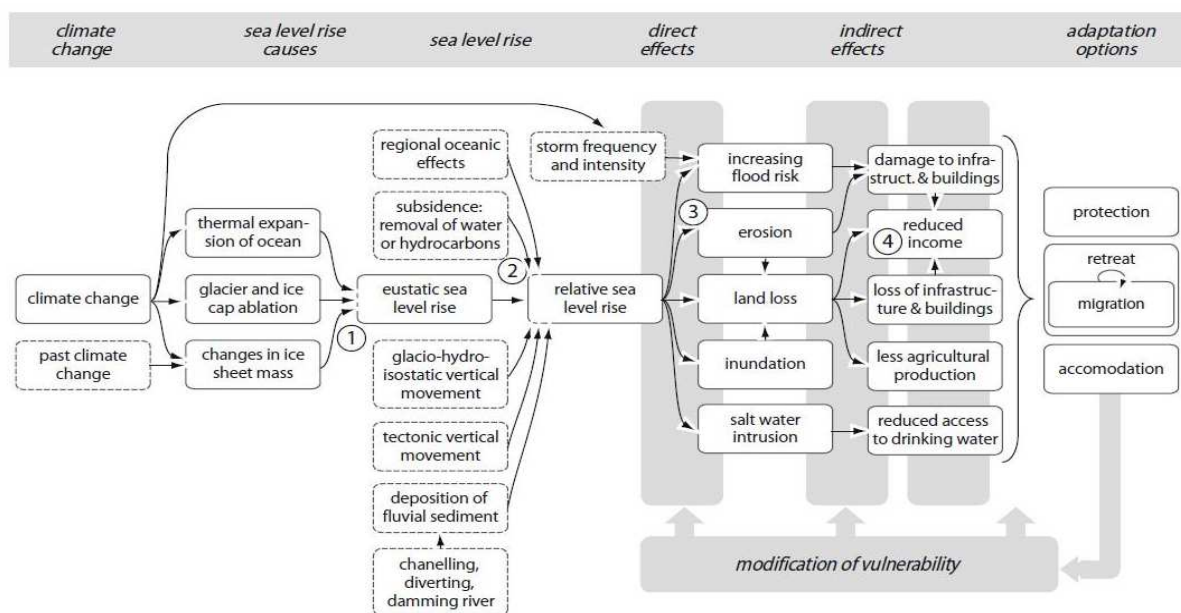


Figure 4.3: Model of influences of climate change on risk through sea level rise (Perch-Nielsen et al. 2008, p. 386)

Perch-Nielsen et al. (2008) argue that in the specific context of sea level rise, migration is a response of last-resort, even more relevant than for floods, because remaining on the land may cause loss of life. The authors then suggest that migration triggered by sea level rise is potentially substantial and may impact more than 20 million people in Bangladesh, Nigeria and Egypt alone. The authors argue that the linkages between climate change and migration can be made explicit by including a range of variables from the starting point 'climate change' to the end point 'migration'.

These two models illustrate the assumed connections between environmental change and migration. Perch-Nielsen et al. (2008) acknowledged that other adaptive responses can be employed to reduce vulnerability, and that spatial mobility cannot be examined in isolation, "but it must be analysed in the context of its alternatives" (Perch-Nielsen et al. 2008, p. 389). However their models do not explicitly refer to household exogenous process, for example, the availability of assets and household composition, nor does it include the range of institutional responses that provide *in situ* adaptation strategies for the impacted population. The structures and processes implemented by government and institutions can create or improve access to a diversity of assets to enhance adaptive capacity. Investment frontline services and welfare policies are two common approaches adopted by many countries. Governments can also regulate access to specific assets by changing land rights, and influence the rate of asset accumulation. Perch-Nielsen et al. (2008) argued that households

and communities are affected by changes to external structures and process that, along with endogenous factors, mediate livelihood strategies including migration. From a methodological perspective, the novel conceptual model presented in this chapter includes the exogenous context, the institutional responses, and the endogenous context, in order to increase the transparency of these linkages. This makes it an appropriate approach for incorporating all relevant contexts that mediate the relationship between the environment and spatial mobility.

Although not explicitly demonstrated in the Perch-Nielsen et al. (2008) model, the authors argue that in some cases migration might not be permanent for people displaced by environmental change and events. However, the models do not convey the dynamic process of spatial mobility linked to livelihoods in response to climate change events. Changes in the pattern, composition, purpose and frequency of trips linked to mobility are not included in the models. Consecutive temporary moves by first-wave migrants that might influence the adaptation responses available to household members who stayed behind are likewise ignored. In response, the new model presented in this thesis acknowledges these dimensions in a systematic way, making it suitable to convey the dynamic process of spatial mobility as part of livelihood strategies to respond to severe climate events.

An approach aimed at incorporating a range of elements presented in the Sustainable Livelihoods Framework is shown in Figure 4.4. Gilbert and McLeman's (2010) model investigates how access to human, economic and social capital influenced the ability of households in the 1930s to adapt to droughts rural Canada.

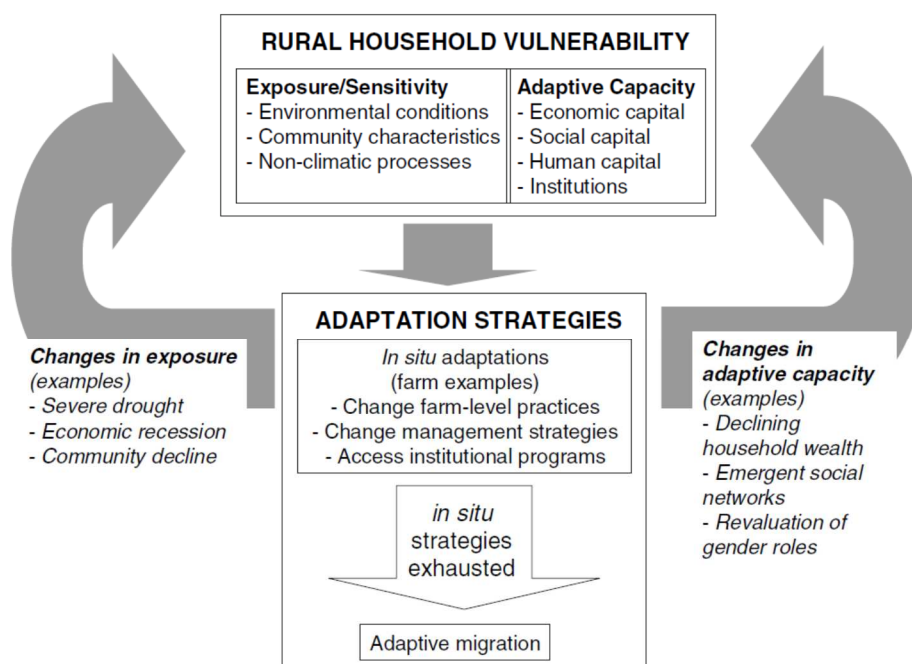


Figure 4.4: Gilbert and McLeman’s (2010, p.11) conceptual diagram of rural household vulnerability in relation to droughts

These authors argued that migration behaviour can be seen as one option out of many undertaken by communities within the context of broader interactions between socioeconomic and environmental processes (Gilbert and McLeman 2010). Distinct responses are described as reflecting different levels of vulnerability and adaptive capacity mediated by the range of assets available to each household. Gilbert and McLeman’s model acknowledges the interacting roles of endogenous elements in the form of social, economic and environmental capital, along with external factors and *in-situ* adaptation strategies, in shaping vulnerability and adaptive capacity. However, the model does not acknowledge the role of the many forms of spatial mobility – such as diurnal, circular or seasonal - that form an integral part of households’ livelihoods.

The four conceptual models analysed above are focused on the environment as a main driver of spatial mobility. However, the literature argues that spatial mobility is a multifaceted phenomenon that takes into account a range of drivers, intervening obstacles and dimensions (Henry, Boyle and Lambin 2003; Bell 2004). Recent efforts investigating linkages between the environment and migration have moved beyond a simple causal relationship towards a more complex approach.

In 2011, the Foresight Programme of the United Kingdom’s Government Office for Science commissioned a report with the general aim of assessing the likely impact of global

environmental change on migration. The findings were used to inform the development of policies, to explore scenarios characterising feasible potential future migration influenced by environmental change, and to develop hypotheses in empirical studies investigating the relationship between the environment and migration (Black et al. 2011). The resulting model explores the multiple variables interacting with migration, dividing the potential drivers of migration into five categories: social; economic; political; demographic; and environmental. The shocks or changes brought about by the environment are modelled as influencing all drivers in an interconnected manner through the pentagonal linked structure, but the outcome identified in the model is also one of its limitations, as it does not move beyond the dichotomy of movers and stayers (Figure 4.5).

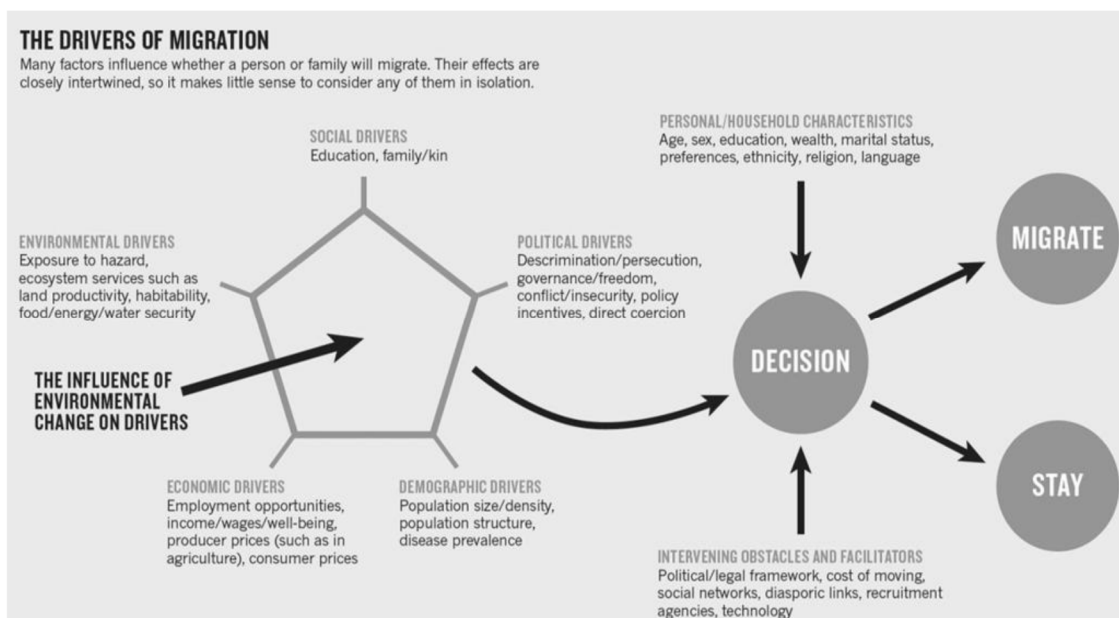


Figure 4.5: The Drivers of Migration (Black et al. 2011, p.448)

These drivers, subject to the influence of environmental change, are then seen in the model as contributing to the decision to migrate, which is itself affected by personal/household characteristics and intervening obstacles/facilitators. As a result, an individual or a family decides to either migrate or stay. The primary value offered by this model is the representation of environmental change as a pervasive factor that affects all five drivers of mobility in an interconnected manner. As such, migration is presented as being potentially driven by environmental stressors that can affect non-environmental drivers. On the one hand, the model is a useful representation of the complex intertwined nature of migration as

a response to environmental shocks. On the other hand, due to the move-stay binary portrayal of the migration phenomenon, the 'Drivers of Migration' model is not able to identify the multidimensional nature of mobility outcomes, which ranges from daily commuting to seasonal moves to permanent resettlement. These forms of spatial mobility are shaped by the interaction between household characteristics and intervening obstacles and facilitators. As previously mentioned, one of the main strengths of the conceptual model developed in this thesis is the addition of core dimensions of mobility identified by Bell (2004) as being paramount to understanding the spatial and temporal dynamics of population movement.

A common feature of the conceptual models assessed above is an approach that solely focuses on how and why people move in response to the impacts of climate change and variability, along with a range of other environmental stressors. This concept often overlooks the role of spatial mobility as an ongoing livelihood strategy employed by households across the globe in response to economic fluctuations, political instability or environmental limitations. A conceptual model introduced by Martin et al. (2014) examines the behavioural characteristics of migration decision-making based on recurrent exposures to a range of structural factors, including environmental stresses brought about by climate variability.

Building on the New Economics of Labour Migration theory postulated by Stark and Bloom (1985), the model developed by Martin et al. (2014) (Figure 4.6) suggests that migration decisions take into consideration the opportunity to maximise income, reduce risks, and counterbalance potential market losses. Spatial mobility is also shaped by changes in the environment as well as by the internal dynamic of households and individuals characteristics of their members. The model also includes the values, beliefs and attitudes that play a role in migration decision-making. To further explore the linkages between the environment and migration, Martin et al. identify risk perception and perceived adaptive capacity observed by individuals impacted by an environmental shock.

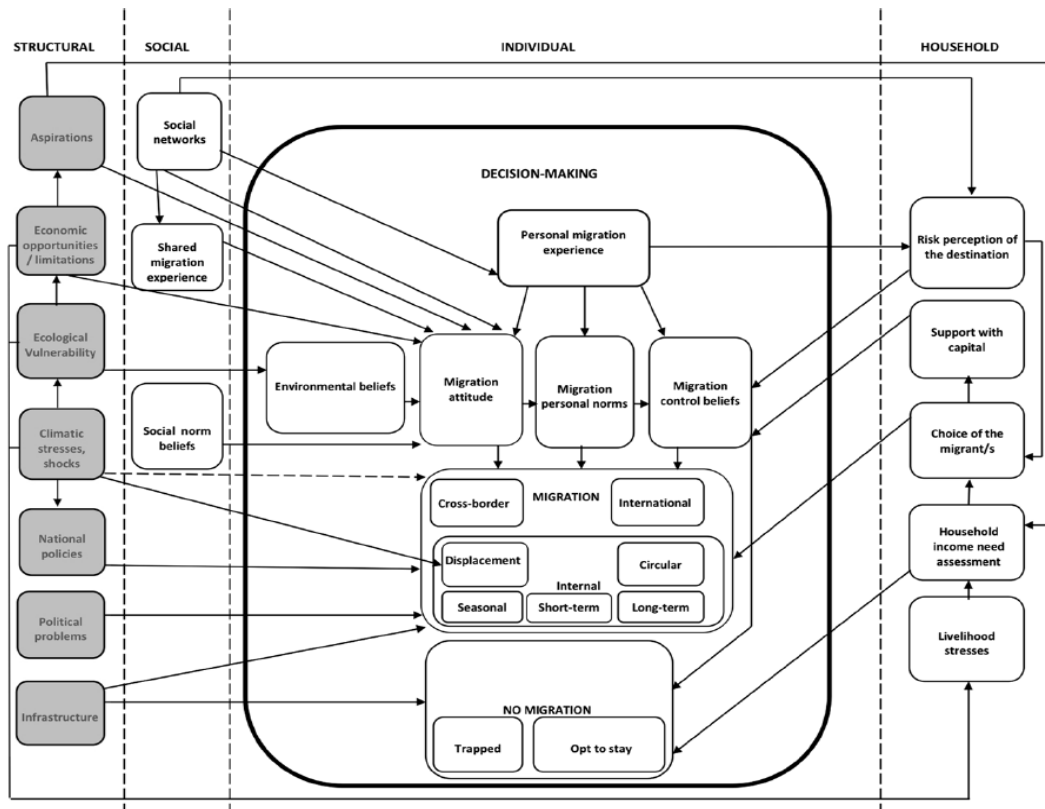


Figure 4.6 Model of migration decision-making (Martin et al. 2014, p. 9)

To form its theoretical basis, the model draws from social psychological theories of reasoned action and planned behaviour aimed at incorporating intentions and attitudes towards migration in the context of changing rainfall circumstances (Martin et al. 2014). The main strength of the model is the inclusion of four levels of analyses (structural, institutional, individual and household) while acknowledging that migration can take many forms ranging from permanent resettlement to circular moves that are part of livelihood strategies. The model is limited, however, by the non-inclusion of key dimensions of spatial mobility that result in shifts in the frequency, intensity, composition, duration, spatial pattern and purpose of moves associated with household responses to climatic events. Capturing these dimensions of spatial mobility represent a serious challenge to scholarship investigating the environment-migration nexus, because they shape the spatial and temporal dynamics of population movement available at individual, household and community levels.

If migration is to be linked to livelihood strategies, it needs to take into account a range of factors from access to capital assets to external stressors that mediate the type of mobility available to each individual or household. Residents of marginal areas often see spatial mobility – in its different spatiotemporal patterns - as a strategy to diversify livelihoods in the

context of a severe climatic event. A framework that builds on the strengths of previous models, while expanding on these dimensions of spatial mobility, is fundamental to capturing, measuring and interpreting the shifts in mobility behaviour brought about by climate events and a myriad of other drivers.

4.3 Towards a conceptual model: Integrating the Sustainable Livelihoods Approach

As a necessary second step to gain greater insight into how spatial mobility occurs as a household response to environmental shocks, this study utilises ideas from the Sustainable Livelihoods Approach (SLA). A robust conceptual model must acknowledge that the impacts of climatic events upon human populations are best considered in terms of vulnerability, which is a widely used term by many scholarly communities. Attempts to develop a consensual definition have so far been unfruitful. Several authors argue that ‘vulnerability’ can only be used meaningfully with explicit reference to a particular vulnerable situation for a community, household or individual (Brooks 2003; Luers 2005) as it is context and place specific. One of the most elaborated definitions of vulnerability comes from Chambers (1989):

“The exposure to contingencies and stress, and difficulty coping with them. Vulnerability has thus two sides: an external side of risks, shocks and stress to which an individual or household is subject; and an internal side which is defencelessness, meaning a lack of means to cope without damaging loss.” (p. 1)

Most relevant to this research, the vulnerability of households can be reduced with increased adaptive capacity, which is, in turn, affected by factors such as, social, physical, financial, natural and human capital, institutional responses, and macro-level socioeconomic and environmental contexts (Kniverton et al. 2008). As such, these are all fundamental factors that need to be included in a conceptual model examining the relationship between spatial mobility and environmental change or events.

The SLA builds on the idea that individuals and households make decisions and plan their actions in order to maintain or improve livelihoods, according to existing socioeconomic and environmental contexts (DFID 1999). Chambers and Conway (1992) indicate that “a livelihood is environmentally sustainable when it maintains or enhances the local and global assets on which livelihoods depend, and has net beneficial effects on other livelihoods” (1992, p. 6).

The primary purpose of the SLA was as a platform to plan for and understand people's livelihood strategies in the context of other influencing factors, so that policies and programs geared towards development could be designed and deployed more appropriately and effectively. The key notion of the SLA is that households can access a combination of human, financial, social and physical and natural capita, which is used to support and maintain livelihoods. If a loss of a particular asset occurs, it can be compensated for by turning to the other available capitals. Furthermore, external factors and institutional responses are also implicated in the potential outcomes (DFID 1999). The SLA is a platform to further understand how vulnerable livelihoods are to external shocks, oscillating macro-economic tendencies and seasonal vagaries. It is also concerned with the structures and processes that allow household access to assets, and what forms of adaptation strategies are employed by households when one or more of these events occur (Carney 1998).

The Sustainable Livelihoods Guidance Sheets, published by the Department for International Development (DFID) in 1999, discusses the SLA in detail (Figure 4.7). The main concept of the SLA model argues that livelihoods are mediated by access to different combinations of assets. Furthermore, the SLA suggests that in the context of vulnerability, households act in ways to minimise risk. Their livelihood is threatened by a range of external shocks, including political instability, climatic events, diseases, economic crises, seasonality of production, civil unrest, war, as well as a range of political and socioeconomic tendencies on the global scale and at the local level (DIFD 2000).

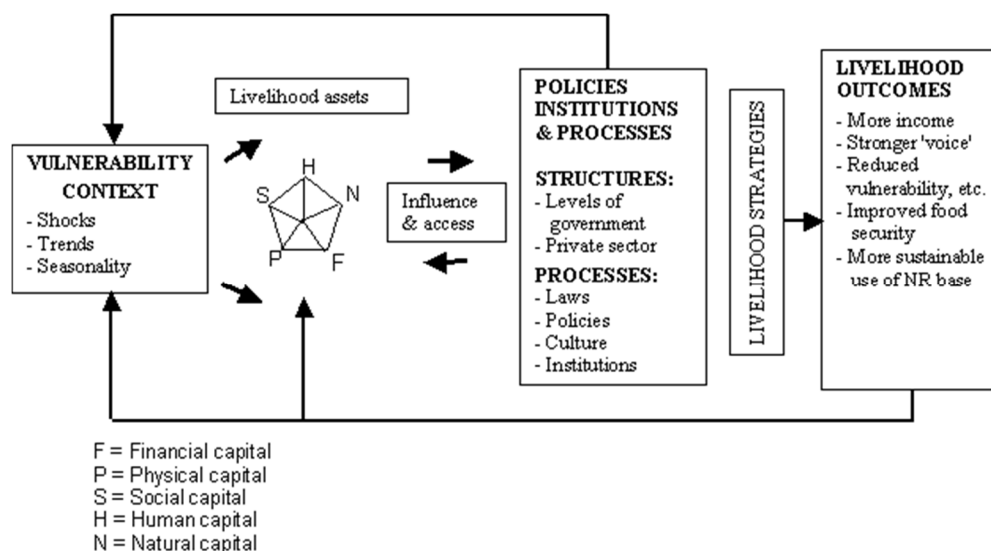


Figure 4.7: The SLA model developed by Ashley and Carney (1999)

Access to the five discrete forms of capital in the asset pentagon in Figure 4.7 is associated with level of exposure to the contextual factors discussed above, as well as governmental

policies, structures, and the institutional processes in place. In this context, households endeavour to combine and diversify their assets in many different ways to maintain or improve livelihood outcomes (DFID 1999).

The strengths of the SLA are related to the encompassing assessment of a range of strategies households employ in order to conserve their livelihoods. It also places people at the core of its analysis. However, one of the main limitations of the SLA is associated with its methodological approach. One of the key arguments against the framework is that it overlooks the inequalities of power within households. Households are not conflict-free entities, and often internal decisions tend not to be based on mutual agreement between its members. In response to this limitation, many gender-sensitive studies on people's livelihoods have been designed to address inter-generational and gendered conflicts (Moser 2008).

Despite its limitations, the SLA is a valuable approach in the development of a conceptual model to investigate the environment-migration nexus. The SLA framework suggests that people respond to external stressors by combining and switching between different assets. Moreover, the SLA is based on the principle that livelihoods are affected by a range of external factors, including, but not limited to, climatic events. This is a focal point for the construction of the conceptual model which guides this study, because this approach supports the notion that the environment-migration nexus is not linear. For example, in the context of a given climatic event, households employ a combination of responses which are mediated by access to capital assets and livelihood strategies.

The link between migration and sustainable livelihoods stems from the understanding that migrants come from a variety of backgrounds and have different levels of access to capitals assets. Coping and adaptation strategies used by households to respond to climatic and other environmental events depend greatly on variables such as duration, strength, frequency, and nature of the phenomenon. Other factors that need to be taken into account relate to the internal dynamic households, their livelihood strategies and capital assets, past experience and the networks to which they have access. Furthermore, the household's perceptions of the intensity of the event along with other socioeconomic aspects of everyday life, and their ability to cope and circumvent its effects, influence the adaptation strategy employed. Consistent with the literature (McDowell and De Haan 1997; Moser 2008) the conceptual model presented in this chapter acknowledges this fact by incorporating spatial

mobility as one of the livelihood strategies available to households while also recognising it as an adaptive response in the context of severe climatic events.

A brief review of the literature on the linkages between migration and livelihoods strategies suggests that migration can lead to positive livelihood outcomes for migrants and their family members and communities (Barnett and Webber 2010; de Haas 2007). The main benefit of migration stems from the opportunity it provides migrants to access non-farm products or services as well as sources of income to ensure support in times of hardship. The model presented in this chapter incorporates elements from the SLA framework to provide transparency to the assumed connections between all structures that mediate livelihood outcomes, including spatial mobility.

4.4 A conceptual model of mobility dimensions linked with livelihoods in the context of climatic events

Conceptual models are tools for communication within and across scientific fields which assist framing questions, clarifying system boundaries and offering an inclusive representation of the relevant processes contained in any phenomenon (Heemskerk, Wilson and Pavao-Zuckerman 2003). Drawing on previous theoretical models, this research sets out a novel conceptual model that incorporates a range of mobility dimensions linked to livelihoods in the context of severe climate events. Bell (2004) suggested that nine dimensions of temporary mobility could be recognised. Five of these – movement intensity, duration, frequency, seasonality and periodicity – relate to the temporal dimensions while the remaining four – distance, direction, connectivity and impact – are concerned with the spatial aspects. These dimensions are fundamentally interwoven but each reflects a particular aspect of temporary mobility and provides a different perspective on the nature of such movement

Environmental stressors are not the sole driver of population movements. Studies examining the complex, multi-causal nature of migration argue that climatic and other environmental issues impact migration outcomes in combination with socioeconomic, political, cultural and demographic factors. However, mobility of household members is not the only response strategy to stressors such as climatic events. Households facing multiple livelihood challenges often choose between various responses among which mobility might be one alternative. Theoretical approaches such as the SLA and the NELM indicate that households minimise the risk of income loss by diversifying livelihoods, according to their level of access

to capital assets. In developing a comprehensive conceptual framework to examine the environment-migration nexus, the multi-causality of migration, and the various forms of household responses according to demographic composition, livelihoods and access to capital assets needs to be acknowledged (Fotheringham et al. 2004). These characteristics are included in the conceptual model illustrated in Figure 4.8 and described below.

The model is represented as a simple graphic set of boxes-and-arrows. Boxes identify factors and arrows represent relationships and influences between them. Boxes and arrows do not indicate the intensity and strength of the influence but simply provide a general overview of interconnectedness. The first panel of the model (Figure 4.8) illustrates how interactions between the exogenous context (e.g. economic recession, political isolation, change in global price of commodities, global climate change and so on), socio-cultural and governance institutional structures and responses (e.g. laws and regulations, policies and community support) and the endogenous context (households' livelihood strategies) trigger mobility responses characterised by a range of different features. The horizontal arrow on the left represents the impacts of climate events (e.g. the 2010-2013 drought in Northeast Brazil) overlapping with the elements that constitute the three layers displayed in the panel. The vertical box on the right illustrates dimensions of spatial mobility which are affected by interactions between the elements that constitute the household livelihoods, the social and governance institutions and other exogenous factors. The horizontal arrow on the top right of the diagram links spatial mobility responses to the dimensions of mobility displayed in the horizontal panel on the right of the model. The focal point of interest in this model is the linkages between mobility processes, livelihoods and climatic events. Consistent with the literature, mobility of individuals is often used as a way of diversifying livelihoods because migrants commonly remit to the household, or return to the household with their financial earnings or acquired skills (Chambers and Conway 1992; Brown 2007; Castles 2002; Gray 2009; Hampshire and Randall 1999).

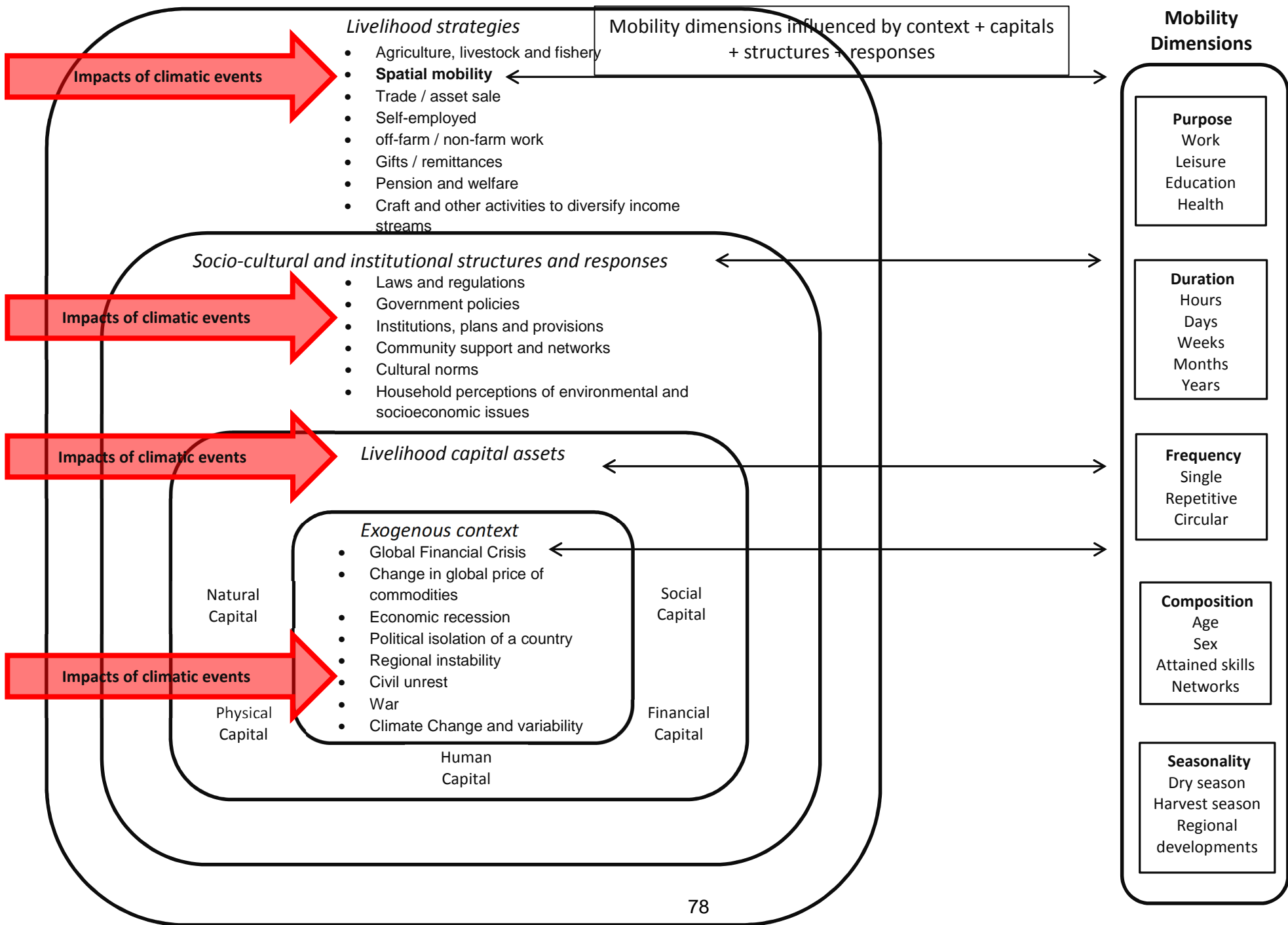


Figure 4.8: Conceptual model to explore spatial mobility as a livelihood strategy in the context of climatic events

This model underlines the variety of mobility processes in the context of climate events through the analysis of key dimensions of spatial mobility represented by purpose, duration, frequency, composition and seasonality. These features were selected because they represent a range of characteristics that determine the nature of spatial mobility (Bell and Ward 2000; Fotheringham et al. 2004). Consistent with the literature, the model identifies that mobility outcomes can be influenced by a complex interplay between exogenous factors, institutional responses and household capital.

The model incorporates a series of broad intervening exogenous factors and socio-cultural institutional structures and responses that shape mobility behaviour. The first panel of the model draws from the SLA to include exogenous factors such as the macro-economic and political context that impinge on household livelihoods. The meso-level of the model is formed by socio-cultural and institutional structures and responses that bridge the divide between the broader exogenous context and the household level. It is also commonly accepted that mobility is selective on the basis of factors such as sex, level of education, work experience and age (Castles 2002; De Haan and Rogaly 2002). Mobility also depends on a series of obstacles that determine duration and destination such as cost of moving, attained skills, means of moving and the existence of networks and opportunities. In the model, these characteristics are represented by the different forms of capital that a household can draw upon.

The core element of the model (Figure 4.8) is that households draw on a diversity of livelihood strategies or activities for their income and subsistence according to the capital assets available. For example, potential strategies could include agriculture (e.g., subsistence cropping, cash cropping, and livestock raising), wild product collection (e.g., hunting, timber harvesting, and fuel-wood collection), wage labour (both agricultural and non-agricultural), self-employment (e.g., small-scale commerce, manufacturing, or construction), each of which involves moves associated with production- or consumption-related activities. Motivations to diversify livelihood activities include ensuring subsistence in the face of external factors and environmental hazards, reducing consumption demands, profit maximization given seasonality and assets availability, and the cultural importance of maintaining traditional activities (Sen 1990). Decisions to adopt livelihood strategies are not assumed to be independent, and trade-offs or synergies may exist between different activities. Among these strategies, agriculture and livestock are particularly prone to the impacts of climatic events. This is important because rural

households in the developing world rely primarily on agriculture for their livelihoods, but studies have shown that non-agricultural sources account for 40% or more of rural incomes in Latin American countries (Reardon et al. 2001), with self-employment and non-farm wage labour typically more important than agricultural wage labour and migrant remittances.

In the model, the household is the central unit of analysis because decisions are frequently made in a family context (Black et al. 2011). Furthermore, the household, placed in its local and broader context and with attention to differences among individuals, is an appropriate unit of analysis for the investigation of livelihoods, spatial mobility and climatic events, as attested to by the large number of household-centred studies of these processes (Adams, Cekan and Sauerborn 1998; Massey and Espinosa 1997; Pichón 1997). Household responses to external shocks are mediated by their portfolio of five capital assets (Sen 1990). Human capital is represented by age and sex of members of the household, formal education and traditional knowledge, health status, and work experience. Social capital is associated with the networks that can be drawn on for assistance, including relationships with kin, wealthy patrons, migrants, governmental and non-governmental organizations. Physical capital includes manufactured goods, business or farm equipment, livestock, housing, and infrastructure (broader community or at the household level). Financial capital accounts for the means of income, including loans, savings, cash-transfer assistance programmes and remittances. Lastly, natural capital includes water availability, soil quality, favourable climatic conditions and biophysical resources (Scoones 1998).

The second panel on the right hand-side of the model turns attention to the dimensions of mobility. Mobility processes are mediated by household diversity of, and access to capital assets, socio-cultural and institutional structures and responses, and exogenous factors. As a result, the purpose of travel can vary greatly within households and individuals within the same community. Duration can be simply defined as the length of time spent away from home and are heavily associated with the purpose of the trip. Bell (2004) identified that the duration is shorter for business and longer for leisure journeys. Frequency is a third dimension of mobility that is particularly relevant in the case of temporary moves due to its repetitive nature. Mobility composition is selective on the basis of factors such as sex, level of education, work experience and age. Finally, the seasonality of moves is another key factor that is also contemplated in this model as it can be affected by, for example, the availability of water for subsistence farming

and livestock keeping in the study area. More relevant for this study is the distinction between moves performed before and during the 2010-2013 drought in the study area.

An alternative approach to examine the environment-migration nexus, relative to the model proposed in this chapter, needs to include the spatiotemporal dimensions of population movements, which form the full spectrum of mobility. Furthermore, conceptual models should recognise that migration decisions are based on the strength and duration of the impacts of climatic events on macro-socioeconomic factors and the internal dynamic of households. The type of response to these external shocks is also based on livelihood strategies, access to capital assets, and household members' perceptions.

4.5 Conclusion

The conceptual model introduced in this chapter sought to integrate contributions from the literature on spatial mobility, climate change adaptation, and sustainable livelihoods to produce a new conceptual model. This literature has sought to identify obstacles and drivers which shape population movements. A systematic analysis of existing conceptual models examining the relationship between the environmental change and migration has shown that, although current frameworks provide insights into the range of drivers and linkages, there are also substantial gaps in knowledge in the form of an often binary (migrate or stay) overview of migration in response to environmental factors. What these approaches share in common is a primary focus on understanding the causes and consequences of mobility decisions, but with comparatively little attention to the underlying spatiotemporal dynamics of mobility itself.

In addition, these models represent static push-pull frameworks and treat migration as a unidirectional response of last-resort, with all individuals responding to the stimuli in the same way. To overcome these limitations, an alternative conceptual approach is needed. The model introduced in this chapter represents a departure from the conventional mover-stayer framework in favour of a perspective that acknowledges that migration is a complex, multi-faceted phenomenon and that people respond differently to its various drivers depending on individual characteristics, household composition and their contextual setting. Moreover, migration itself forms just one component in a broad spectrum of mobility behaviour. The conceptual model developed for this study provides a framework to examine this multi-

causality, and key dimensions of mobility, as the basis to explore the way in which climatic events shape household responses including mobility.

Chapter 5. Socioeconomic characteristics, environmental features, and migration patterns in Northeast Brazil

5.1 Introduction

This chapter describes the study area, with emphasis on its socioeconomic and environmental characteristics, including a brief history of its development. The context presented here, combined with the conceptual framework introduced in chapter 4, forms the basis against which to situate and interpret the subsequent analysis. The sections of this chapter provide an overview of internal migration dynamics in Northeast Brazil, in the state of Ceará and in the municipality of Irauçuba, highlighting both the net migration rates across the state, and age-specific migration dynamics in the four districts of the municipality.

The chapter is structured as follows. The first section describes the socioeconomic and climatologic characteristics of semi-arid Northeast Brazil. Section 5.2 describes the characteristics of the local climate in Irauçuba, focusing on climate variability over a 30-year period. Section 5.3 focuses on the demographic characteristics of the municipality, examining the age and sex composition of the population. This section also briefly contextualises migration dynamics in Northeast Brazil and in the state of Ceará, before it investigates internal migration within Irauçuba. Section 5.4 summarises the chapter.

5.2 Socioeconomic and environmental characteristics of semi-arid Northeast Brazil

Officially, the technical existence of the semi-arid region is due to Article 159 of the Brazilian Constitution of 1988, establishing the Constitutional Fund for Financing the Northeast (FNE). Legally, the semi-arid area in Brazil was defined by Law No. 7.827, of 27 December, 1989, characterizing it as a region with high spatiotemporal rainfall variability and frequent drought, with a mean annual rainfall less than or equal to 800 mm (Silveira et al. 2007). In 2005, the Ministry of National Integration updated the official coverage area of the semi-arid region following the Ministerial Decree No. 89. The new delineation of semi-arid considered two technical criteria: an average annual rainfall of less than or equal to 800 mm; and a drought index of 0.5 in the period between 1961 and 1990 (calculated by water balance which relates to the annual rainfall and potential evapotranspiration).

Under the current boundary (shaded area in Figure 5.1), the semi-arid region covers 1,133 municipalities with an area of 969,589.4 km², corresponding to almost 90% of the total area of the Northeast (in the states of Piauí, Ceará, Rio Grande do Norte, Paraíba, Pernambuco, Alagoas, Sergipe and Bahia). With a population of about 23,5 million people, semi-arid Northeast Brazil is an increasingly urban space characterised by a concentration of population in urban areas, mainly on the outskirts of municipalities, regardless of their size. Between 1991 and 2010, the total population grew by 8.6% but urban growth reached 26.5% while the rural population decreased 8.2% (IBGE 2010). The abandonment of rural areas in the semi-arid region is due to the recurrent crises in agricultural activities (animal husbandry, cash crops and subsistence), the attraction of an urban lifestyle, and cyclical droughts.

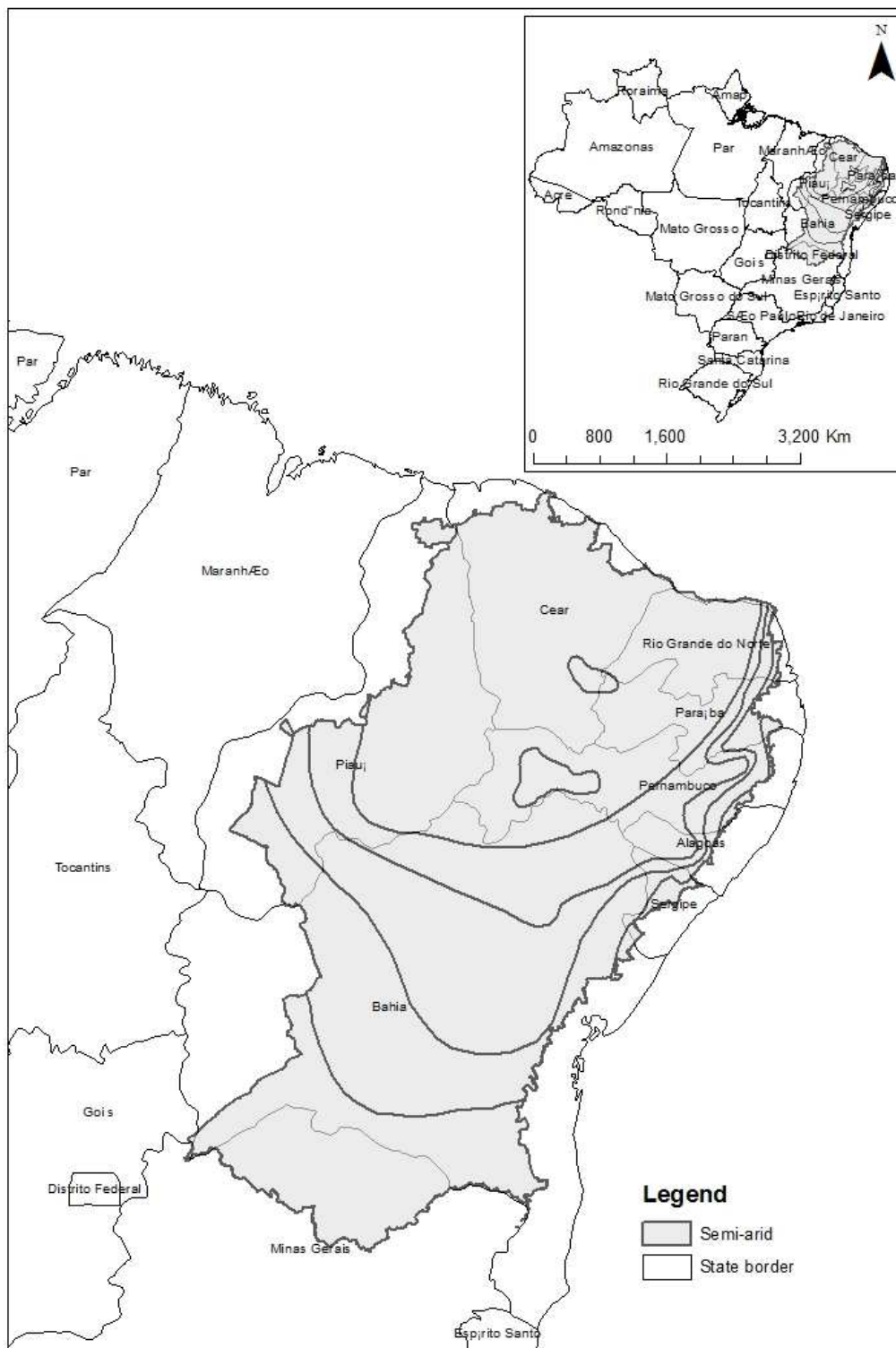


Figure 5.1: Semi-arid region of Northeast Brazil.

Source: Elaborated with data obtained from IBGE (2014)

The semi-arid region has also been marked by enduring socioeconomic contradictions. The Gross Domestic Product (GDP) per capita of the region in 2010 was US\$ 911, well below the average recorded in Northeast Brazil of US\$ 1,379; and less than half the national average, which was US\$ 2,497 (IBGE 2010). A comparison of income between the richest 10% and the poorest 40% in the semi-arid region reveals more clearly the persistence of social inequalities. In 2010, the richest 10% of the population earned 43.7% of aggregate income; while the poorest 40% earned just 7.7% (Atlas of Human Development in Brazil 2013). With slow economic growth and low income, most semi-arid municipalities depend on the transfer of financial resources from both federal and state levels to provide basic services to residents.

Socioeconomic indicators show the vulnerable condition faced by the inhabitants of the semi-arid region. The Atlas of Human Development in Brazil (2013) reported that in 47.5% of municipalities in the region, about one-third of the population receive more than half their income from government welfare transfers, mainly social security benefits. In almost half of the semi-arid municipalities, the percentage of people 15 years or more who are illiterate varies between 25 and 36%. In 42% of the municipalities, this variation is even higher, ranging between 36 and 48% of the population in this group.

Infant mortality indicators reveal a large discrepancy between the semi-arid region and the national average. In 45% of semi-arid municipalities, the infant mortality rate ranges from 50 to 75 per thousand live births. This figure is well above the national average of 18 per thousand children who die before their first birthday. 82% of all semi-arid municipalities, (comprising two thirds of the total population of the region) have a low Human Development Index (HDI). These percentages are well above the national average, which recorded 31% of the municipalities and 15% of the population in this range. In semi-arid Northeast Brazil, no municipality is placed in the higher range of HDI (between 0.800 and 1.000). These poor socioeconomic indicators are compounded by successive droughts (Kenny 2002). Smallholder farmers and pastoralists who practice rain-fed agriculture are extremely vulnerable to environmental forces such as climate variability, which often compromise already fragile livelihood systems (Finan and Nelson 2001; Marengo 2008).

The introduction of economic practices not always suited to the local climate is the result of an unplanned spatial occupation process which failed to integrate sustainable techniques suitable

to the harsh semi-arid ecosystem. Anthropogenic activities (fires, deforestation on riverbanks) and inappropriate agricultural cultivation (intensive agriculture coupled with slash and burn techniques) caused and continue to cause environmental degradation in the region. The endemic biome of *Caatinga* (savannah-type of biome with extended steppes with shrubs and palms) is now one of the most threatened ecosystems in Brazil, due to the over-exploitation of its natural resources (de Oliveira et al. 2012). Besides being one of the most devastated Brazilian biomes, the *Caatinga* was for a long time the most neglected. Only at the end of the 1990s did the Ministry of Environment recommend the expansion of the protected area in the *Caatinga* to 10% in the next ten years, with priority given to the indirect use of protected areas because of their importance for maintaining biodiversity (Sales 2003).

From an economic perspective, the semi-arid region is also marked by contrasts. The recent economic modernization in the region, propelled by tax incentives and the arrival of agro-industrial enterprises, introduced technological and managerial innovations. However, the economy of rural semi-arid municipalities is still characterized by a combination of subsistence and market-oriented small agricultural production, which are markedly impacted by climate variability and the occurrence of cyclical droughts (Ribot, Magalhães and Panagides 2005)

Due to the significance of droughts in the region, it is important to establish the nature of this climatic event in semi-arid Northeast Brazil. The literature indicates that a drought can be classified into three distinct types: hydrological, meteorological, and agricultural (Wilhite and Glantz 1985). The first two types are associated with deficiency in a hydrometeorological variable. These droughts are caused by extended periods of decreased precipitation on surface or subsurface water supply. The impacts of rainfall shortage are exacerbated by high temperature and/or high evaporation. Agricultural drought combines the characteristics of hydrological and meteorological droughts to agricultural effects through soil water deficits, which impact crops (Wilhite and Glantz 1985).

The cycle of drought in semi-arid Northeast Brazil assumes all three characteristics described above. In addition, it exacerbates the existing social inequalities that make dry spells into socioeconomic crises. When drought occurs in the region, agricultural producers who already live in precarious conditions are the first affected (Watts 1983; Magalhaes and Glantz 1992; Khan and Campos 1992). The Brazilian Agricultural Research Corporation (EMBRAPA)

revealed that in the semi-arid region, there are about 16 million hectares (16% of the total) with good agricultural potential; 43 million hectares (44%) with limited agricultural potential but exploitable under certain conditions; and about 35 million hectares (36%) with strong impediments to agricultural use (Paupitz 2010).

The severity of social problems in semi-arid Northeast Brazil has been observed for hundreds of years. This situation has always been related to the problem of drought, when rainfall is insufficient or too irregular to allow agricultural production, impacting on the livelihoods of families. First reports of the occurrence of droughts date from the seventeenth century, when the Portuguese first arrived in Northeast Brazil. The various authors who list the droughts of the XVI and XIX centuries base their analysis and comments on the historical record made by the writers of the time (Marengo 2008). The history of these climatic events in Northeast Brazil is extensive and widely recorded. In the sixteenth century Portuguese Jesuit priests documented the earliest occurrences of drought. Later, in the 1800s, a drought triggered by a severe El Niño event caused the death of an estimated 500,000 people (4% of the Brazilian population at the time), and forced 3 million people to migrate (Villa 2000; Davis 2002). Table 5.1 shows a timeline of drought events in the region.

Table 5.1: Drought events in Northeast Brazil

| XVII Century | XVIII Century | XIX Century | XX Century |
|---------------------|----------------------|--------------------|-------------------|
| 1603 | 1710-11 | 1804 | 1900 |
| 1614 | 1721 | 1809 | 1903-04 |
| 1692 | 1723-24 | 1810 | 1907 |
| | 1736-37 | 1816-17 | 1911-12 |
| | 1744-46 | 1824-26 | 1915 |
| | 1754 | 1827 | 1919 |
| | 1760 | 1830-33 | 1930-33 |
| | 1772 | 1835-1837 | 1936 |
| | 1776-78 | 1844-45 | 1941-44 |
| | 1783-84 | 1877-79 | 1951-53 |
| | 1790-94 | 1888-89 | 1958 |
| | | 1891 | 1966 |
| | | 1898 | 1970 |
| | | | 1977 |
| | | | 1979-84 |
| | | | 1986-87 |
| | | | 1991-93 |
| | | | 1997-99 |
| | | | 2001-02 |
| | | | 2005 |
| | | | 2007 |
| | | | 2010-13 |

Sources: Gutiérrez et al (2014); Marengo (2008); Siegel (1971)

Table 5.1 reveals that the twentieth century was the driest ever recorded, with no less than 27 years of drought events. The longest drought in that era began in 1979 and 50% of the cattle died from lack of water; malnutrition among the population was rampant and thousands perished of thirst and famine. The productive capacity of the region only stabilized once rain returned to normal in 1983 (Marengo 2008). The 1979–1983 drought impacted 18 million people, with approximately US\$1.8 billion invested in emergency programmes to respond to the hardship (Ribot, Najam and Watson 1996). More recently, Northeast Brazil experienced an intense and prolonged drought for the majority of 2010-13, with over 880,000 rural farmers having received federal assistance involving social and financial support (Gutiérrez et al. 2014).

In the State of Ceará, where the study area of this thesis is located, the impacts of increased climate variability can potentially be devastating, since an estimated 96% of agriculture is rain-

fed and 40% of the economically active population still rely on it for their livelihoods (Silveira et al. 2007). Because rain-fed agriculture is highly vulnerable to the variability of seasonal rains, a clear understanding of the influence of climatic events is needed to assess the role of mobility in livelihood strategies.

The state of Ceará registers a single rainy season during the year (often from February to May, but it can have an earlier onset in January) when the Atlantic Intertropical Convergence Zone (ITCZ) reaches its southernmost position, adjacent or over Northeast Brazil, and promotes atmospheric variability (Hastenrath and Heller 1977). The ITCZ is responsible for most rain systems in Northeast Brazil. Anomalous latitudinal movements of the ITCZ are related to surplus (southward) or shortage (northward) rainfall (Hastenrath and Heller 1977). Various studies have identified that sea surface temperature (SST) variances are the main trigger of the interannual variability of precipitation in the region (Moura and Shukla 1981; Nobre and Shukla 1996). Figure 5.2 shows the annual precipitation and the five-year moving average for the period 1913-2013.

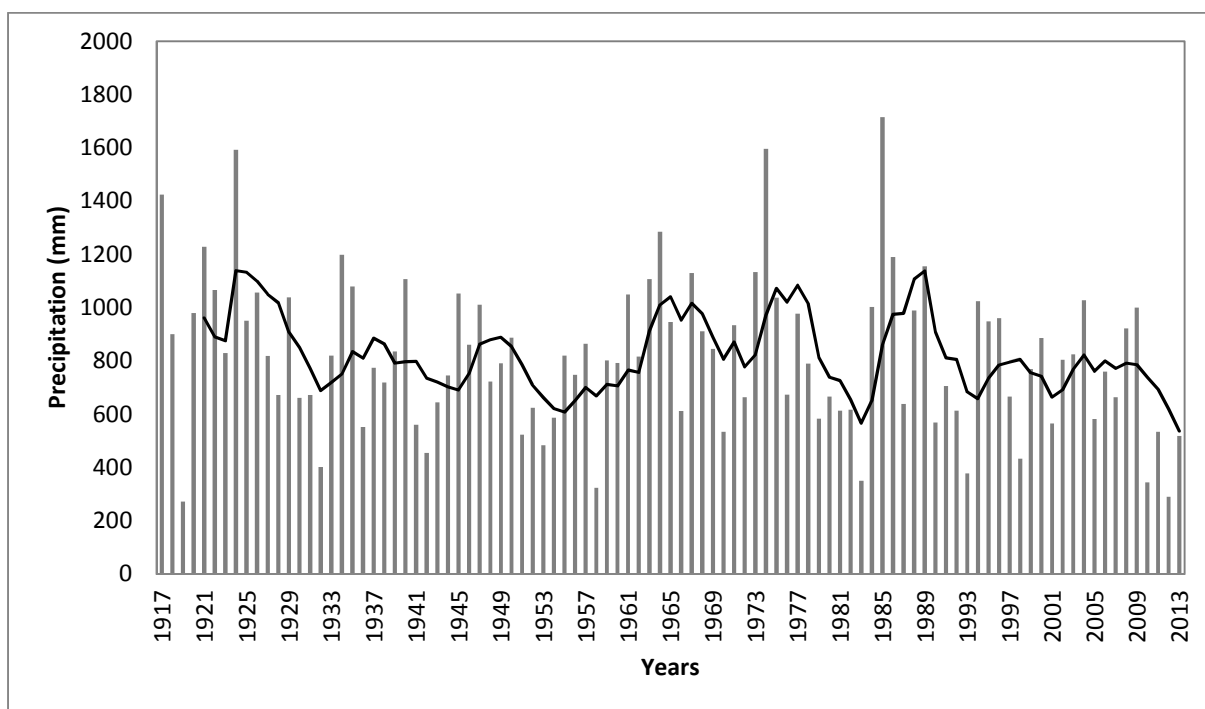


Figure 5.2 Annual precipitation and 5-year running mean 1913-2013 in Ceará (STDV277.52) Besides the interannual rainfall variability, Nobre and Melo (2001) call attention to the concurrent intraseasonal variability, highlighting that even in years when rainfall totals are

similar to the recorded climatological average, periods of severe hindrance to agriculture can occur if precipitation is not evenly distributed throughout the rainy season.

Subsistence agriculture in Ceará and across semi-arid Northeast Brazil is highly susceptible to the impacts of climate variability, particularly to the recurrent droughts which occur in the state. Figure 5.3 shows the relationship between precipitation and agricultural productivity. In years in which a drought or dry spells occurred (1993, 1998 and in 2010), crops such as rice, corn and beans, which account for 96.5% of the total production in the state, recorded a sharp productivity decline affecting yields across the state.

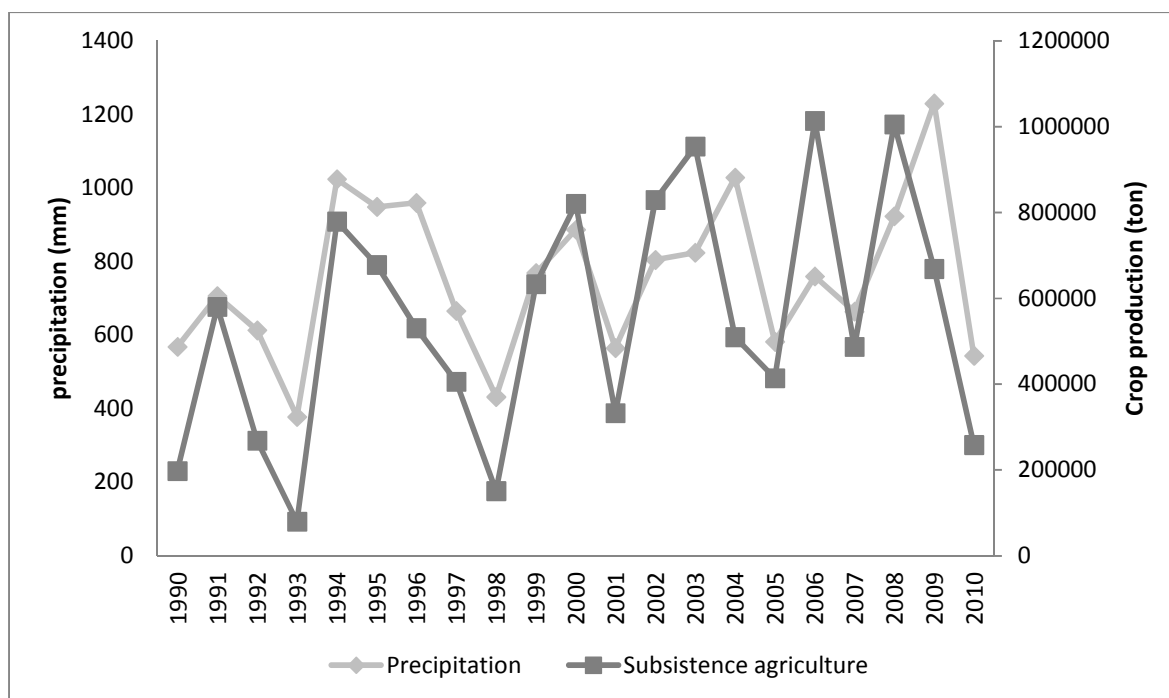


Figure 5.3 Precipitation and subsistence agriculture production in Ceará (1990-2010).

Source: IPECE (2012)

Figure 5.3 indicates a direct relationship between crops production and precipitation. The figure shows a mild reduction in this dependency over the years, since the decreases in production in drought years, until the start of the 2010-2013 drought, have been less severe, which indicates some level of adaptation to climatic events has been developed by residents. To minimize the impact of climatic variability, the State government in conjunction with local municipalities has

been promoting strategies which increase both the adaptive capacity and the diversification of livelihoods in the region.

5.3 The municipality of Irauçuba

The municipality of Irauçuba is located in the north central portion of the State of Ceará, 155 km from the state capital Fortaleza. Access is via the BR-222 paved highway, which connects the city of Fortaleza to the State of Piauí. Irauçuba has an area of 1,451 km² and an altitude of 152.5 meters above sea level. Irauçuba shares borders with the municipalities of Itapajé, Itapipoca and Miraíma in the north; Sobral and Caninde in the south; Tejuçuoca and Itapajé in the east and Sobral in the west. The municipality is comprised of four districts. These are: Irauçuba; which serves as the central business district and is the seat of the municipal council, and the rural districts of Jua, Missi and Boa Vista do Caxitore (Figure 5.4). These rural locations are connected to the urban centre of the municipality by unpaved roads.

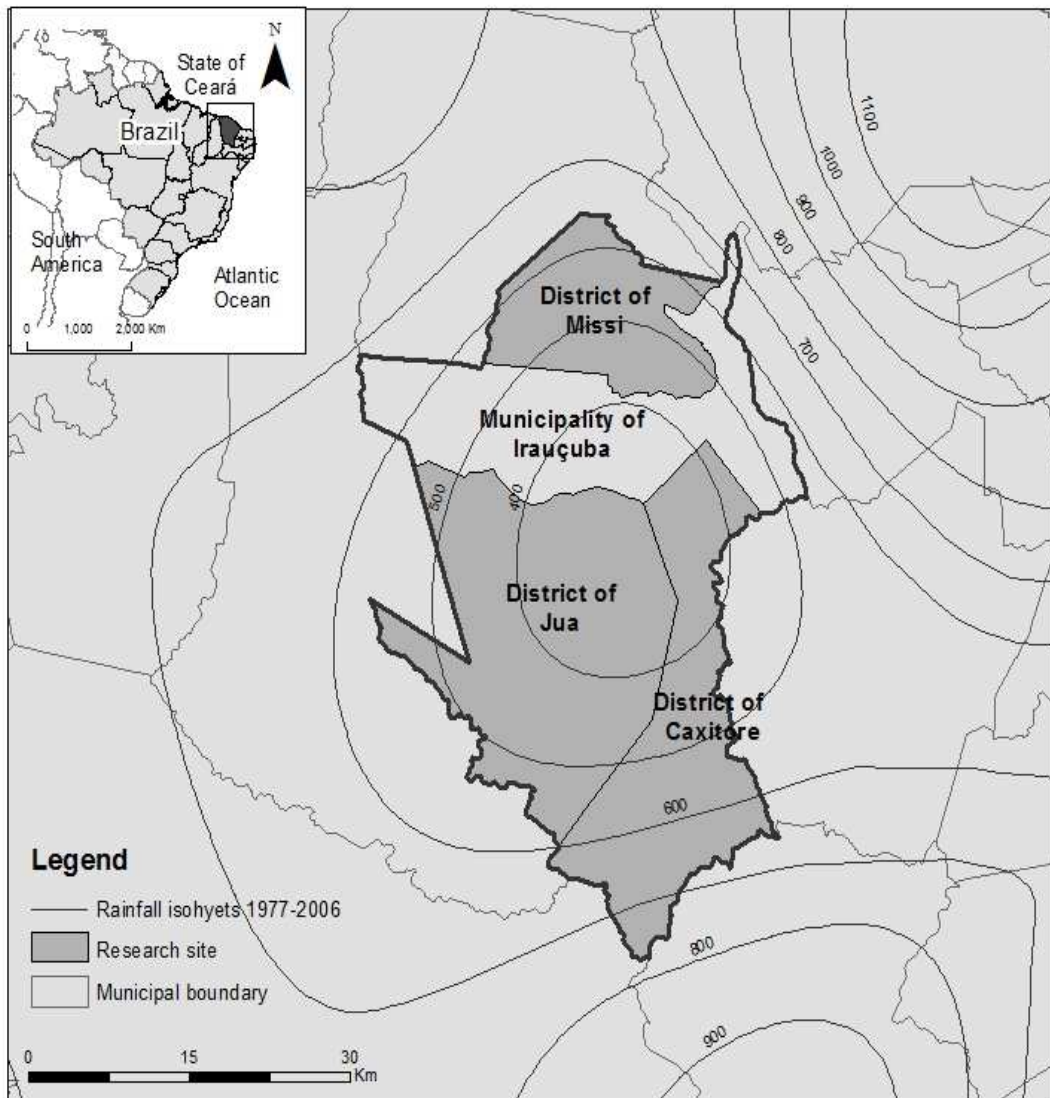


Figure 5.4 The municipal centre of Irauçuba and its rural districts

Establishment of Irauçuba occurred after land distribution in the neighbouring municipality of Itapagé, through Law number 3,598 of May 20, 1957. Initially, the municipality comprised a single district until the inclusion of Missi, Jua and Caxitore in the 1960s. Irauçuba has its historical roots linked to a water well called "*Cacimba do Meio*", which enabled settlers to raise livestock between rainy seasons. In fact, the geographical area where Irauçuba is located was known as "*Cacimba do Meio*" until 1899, when, at the request of a local judge, the name was changed to Irauçuba, which in the indigenous Tupi language means "friendship" (Sales 2003).

The most common economic activity throughout the municipality is livestock keeping. This activity was responsible for the initial organization and occupation of the space and it still has a central role in the municipal economy (Sales 2003). Besides livestock, traditional cultivation of subsistence crops of beans, rice, maize and cassava are important activities complementing the range of agricultural activities performed in the municipality. A few farmers cultivate cash crops such as castor beans and cashews. Normal cultivation practices consist of slash and burn shifting cultivation with cropping cycles varying between three to five years, and a single annual harvest (Machado, Barros and Sampaio 1997). Little fertiliser is employed because of dwindling economic resources and the irregular rainfall pattern, which limits the potential return on fertiliser investment (Sales 2003).

Given the importance of agriculture in the history of the municipality, it seems logical that its social structure is linked to the agrarian structure. The agrarian structure shows a high degree of land concentration (Finan and Nelson 2001; Wolford 2004). In 2010, 78% of farmers owned less than 10% of the land, so substantial proportions are smallholder farmers (Sales 2003). Small farms (up to 3 hectares) represented 55% of all farms in 2010, and those up to 1 hectare made up 20% (IBGE 2010). Of all rural properties in the municipality, 77% were owned in 2010.

In general, smallholder farmers in the municipality regard their family members as their main resource because their resource endowment is scarce, and their technological level is low due to the lack of capital and the low profitability of agricultural enterprises in the region. As a consequence, subsistence has persisted as an important component of household livelihoods in Irauçuba. With regard to non-agricultural activities, Sales (2003) reported that the small manufacturing sector, focused on the production of shoes, clothes, and a range of textile products, provides limited employment opportunities for residents.

5.3.1 Characteristics of the local climate

To examine climate variability over time in the municipality, secondary rainfall data from rain gauges located in its four districts were used. The data selection took into consideration the length of the series, consistency of the data, and their proximity to the study area. Data were obtained from historic rainfall series extracted from the Ceará Foundation for Meteorology and Water Resources (FUNCEME) website, and comprise 30 years of hydrometeorological records.

Irauçuba features a semi-arid tropical climate with an average annual rainfall of 531 mm. The low rainfall recorded in the area, especially in the districts of Jua and Caxitore, is an intrinsic characteristic of the overall dryness in Ceará's semi-arid territory. As shown in figure 5.4, the majority of the municipality is located within the 600mm isohyet. The lowest annual rainfall averages in the 30 year time series were recorded in the district of Caxitore (427 mm) and in the district of Jua (531mm) respectively.

Figure 5.4 reveals an increase in rainfall in the north-northeast sector of the mapped area, which corresponds to the Uruburetama range. Due to its high altitude (1,081m above sea level), and alignment in relation to the moist winds from the coast, the Uruburetama range induces the formation of orographic rain. As a result, localities closer to the range, such as the district of Missi with an average annual rainfall of 635mm, record increased rainfall totals.

The high spatiotemporal rainfall variability also constitutes a striking geographic characteristic of semi-arid Northeast Brazil (Ayoade 1986; Hare, Azevedo and Barros 1992; Conti 1995). In his seminal work, Ayoade (1986) indicates the existence of an inverse relationship between the amount of precipitation and its variability in the region. The historically low rainfall recorded across municipalities in the semi-arid region is accompanied by high variability.

Figure 5.5 shows the mean monthly precipitation and the coefficient of variation in the municipality of Irauçuba for the 1981-2010 period, recorded by rainfall gauges located in the municipality's urban centre and its three rural districts. Analysis reveals a unimodal precipitation pattern centred on January to April. The driest months occur from June to December.

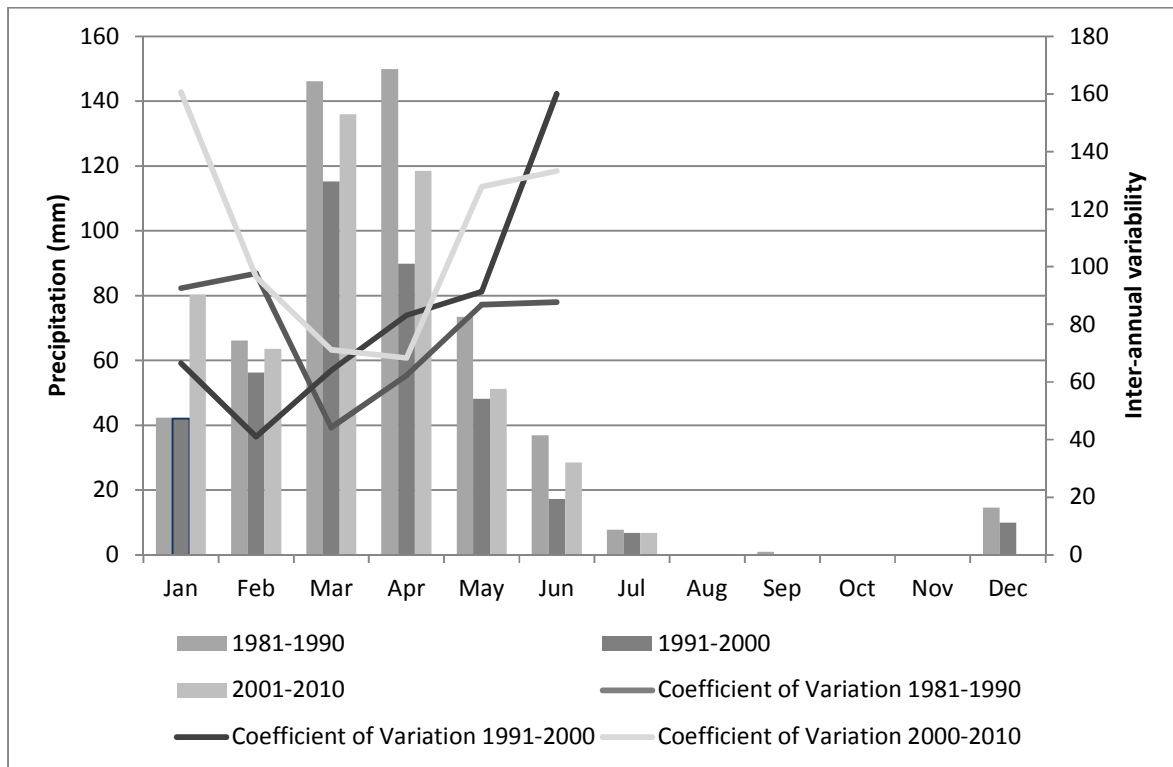


Figure 5.5 Annual distribution of rainfall in Irauçuba

The Coefficient of Variation (CoV) shown in figure 5.5 reveals substantial rainfall variation in the wet months, with interdecadal variation values ranging from 40 to 160mm. Rainfall variation affects the success of agricultural production in Irauçuba, particularly in areas where the distribution of rainfall in time and space is irregular. These irregularities severely impact crop growth and productivity (Cooper et al. 2008).

Another important indicator of climate adversity in the region is the concentration of rainfall over a short period of time. This concentration results in dry spells that can last between eight and 12 months. When precipitation is not evenly distributed or is concentrated in a short period of time, it is known as green drought, and it damages agricultural production (Nobre and Melo 2001).

5.3.2 Characteristics of the population

In 1950, when the first census in the municipality was conducted, the estimated number of residents was 9,020, with a predominantly rural population. Over the next six decades the

population more than doubled, reaching 23,754 at the 2010 Census (IBGE 2010). According to the 2010 Census, Irauçuba has a population density of 16.37 hab/km² compared to the state average of 50,64 hab/km², making it one of Ceará's most sparsely populated municipalities (IBGE 2010). Figure 5.6 shows the evolution of the population in the municipality.

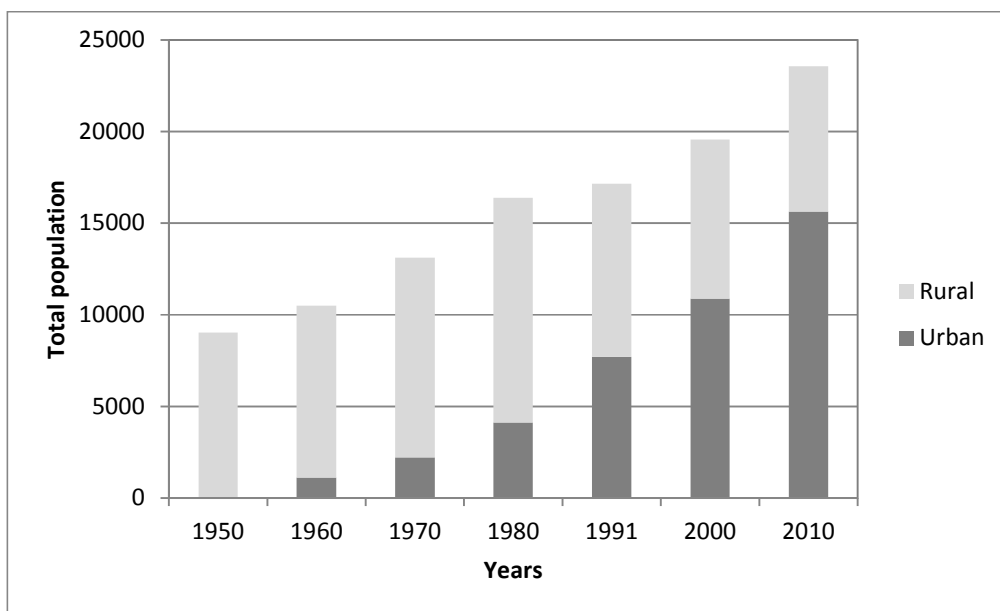


Figure 5.6 Evolution of the population in Irauçuba. Source: IBGE 2000, 2010

Figure 5.6 reveals the shifting of a mainly rural to a predominantly urban population in the municipality, following a national trend of internal migration that occurred between the 1960s and 1990s. Large numbers of migrants moved from remote areas to urban centres, reflecting a process of intensification, industrialization and urbanization in Brazil (Vainer and Brito 2001). In Irauçuba, the shift to a predominantly urban population gained momentum in the 1990s. Until 1980, 75% of the municipality's population still resided in the rural districts. By the 2010 Census, 66.2% lived in the urban centre, reflecting the national tendency in which 84.3% of the Brazilian population currently live in urban areas. In 2010 there were 4,708 households in the municipality, with an average size of 4.2 members. The rural districts of Irauçuba recorded 851 households, with an average of 4.6 occupants. The 3,857 urban households recorded an average size of 3.8 residents.

The sex and age structure of the municipality has also undergone substantial changes in the 2000-2010 intercensal period. Figure 5.7 displays the population pyramid for the municipality.

In 2000 the pyramid displays a young population with a high birth rate (wide base, narrow peak). By the 2010 census the pyramid base had narrowed and its middle section widened indicating a structure in transition. The proportion of children under age 15 decreased from 5.7% in 2000 to 4.4% in 2010, while the proportion of people aged 60 and older increased from 1.1% in 2000, to 1.9% in 2010. The process explaining this transition is the fertility decline in the municipality, which, like Brazil as a whole, declined from 35.5 children per 1000 women in 2000, to 16.7 in 2010 (IBGE 2010)

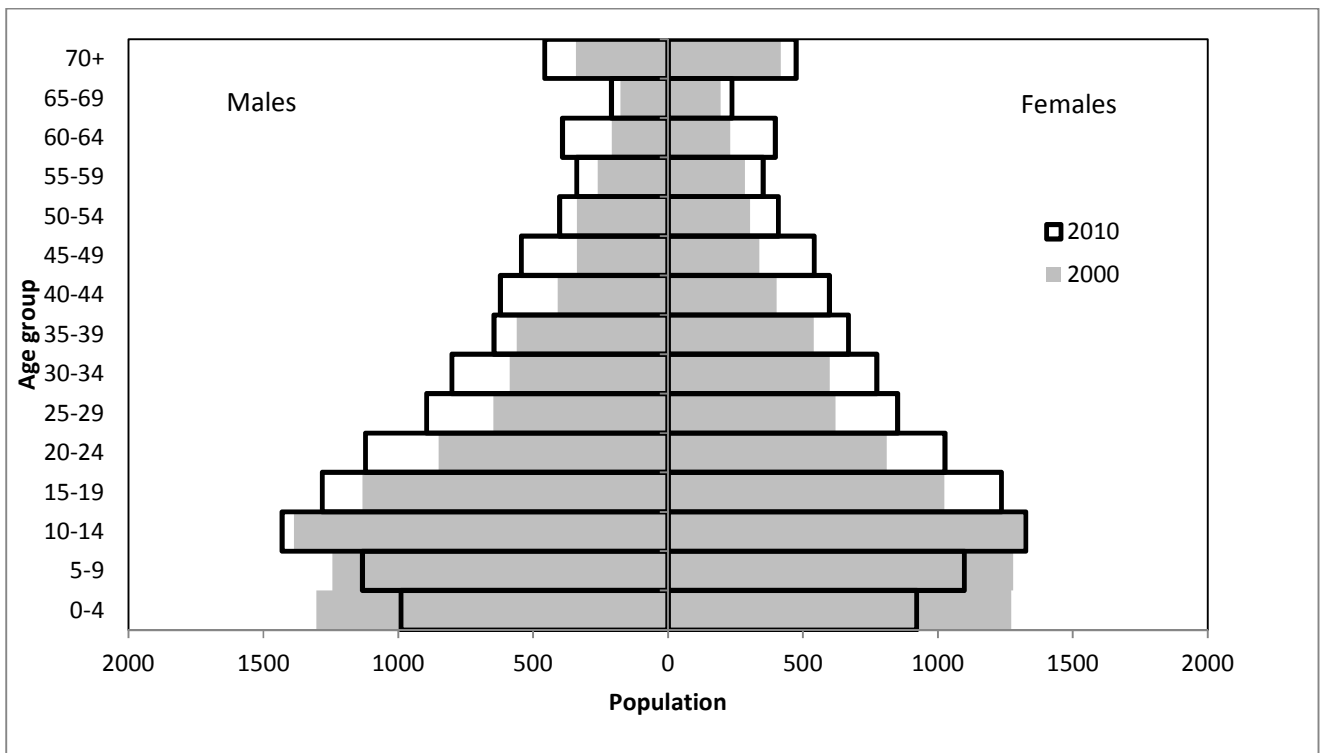


Figure 5.7 Population pyramid of the municipality of Irauçuba. Source: IBGE 2000, 2010

5.4 Migration patterns in Irauçuba and Northeast Brazil

In Brazil, the main source of demographic information is the Census of Population. The Brazilian census is a comprehensive household survey. The Brazilian Institute of Geography and Statistics (IBGE) visits all households in the country, where one or more residents respond to the census and provide information on all who live in the same dwelling. There are two types of questionnaires: the 'short form' and 'long form' types. All questions present in the short form questionnaire are also contained in the long form questionnaire, so that these common

variables are investigated for all households and people. In both 1991 and 2000 the census used two discrete sampling fractions in accordance with a municipality's population. Municipalities with up to 15,000 inhabitants had 20% of its households investigated by the long form questionnaire and in municipalities over 15,000 inhabitants, the sampling fraction was 10%. In an effort to increase the accuracy of the long form questionnaire, the 2010 census employed the following sampling fractions: 33% for municipalities up to 8,000 people; 20% for municipalities between 8,001 and 20,000 inhabitants; 10% for municipalities between 20,001 and 500,000 and 5% for municipalities over 500,001. With regard to internal migration, the Brazilian census collects data in the form of a fixed date question. Interviewees are asked about their place of residence with regard to a specific date in the past, in this case in the five years preceding the census date. In 2000, the census questionnaire asked the following question: "In what State and in what municipality were you living on the 31st of July 1995". In the 2010 census, the same question was asked with the fixed date being 31st of July 2005.

In the 1991, 2000 and 2010 censuses, Northeast Brazil was the only region of the country to experience a consistent loss of migrants. The northeast region suffered a net loss of almost 880 thousand in the 1986-1991 period, followed by a steady but small decline in net losses in the subsequent intercensal periods. Associated with these substantial flows of out-migration were the limited economic development and low socioeconomic indicators discussed in detail in this chapter. These factors have historically been the forces driving migration in the region. In stark contrast, the more developed southeast region consistently gained migrants, experiencing the largest total net gain in each five-year period. The attraction of the southeast region as a migrant destination was more pronounced in the 1986-1991 period, when the region gained almost 600 thousand migrants. Table 5.2 shows the total net gains and losses for all five regions of Brazil.

Table 5.2: Regional net gains and losses from five-year migration intervals

| North Region | | | |
|----------------------------|---------------|--------------|----------|
| Year | Out-migration | In-migration | Net |
| 1986-1991 | 285,422 | 318,464 | 33,042 |
| 1995-2000 | 292,751 | 355,434 | 62,683 |
| 2005-2010 | 286,414 | 321,164 | 34,750 |
| Northeast Region | | | |
| Year | Out-migration | In-migration | Net |
| 1986-1991 | 1,354,449 | 477,911 | -876,534 |
| 1995-2000 | 1,411,420 | 647,373 | -764,047 |
| 2005-2010 | 1,361,916 | 624,302 | -737,614 |
| Central-West Region | | | |
| Year | Out-migration | In-migration | Net |
| 1986-1991 | 387,911 | 593,459 | 205,548 |
| 1995-2000 | 363,275 | 625,246 | 261,971 |
| 2005-2010 | 378,741 | 636,621 | 257,880 |
| Southeast Region | | | |
| Year | Out-migration | In-migration | Net |
| 1986-1991 | 950,797 | 1,546,192 | 595,395 |
| 1995-2000 | 946,287 | 1,404,872 | 458,585 |
| 2005-2010 | 900,043 | 1,270,331 | 370,288 |
| South Region | | | |
| Year | Out-migration | In-migration | Net |
| 1986-1991 | 338,628 | 474,863 | 136,235 |
| 1995-2000 | 349,813 | 330,619 | -19,194 |
| 2005-2010 | 297,525 | 372,151 | 74,626 |

Source: IBGE (1991, 2000 and 2010)

Since the first official records, internal migration in Brazil has been characterized by movements from people born in the Northeast region to other parts of the country. From occupation of the Amazon region in the nineteenth century, through the shifts towards the Southeast and South in the twentieth century, migrants from the Northeast region have been protagonists of these processes. The census information on the percentage distribution of the population residing outside their region of birth over the 1991, 2000 and 2010 periods, shows the importance of migration in the lives of Northeast-born people (Table 5.3).

Table 5.3: Proportion of people with residence outside their birth region 1991, 2000 and 2010

| Region of birth | Census year | | |
|-----------------|-------------|------|------|
| | 1991 | 2000 | 2010 |
| North | 4.1 | 4.9 | 5.2 |
| Northeast | 15.1 | 17.2 | 15.6 |
| Central west | 5.3 | 5.2 | 4.8 |
| Southeast | 9.4 | 9.4 | 8.2 |
| South | 9.5 | 10.1 | 9.2 |

Source: IBGE (1991, 2000, 2010)

In the census year of 1991, over 15% of people born in the Northeast Region were living outside their region of birth, a much higher proportion than the 9.4% recorded for the Southeast. The stock of Northeast natives outside their place of birth increased to 17% in 2000, before a slight reduction at the 2010 census.

Census data enables the investigation of origin-destination patterns. The tradition of Northeast migrants moving to other parts of Brazil in search of employment and education, particularly in the more economically developed southeast region, persisted over the 1991-2010 period (Table 5.4)

Table 5.4: Distribution of Northeast-born migrants residing in other regions 1991, 2000 and 2010 (%)

| Region of residence | Census year | | |
|---------------------|-------------|------|------|
| | 1991 | 2000 | 2010 |
| North | 18.3 | 13.9 | 14.4 |
| Central west | 15.1 | 17.9 | 19.7 |
| Southeast | 63.9 | 66.1 | 62.4 |
| South | 2.7 | 2.1 | 3.5 |
| Total | 100 | 100 | 100 |

Source: IBGE (1991, 2000, 2010)

Table 5.4 shows that the southeast region remains the preferred destination for northeast-born migrants, albeit with a slight decline in 2010 compared to previous censuses. Migration to the

central west region - an area characterized by a strong commercial agriculture industry - has increased throughout the 30-year period indicating a potential for upward social mobility for migrants.

Previous studies have established that migration, both seasonal and permanent, is a common occurrence in remote parts of semi-arid Northeast Brazil when external forces impact on people's livelihoods (Kenny 2002). Droughts are considered one of these stressors because, despite being a natural climate event of semi-arid regions, they exacerbate the already difficult situation affecting the majority of the population living in these areas. Coupled with the lack of employment and education prospects in rural areas of the region, this creates a scenario within which migration is a potential outcome.

Figures 5.8 and 5.9 show the net migration rate for the municipalities in the state of Ceará (the difference of immigrants and emigrants in each city over the periods 1995-2000 and 2005-2010 divided by 1,000 inhabitants) between the 2000 and 2010 censuses. A major advantage of using net migration is that long time series are available for all municipalities of Brazil. An excess of persons entering a municipality is referred to as net immigration (for example, 4.2 migrants/1,000 population); an excess of persons leaving the municipality as net emigration (for example, 8.8 migrants/1,000 population). This metric expresses the number of migrants related to the population at risk of moving during the given interval. The net migration rates for the municipalities in Ceará were calculated aggregating internal migration data for all Brazilian municipalities. The patterns show movement from western and central parts of the state towards the east coast, where the capital city of Fortaleza is located.

A major advantage of using census data to calculate net migration rates is that long time series are available for all municipalities of Brazil. In the 2000 and 2010 censuses, information on municipality of residence at a fixed date in the past (in this case 1995 and 2005 respectively) captured intercensal population at the middle of two period, thus enabling the investigation of migratory balances for two distinct temporal intervals. However, this information also has some limitations, of which two stand out: it does not capture migration of children less than five years, which has to be estimated using indirect methods; it also does not include the previous moves in the period between the application of the survey and the fixed date.

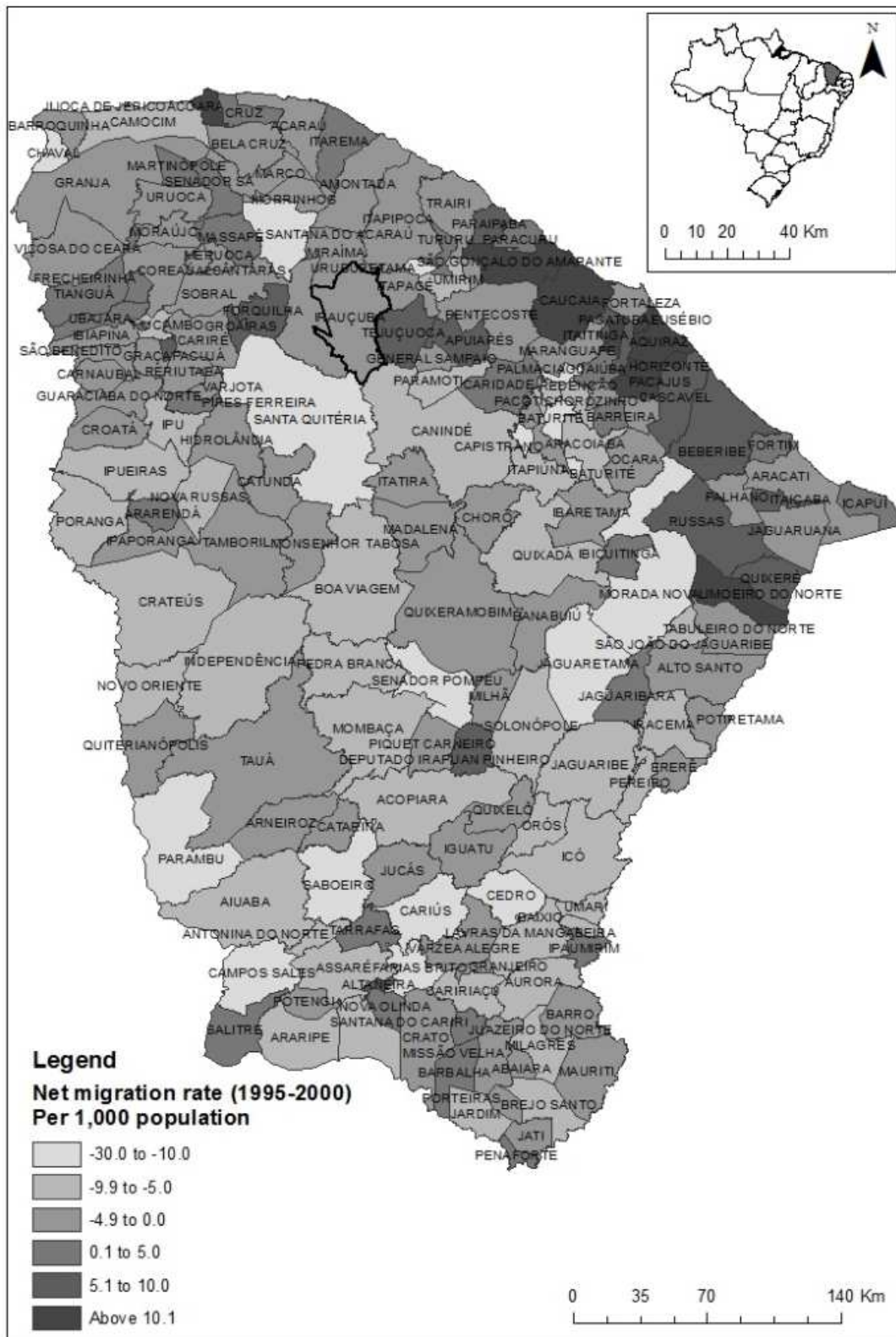


Figure 5.8 Net migration rate for the period 1995-2000. Calculated from data collected from the 2000 Census (IGBE 2000)

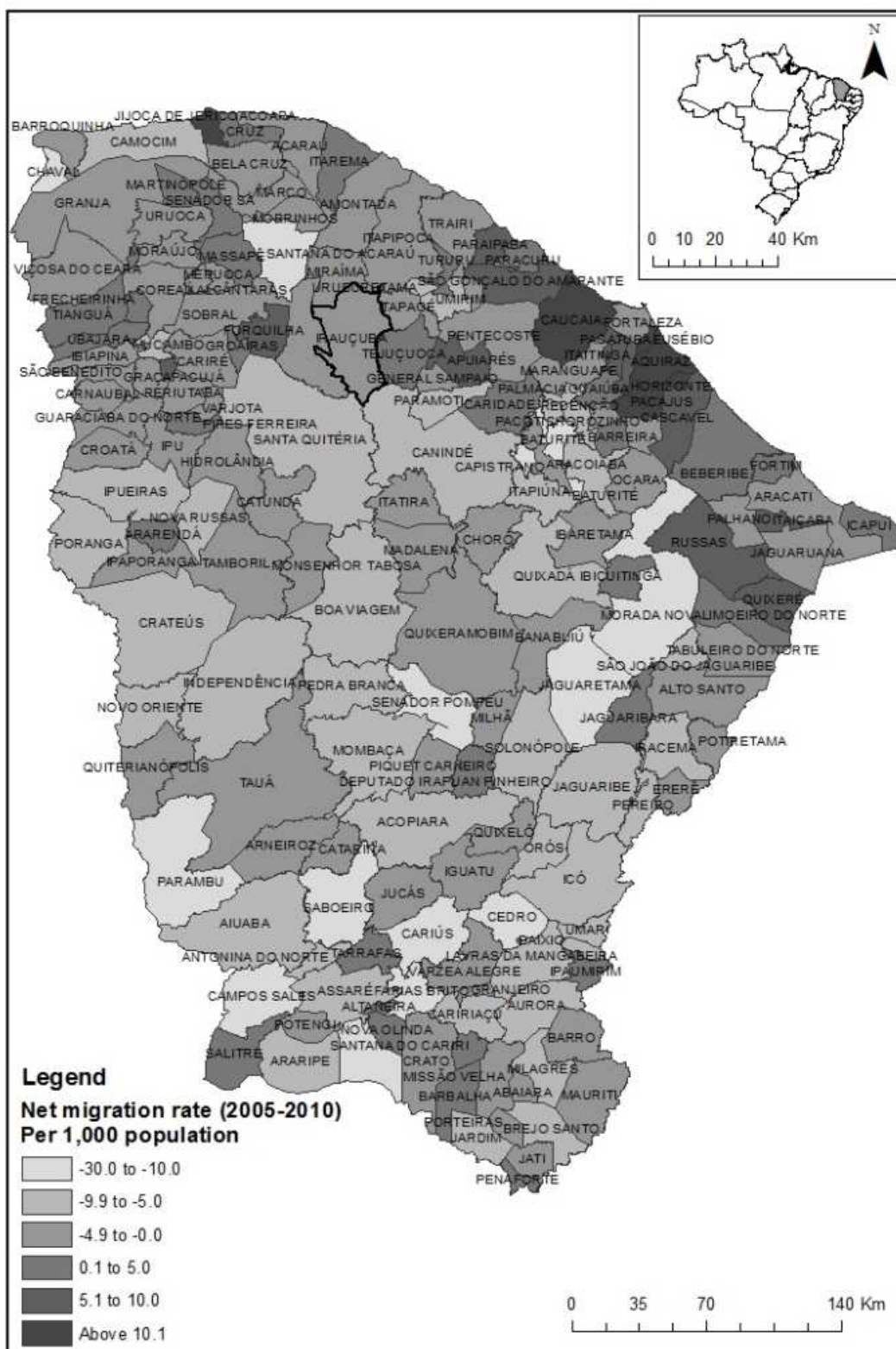


Figure 5.9 Net migration rate for the period 2005-2010. Calculated from data collected from the 2010 Census (IGBE 2010)

The maps show that most municipalities bordering Fortaleza recorded positive values which denote that the expanded metropolitan area is experiencing positive net migration. Conversely, Fortaleza itself recorded negative net migration rates in both censuses indicating that the city is experiencing net out-migration. This is partly due to the more expensive cost of life and housing, but also due to a regional development plan which targets peri-urban areas surrounding the capital of the state (Pequeno 2013). The semi-arid region of the Ceará, where the municipality of Irauçuba is located, has recorded negative net migration rates with the exception of regional centres. Overall, the general direction of flows did not change significantly between the 1990-2000 and the 2000-2010 intervals.

While semi-arid Ceará as a whole is losing migrants, other parts of the region exhibit positive net migration rates. For example, in the 2000-2010 interval, the municipality of Tejuçuoca, which borders Irauçuba, experienced a positive net migration rate of 4.3 people per 1,000 population. It was the only positive net migration rate among the seven municipalities bordering Irauçuba. This can be partly explained by an economic development plan which enticed factories to the city, attracted by generous tax reductions (Chacon and Bursztyn 2013). Irauçuba recorded a net migration loss of -2.5 people per 1,000 population in the 2000 Census. The 2010 result for the municipality exhibits a marginal reduction in the loss of migrants, at -2.2 people per 1,000 population.

One of the main factors affecting an individual's propensity to migrate is their age. A large volume of scholarly contributions (Bates and Bracken 1982; Rogers and Castro 1981; Bernard, Bell and Charles-Edwards 2014) has identified the importance of age on migration behaviour. Roger and Castro (1981) proposed a model comprising a range of key age-related components. In summary, the model identifies an initial 'pre-labour force' (0-14 years) component, which is characterised by a gradual decline in the rate of migration. The second component can be identified as 'labour force' (15-59 years) identified by a sharp increase in the rate of migration, culminating with the high peak towards the beginning of the labour force component at age 20-24 followed. This peak represents a period of the life course when individuals are more likely to move, and is associated with employment seeking moves influenced by changing characteristics of labour market demand. The 'post-labour force' component (from 60 years) indicates when retirement is most likely, and shows a steady decline in migration propensity from the initial peak, followed by an increase towards the end of the life course associated with

moves to be closer to family or into communal establishments in order to access health services and other essential infrastructure.

The Brazilian census does not collect data on gross flows by age for districts of municipalities. The alternative employed to estimate movements for these consisted of calculating net migration by age using life table survival ratios as an indirect measure of net internal migration, based on average mortality conditions of the intercensal period between 2000 and 2010. Figure 5.10 shows the estimated net migration by district for the 2000-2010 period. Results reveal that for the rural districts of Missi, Jua and Caxitore migration losses are most pronounced at age group 20-24. Lower losses from the town suggest movements of individuals seeking employment in more developed urban areas.

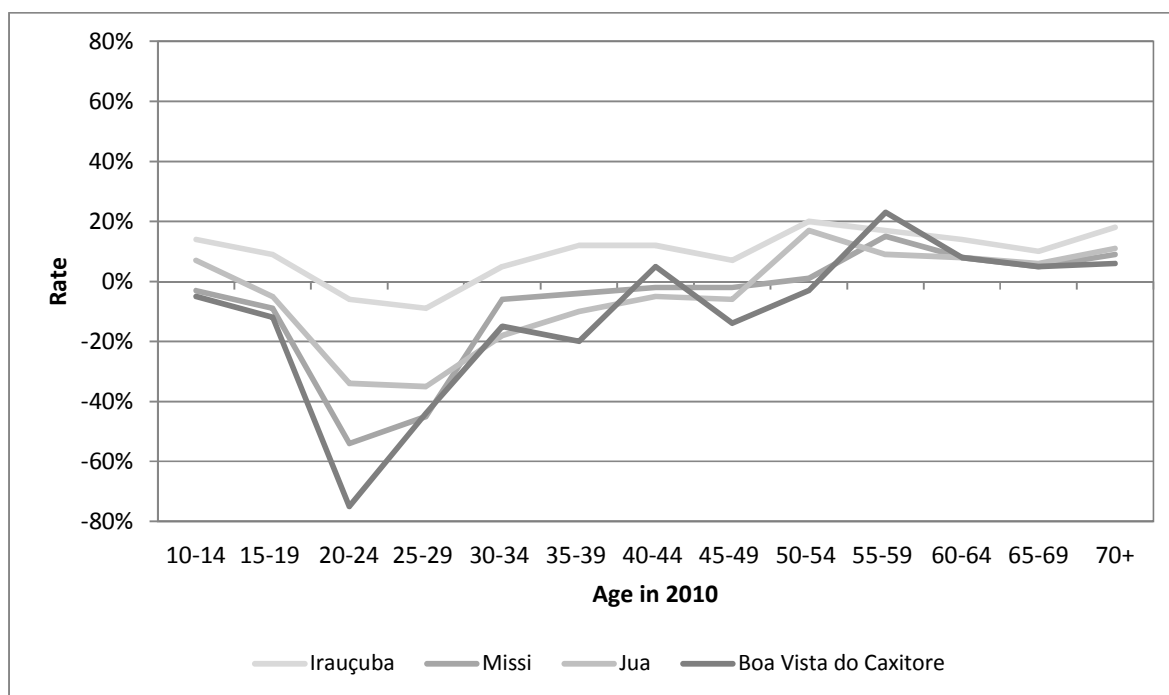


Figure 5.10 Net migration 2000-2010 by age in Irauçuba

Between the 2000 and the 2010 Census, Missi, Jua and Caxitore lost 66, 58 and 26 individuals aged 10-19 respectively. On the other hand the town of Irauçuba gained 346 individuals. This can be explained by the better infrastructure and employment opportunities found in the district, resulting in a number of young individuals moving with parents. Net gains in the same age group in the town of Irauçuba suggest that residents from neighbouring towns are migrating to the city, implying some level of local migration exchanges in the region.

In contrast to the 10-19 age group, the 20-29 age group pattern of net out-migration is negative, with all four districts of the municipality losing significant volumes of migrants. Of the 4,533 estimated survivors at this age group, 19% have left the municipality. Net out-migration appear to increase with rurality, with the rural districts recording almost six times the net out-migration recorded in the urban centre of the municipality. In Caxitore, 39% of individuals in the 20-29 age group left the district. Jua and Missi recorded 34% and 33% respectively. Net out-migration rates are high for rural districts as expected in this age category, as these areas offer limited education, employment and entertainment opportunities for young populations. These findings corroborate previous work which identified the prevalence of movement of young adults from rural areas to urban centres in Northeast Brazil (Oliveira and Januzzi 2005).

The characteristics of migration for the 30-39 age group are very similar to those of the 10-19 group. The rural districts continue to lose migrants but at a less pronounced rate, corroborating Oliveira and Januzzi's (2005) findings that suggested there are less work opportunities outside the municipality for people in this age group if they have not attained skills and formal education during the earlier stages of their lives.

The pattern of migration in Irauçuba changes for the 45 to retirement age group. All four districts of the municipality exhibit positive net in migration at all age groups between 45 and 70+ with the exception of Caxitore at age group 45-54. It should be noted that the net out-migration computed for the district is 3% of all residents at the same age group, and it can be related to the movement of parents moving in with relatives who live in other localities. This finding corroborates recent studies identifying a gradual increase in return migration in Northeast Brazil among people who want to live closer to relatives (Brito 2009).

5.5 Conclusion

The objective of this chapter was to provide the contextual background for the selection of the study sites. It is important to note that the municipality of Irauçuba forms part of the broad regional landscape that was presented in this chapter, but it has its own characteristics which are important to frame household livelihood decisions.

There are several key features which are important for the overall objective of this thesis. The regional climatological profile indicates that climatic variability and the cyclical occurrence of droughts are the dominant environmental characteristic of the region where the study site is located. Within this context, pre-existing social inequalities are exacerbated in times of droughts and extended dry seasons, often leading to increased vulnerability and poverty (Watts 1983; Magalhaes and Glantz 1992; Seitz et al. 2006).

The demographic and socioeconomic regional profile of semi-arid Northeast Brazil displays limited internal diversity in terms of demographic trends, and economic and social development. The overall pattern in the region includes consistently higher levels of poverty among rural populations, the importance of adequate climatic conditions for agricultural activity, and the slower consolidation of alternate economic activities in the region in the last two decades. These continuities and breaks in social and economic processes help explain vulnerability to external adversity such as the recurrent droughts.

Regarding spatial mobility, the findings revealed that, in relation to net migration, the evidence assessed in previous studies of internal migration in Northeast Brazil persists. With regard to the national level, the region has and continues to experience substantial net migration losses. In the state of Ceará, urban areas in general are net gainers of migrants, while marginal areas in the hinterland are net losers. Moving beyond this, the emergence of regional centres such as Tejuçuoca and the peri-urban areas surrounding Fortaleza were, in fact, all substantial net gainers of population via migration in the 2000-2010 periods. This runs counter to the expectation of Fortaleza as the major centre of attraction for migrants. The capital of the state has been losing migrants, while rural or semi-urban areas are gaining population due to more attractive housing prices and the establishment of factories in these municipalities.

The study area, Irauçuba, is losing migrants, but at a slower rate than other municipalities in the semi-arid region. The net out-migration characteristics observed for this area fall into the expected norm which includes many from younger age groups. This chapter has emphasised the significance of considering the age factor in migration studies. When age is taken into consideration, spatial distribution and net migration rates fluctuate radically. Stage in the life-cycle also affects rates, specific origins, directions of flow, and choice of destinations of internal migrants. By means of life-tables, it has been possible to construct some typical age-specific

analysis related to stages in the life-cycle in the municipality of Irauçuba. Between the ages of 0 and 15, with few exceptions, people tend not to move away from the place of origin. Between the ages of 16 and 29, a stark increase in migration flows support the common assumption that these cohorts leave rural areas. From the ages of 45 onwards, there seem to be a pattern of gradual return migration to places of origin.

In conclusion, the discussion of semi-arid Northeast Brazil and the municipality of Irauçuba's current socioeconomic, climatological and demographic conditions presented in this chapter, provide an overview of the structural characteristics fundamental to frame household livelihoods, and the nature and patterns of spatial mobility.

Chapter 6. Livelihood strategies in the rural communities of Jua, Missi and Boa Vista do Caxitore

6.1 Introduction

Building on the notion that the livelihoods of people are not restricted to one particular economic sector, Chapter 4 outlined the conceptual framework for the analysis of spatial mobility as a central component in the livelihoods of many rural households in developing countries. It identified five types of capital which shape household livelihood portfolios. Consideration of the context in which the relationship between access to resources and livelihoods occurs is crucial to understand the role of spatial mobility within livelihood strategies in the research locations. The objective of this chapter, then, is to identify and compare livelihood strategies in the three rural locations of the municipality of Irauçuba; the ownership of and access to resources represented by the five types of capital; and the strategies used to mobilize these assets and transform them into means to generate income, food and other basic provisions.

To do so, Chapter 6 builds an inventory of the types of capital at the disposal of households in the three locations. It then determines the most common household livelihood strategies and classifies them into a number of discrete categories. This approach has been favoured because assets are intrinsically linked to the means of subsistence; the larger the number of assets a household can call upon, the more forms of livelihood diversification are available to them in stressful situations. It draws on a comprehensive questionnaire which sought to collect a range of information including demographic and labour force data, household capital, and livelihood strategies; as outlined in chapter 4. The questionnaire also sought to identify migration characteristics of members of households by including questions about the current status of their members.

The chapter is structured as follows. The next section describes household socio-demographic characteristics and life-cycle stages. Section 6.3 focuses on the five types of capital introduced in the conceptual framework, and provides inventories of the assets available to households in order to examine their role in mediating livelihood strategies. Section 6.4 Examines livelihood strategies to depict the means of subsistence in the three research locations, and sets out a typology of subsistence strategies. Section 6.5 summarises the conclusions from these analyses.

6.2 Households socio-demographic characteristics

Households are widely recognised as an interface between people and the environment that surrounds them (Morvaridi 1998). The investigation of household characteristics is critical to understand livelihood decisions and strategies. Morvaridi (1998) identifies household size, structure and composition, internal dynamics between household members, and access to capital as the key factors mediating this relationship. The first four factors may be considered as socio-demographic characteristics, while the fifth aspect refers to elements that can be mobilized into livelihood strategies.

A broad understanding of household characteristics is relevant for three interconnected reasons. First, socio-demographic features serve to increase or avert vulnerability to discrete forms of stressors since they shape the acquisition and management of resources (Moser 1998). Second, household internal life-cycle factors (marriage, fertility and mortality) influence responses to external events. They affect household age-sex structure and composition, which in turn shapes the household's labour force available for agricultural activities and non-farm employment, including labour mobility. This is fundamental to rural households' livelihood strategies. Third, the unevenness in rights and obligations within the household due to sex and age composition mediates the ability to successfully cope with socioeconomic and environmental problems (Moser 1998).

In this section, the socio-demographic characteristics of households in the three research sites have been grouped into two dimensions: a) structure and life cycle stage, and b) basic demographic conditions, which include size, dependency ratio, and composition by age and sex. The definition of household employed in this thesis incorporates several elements of classical characterisations found in the literature. A household or domestic unit may be composed of a person living alone, or a group of persons related or unrelated, who share the same physical space and a set of activities oriented to the daily reproduction of the unit. Some of these activities are common provision for food and other basic necessities, consumption of goods, and sexual reproduction and childrearing (Shryock and Siegel 1973; Yanagisako 1979).

6.2.1 Structure and life cycle phase

The key element in the characterisation of household structure is the relationship of its members with the household head. This thesis employs the widely recognised definition that the household head is the person acknowledged as such by the rest of the members (Shryock and Siegel 1973). Field experience indicated husbands were cited as the household head by almost all respondents. This lends credence to the notion of a patriarchal household structure in the study area, which corroborates with previous findings which characterize men as the *de-facto* household head in Northeast Brazil (Chilcote 2006). It is relevant to mention however that some interviews suggested that the spouse was the actual bread-winner and acted as the informal decision-maker.

Classification of household structure follows the categories used by the Brazilian Institute of Geography and Statistics (IBGE 2000). These categories are: single person, nuclear (couple with no children), nuclear incomplete (one parent and the children), nuclear extended (the couple, its children and other relatives), composed (related and unrelated persons), and unrelated multi-person households. To depict a more accurate representation of the study area, a fifth category was added, nuclear complete (the conjugal couple and their children) Table 6.1 displays the socio-demographic characteristics of the households in the sample.

Table 6.1: Structure and life cycle characteristics of households in rural Irauçuba

| Household structure and life cycle | Jua | Missi | Caxitor e | Total |
|------------------------------------|------|-------|--------------|-------|
| Household type | 30 | 30 | 30 | 90 |
| # of Single person | 2 | 1 | - | 3 |
| # of Nuclear | 3 | 5 | 1 | 9 |
| # of Nuclear incomplete | 3 | 2 | 2 | 7 |
| # of Nuclear complete | 15 | 18 | 15 | 49 |
| # of Nuclear extended | 7 | 5 | 11 | 23 |
| Average household size | 4.0 | 3.8 | 4.5 | 4.1 |
| Average age of household head | 49.5 | 42.7 | 44.5 | 45.5 |

Source: Compiled from the field interviews in the research site, 2014 (n=90)

Household size did not record a substantive variation in all three research sites. On average, the size of households in rural Irauçuba is only marginally larger than that of the urban centre of the municipality. However, an important feature to highlight was that although households

shared similar sizes, they showed differences in terms of composition. Across the three research sites, households were distributed into three main types: nuclear complete (49 households), nuclear (9 households), nuclear incomplete (7 households), and nuclear extended (23 households). Only three households in the sample were composed of a single person. There were no cases of either unrelated multi-person households or composed households, consistent with the literature that indicates strong family ties across semi-arid Northeast Brazil (Chilcote 2006). It is important to underline certain minor differences by locality. For example, Caxitore recorded a larger proportion of extended households than Jua and Missi, and fewer nuclear and single resident households. This is consistent with the fact that on average, the district recorded higher average length of residence in the same household, leading to aggregate family members living together in the same household, a common behaviour in the region as identified by Sales (2003).

Complete households are the most common type in all three localities, comprising 55% of the sample. Nuclear extended households comprise 26%. These are relevant findings because differences in livelihood strategies and forms of response to external stressors are related to the human capital that can be mobilised by each household. For example, non-farm labour might be more common in nuclear extended households. Household structure is correlated with age of household head in the three research sites. Average age of household heads varies across the three locations: it is 49.5 years in Jua, 42.7 in Missi and 44.5 in Caxitore. Household heads in nuclear complete households were younger than those in nuclear extended households. Nuclear households were formed by young adults, with the head averaging 28.6 years.

Nuclear extended households in the sample had more able adults in the labour force, and consequently a lower dependency ratio, a measure defined by proportion of people aged 0-15 and over the age of 65 to the total population aged between 15-64 (Yanagisako 1979). Overall, the percentage of people in the three age groups is very similar across the study site, the state, and Northeast Brazil. The dependency ratio in rural Irauçuba closely matches those recorded in the state and in Northeast Brazil, reflecting the high proportion of working-age people.

The household type classification presented in the section is an informative but static perspective of the composition of households in the study area, however, these households are

dynamic in nature. Their structure is mutable, leading to changes in size and composition over time. These differences reflect discrete life cycle stages which are marked by vital events such as marriage, birth of the first and last children, marriage or departure of the last child, and death of one spouse (Fortes 1971). For example, household head ages extended from age group 25-29 to age group 80-84 while that of spouses ranges from age groups 20-24 to 75-79 years. These figures indicate that the households in the study area were at different stages of their life cycle. To this end, this current study adopts Murphy (1987) and Forni, Benencia and Neiman (1991) classifications to further categorize households according to several life cycle phases. This classification takes into account the age of household head, age of partner or mother, and age of the children. The categories are: a) *formation*: nuclear couple recently formed without children, age of the mother is less than 50 years old; b) *expansion*: both parents are present, mother is less than 50 years old, children are not yet old enough for marriage or migration (children are 16 years old or less); c) *fission*: begins when the first child marries or migrates, or when they are potentially able to do so (over 16 years old); d) *replacement*: complete couple, mother is more than 50 years old, all children have left the household. Table 6.2 sets out household distribution by life cycle stage in the study area.

Table 6.2: Life cycle distribution of households in rural Irauçuba

| Household type | Formation | Expansion | Fission | Replacement |
|--------------------|-----------|-----------|---------|-------------|
| Nuclear incomplete | - | 2 | 1 | - |
| Nuclear | 9 | - | - | 2 |
| Nuclear complete | - | 19 | 29 | - |
| Nuclear extended | - | 1 | 20 | 2 |
| Total | 9 | 27 | 50 | 4 |

Source: Compiled from the field interviews in the research site, 2014 (n=90)

Table 6.2 shows that of the households interviewed, more than half were in the fission stage. The large number of households in this group reflects an established population with a large number of children of working age still living with their parents, a characteristic that is common in areas where economic development is marginal in Brazil (Martine 1996). Field interviews corroborated this finding. Household heads reported that due to the severity of 2010-13 drought, members of households in the fission stage remained with their families due to the more robust safety network provided by these larger families. Parents were able to search for non-farm work opportunities with the knowledge that a family member would be able to look after their children.

One third of the sample household are in the expansion group. This finding suggests that fewer households are being established in the study area. Besides the slow economic development which impact household composition, another explanation for the number of expansion households lies on the late national average age of first marriage (27 years). Because of the dynamic nature of household composition, is important to underline that one third of the sample households in the rural Irauçuba are home to single adults aged between 18 to 30 years. The high proportion of people in this age cohort implies there is a potential chance of new household formation.

6.3 Inventorying household capital portfolios

The terms capital and asset have both been used by scholars in the field of sustainable livelihoods to refer to the different capital assets that households own. Scoones (1998) distinguishes five discrete categories of capital asset related to rural livelihoods:

- natural capital (land, water and natural vegetation cover)
- physical capital (irrigation canals, roads and farm implements)
- human capital (education, attained skills and health)
- financial capital (credit, savings, livestock)
- social capital (networks and associations)

Reardon and Vosti (1995) identify four types of asset: natural resources (land, water, wildlife, biodiversity and vegetation cover); human resources (education, health, nutritional status and skills); on-farm physical and financial (farmland, livestock, equipment and farm improvements) and off-farm physical and financial (roads, access to markets, and access to frontline services). Both approaches argue that capital assets are linked to specific types of poverty and shape the sources from which different flows of income are derived, but Reardon and Vosti exclude the various forms of support (social capital) which households can call upon to complement their livelihood. This thesis adopted Scoones' (1998) classification in designing the field questionnaire because social networks are an important asset during times of climatic crisis (Adger 2010). The next section examines the situation in the three field sites with respect to each of these five types of asset.

6.3.1 Human capital

According to the literature, the availability of labour is the most important asset for rural smallholder households (Rakodi 1999; Reardon, Berdegúe, Barrett and Stamoulis 2007). Most survey respondents depend on agriculture and livestock for their subsistence but draw on non-farm work to secure income. From this perspective, the first tasks in analysis of human capital are to distinguish the nature of farm work compared with non-farm work, and to establish the labour force participation of household members.

Farm workers are members of the household who work on the family farm. They take care of the livestock and subsistence crops, and contribute to basic household maintenance and reproduction with their non-wage work. These activities are performed primarily by spouses, retired people and other household members who are not engaged in non-farm work. The contribution from household members engaged in non-farm work is twofold. They add to household income and they join the group of farm workers on weekends or weekdays if they are employed in a part-time position. Table 6.5 sets out the number of non-farm workers employed in a full-time wage labour position, and farm workers in each household in rural Irauçuba. The table accounts for adults aged 16 or over. It should be noted that field interviews detected a small number of school aged children between 14 and 16 years in occasional part-time work, delivering goods for the small shops in the districts. For the purpose of identifying the labour force in the study area, these part-time workers have not been included in the table below.

Table 6.3: Households by number and category of workers

| # Non-farm workers | # Farm workers | | | | | | Total |
|--------------------|----------------|----|----|----|----|----|-------|
| | 0 | 1 | 2 | 3 | 4 | 5+ | |
| 0 | 0 | 4 | 17 | 12 | 10 | 8 | 50 |
| 1 | 1 | 14 | 11 | 4 | 3 | 2 | 35 |
| 2 | 0 | 0 | 2 | 0 | 1 | 2 | 5 |
| Total households | 1 | 18 | 30 | 16 | 14 | 12 | 90 |
| Total workers | 1 | 32 | 75 | 52 | 61 | 66 | 242 |

Source: Compiled from the field interviews in the research site, 2014 (N=90)

Table 6.3 reveals that, of the 90 households interviewed, less than half (45%) have members employed in non-farm work, and in the majority of these cases there is just a single non-farm worker in the household. Only five households reported having two non-farm workers, and these were principally very large households in which there was a total of six workers or more. At the same time, it tends to be the smaller households in which non-farm work is most prevalent. In 14 of the 40 households with non-farm workers, the labour force was evenly split, with one farm worker and one non-farm worker, and a further 11 households had one non-farm workers and two farm workers. The table also shows that there are far more farm-workers than household members in full-time employment. Overall, across the 90 households, 242 people of working age were engaged in farm work compared with 45 in non-farm work. However, this is largely a product of the significant number of quite large households in which there was a substantial contingent of farm workers (4 or 5). In broad terms, therefore it is possible to recognise two major types of household in terms of size and labour force composition. At one end of the spectrum is a group of smaller households made up of equal or near-equal numbers of farm and non-farm workers, for which non-farm work appears to be a significant component of household labour. At the other end of the scale is a group of much larger households in which most of the labour force is engaged in farm work, but with some contribution from a single or occasionally two members in non-farm employment.

Further investigation of the data presented in table 6.3 revealed that the districts of Jua and Missi have a large incidence of small households with at least one member in non-farm waged work. Conversely, in Caxitore, 43% of the households are large nuclear extended households, with the majority of members engaged in subsistence agricultural work. These findings support

the results presented in Table 6.3, which established that households in Jua and Missi were generally wealthier than households in Caxitore. In rural Irauçuba, it is not the amount of labour force available in each household but rather the distribution of human capital by type of work performed by household members that impacts the overall capacity to secure income.

The difference between wealthier and poorer households can be traced to another facet of human capital: the formal education attained by household heads. Table 6.6 shows that of the household heads in the sample, 70% had no formal education, while 18% had only finished primary school. These percentages are very similar to those recorded for Northeast Brazil at the 2010 census. However, only 9% of the interviewees had completed secondary school, compared with 20% in the Northeast region. This evidence corroborates the findings of Harbison and Hanushek (1992) suggesting that people are less involved in pursuing further education in economically marginal areas of Northeast Brazil, engaging instead in income-generating activities or helping on the farm.

Table 6.4: Formal level of education attained by household head (%)

| Level of formal education | Northeast Brazil | Jua | Missi | Caxitore | Rural Irauçuba |
|---------------------------|------------------|------|-------|----------|----------------|
| No formal education | 70.0 | 67.0 | 69.0 | 75.0 | 70.0 |
| Primary education | 16.0 | 21.0 | 19.0 | 13.0 | 18.0 |
| Secondary education | 20.0 | 9.0 | 9.0 | 9.0 | 9.0 |
| Tertiary education | 4.0 | 3.0 | 3.0 | 3.0 | 3.0 |
| Total | 100 | 100 | 100 | 100 | 100 |

Source: Compiled from the field interviews in the research site, 2014 (n=90)

Table 6.4 reveals that of the 90 households interviewed in the three districts, household heads in Caxitore have lower levels of formal education than their Missi and Jua counterparts, and in 75% of cases respondents had received no formal education. While low levels of formal education are generally regarded as a limitation to employment opportunities, particularly in non-farm activities, this did not seem to be the case in the study area given the nature of jobs available at the time of the field work. Non-farm work commonly took the form of civil construction, landscaping, menial manufacturing jobs, and low rank public employment. Positions were generally located in the urban centre of Irauçuba. Of the 45 non-farm workers in the sample, 60% were employed in the municipality. The spatial distribution of this non-farm-

work is explored in Chapter 8, but the overall low educational levels recorded in households across all three study areas seriously limit work opportunities outside the municipality. In fact, the nature of employment for those employed elsewhere outside the town was typically in the same category of jobs available in Irauçuba, revealing the stagnant nature of social mobility in rural Northeast Brazil.

6.3.2 Physical capital

Previous studies have established that access to and control of productive assets, type of dwelling, and land and water, are key issues in the livelihood strategies of rural communities in the developing world (Bebbington 1999; Ellis 2000). In the study area, land tenure plays a central role in determining the type of crops that will be planted. A quote from one respondent who rents the land illustrates this:

“I will not plant castor beans again because when I planted it a few years ago in a year with good rainfalls, the owner threatened to break the lease because the fertility of the land had improved to the point where cash crops were a viable alternative again” (Respondent from the district of Caxitore, 2014)

Table 6.5 identifies key indicators of household access to and control of physical capital assets in the three research sites. These include size of land, type of dwelling, access to household amenities, farm improvements and form of access to water. It also indicates land tenure. There were two discrete types of occupancy: ownership, which could be by a single member or by two or more members (as in the case of home and land inherited by siblings who continue to dwell in the same property); and rental under tenancy agreements.

Table 6.5: Household physical capital

| Physical capital | Jua | Missi | Caxitore | Total |
|--|------|-------|----------|-------|
| Land tenure (%) | | | | |
| Owned | 100 | 87.0 | 73.3 | 86.7 |
| Rented | - | 13.0 | 26.7 | 13.3 |
| Total | 100 | 100 | 100 | 100 |
| Size of land (%) | | | | |
| 0-3 acres | 28.0 | 75.0 | 66.0 | 57.0 |
| 4-5 acres | 71.0 | 25.0 | 34.0 | 44.0 |
| Total | 100 | 100 | 100 | 100 |
| Type of dwelling (%) | | | | |
| Brick | 82.0 | 88.0 | 74.0 | 82.0 |
| Mud | 17.0 | 11.0 | 25.0 | 18.0 |
| Total | 100 | 100 | 100 | 100 |
| Inside toilet (%) | 76.0 | 76.0 | 63.0 | 72.0 |
| Access to electricity (%) | 83.0 | 90.0 | 76.0 | 83.0 |
| Form of access to water (multiple responses admitted) | | | | |
| Cistern | 90.0 | 98.0 | 90.0 | 94.0 |
| Communal dam | 69.0 | 70.0 | 60.0 | 67.0 |
| Underground pump | 25.0 | 29.0 | 42.0 | 32.0 |
| Farm improvements (multiple responses admitted) | | | | |
| Cistern | 90.0 | 98.0 | 90.0 | 93.0 |
| Fences | 82.0 | 69.0 | 68.0 | 73.0 |
| Machinery | 1.0 | 1.0 | - | 1.0 |
| Sheds | 6.0 | 7.0 | 3.0 | 6.0 |

Source: Compiled from the field interviews in the research site, 2014 (n=90). Figures indicate % of households with access to each form of asset

Most households in all three research areas own the land on which they live and which they farm. Ownership is highest in Jua, where all respondents had bought or inherited the land they live on. The district of Caxitore, in comparison, recorded the lowest percentage of land owners at 73%. Field interviews revealed that a common condition among large households with nuclear extended families, is a form of shared rights to land and dwelling between two discrete families cohabiting in the same household. In Jua, 36% of household heads reported this arrangement. This form of ownership was less common in Missi (16%) and Caxitore (20%).

Tenancy agreements are most common in the district of Caxitore, where 27% of households pay a monthly fixed rent for the right to use the land and the dwelling. Contracts are established on an annual basis, and some landowners receive their payment in the form of livestock and

dairy produce. This traditional system, called “*permuta*” (exchange), is common in rural areas of Northeast Brazil (Lima 1994). Of the households interviewed in the district of Missi, 13% reported being in a tenancy agreement. The average size of land of tenants is smaller than that of owners and shared-owners. Figure 6.1 shows a smallholder plot owned by a nuclear complete household in Jua. At the time the photo was taken, the land the family plant on, which extends from the camera to the bushes at the top of the picture, had been dry and bare for several months. The household head also reported that almost all livestock they owned, with the exception of a handful of goats, had been sold.



Figure 6.1 Typical smallholder property layout with dwelling in the background and farmland in the district of Jua

Field observations detected a common agricultural practice which takes place on public land owned by municipal authorities in Northeast Brazil (Tiessen, Salcedo and Sampaio 1992). Smallholder farmers often clear small plots of primary or secondary vegetation adjacent to their property, burn the remaining fallen foliage, and plant a mix of subsistence crops for several agricultural cycles. This strategy is employed concomitantly with the crops which are planted on the land owned by the household. Other vegetables, cassava being the most common, are planted on these nearby public areas. Survey respondents reported that this practice is an important agricultural strategy as it enables households to plant more crops for their own consumption throughout the year. Figure 6.2 shows a vegetable garden planted in a very small

portion of public land in Jua. In the photo, the vegetable garden had been fenced to protect it from livestock.



Figure 6.2 Vegetable garden on adjacent public land between two smallholder farms

The size of the plots of land on which respondents live was substantially different in the three locations. In Jua, 71% of properties were between four and five acres. This can be partly explained by shared ownership between family members of larger properties which were inherited. Another explanation is that 100% of the households interviewed in Jua owned the land they were living on, which suggests they had more opportunities to decide what lands they could afford at the time of purchase. The district of Missi consisted mostly of smaller farms, with 75% of properties being three acres or less. Traditional large rural properties which previously comprised the bulk of farms in the 1960s and 1970s, had been subdivided into smaller blocks and sold, resulting in the current pattern of much smaller landholdings (Sales 2003).

The district of Caxitore featured a larger percentage of houses built of natural material such as mud (25%), compared to Jua (17%) or Missi (11%). While most respondents indicated a lack of financial resources to build brick houses, others preferred the traditional mud houses (Fig. 6.3) because they are cooler during the hot summers. Caxitore also had lower percentages of houses connected to the electricity network and with inside toilets.



Figure 6.3 Traditional mud house in Caxitore

Tap water is not available for any of the sample areas. Across all three localities, the major source of freshwater in 94% of the dwellings was by means of privately owned cisterns which collect rainfall for household consumption. Figure 6.4 shows a cistern and fences built on a smallholder farm in Jua. Water from the communal dams spread across the districts is also widely used by households (67%) to provide for daily consumption. Depending on the amount and the distribution of rainfall, communal dams become the main source of water for both farm and household needs.



Figure 6.4 Farm improvements in the district of Jua

In summary, the analysis suggests that livelihood-related physical assets in rural Irauçuba point to a subsistence agrarian condition underlined by small farm size, low technological advancements and intensive farming practices. There were marked variations in land size, land ownership and other forms of tangible asset in the three study sites. Based on physical capital, the households in the district of Caxitore had less access to assets than those in the other two districts. This is suggestive of limited upward mobility reflected in the distribution of material resources and household infrastructure in the district. This finding lends credence to previous studies that suggest households in the rural areas of semi-arid Northeast Brazil share similar access to public infrastructure characteristics, but differ in regard to other forms of physical capital (Dillon and Scandizzo 1978; Obermaier et al. 2009).

6.3.3 Financial capital

Financial resources provide the opportunity to diversify livelihood strategies in rural communities (Carney 1998). Table 6.6 shows the inventory of financial capital in the three localities. It is important to note here that livestock ownership and purpose is included among financial capital items due to its marketability in times of hardship (Ellis 2000). Due to the sensitiveness of the financial situation of households, the field survey excluded detailed

questions on the proportion of monetary funds derived from savings, loans, welfare benefits or assets.

Table 6.6: Household financial capital

| Financial capital (%) | Jua | Missi | Caxitore | Total |
|---|------|-------|----------|-------|
| Livestock ownership | 47.0 | 48.0 | 68.0 | 55.0 |
| Livestock purpose (multiple responses admitted) | | | | |
| Household consumption | 93.0 | 52.0 | 96.0 | 81.0 |
| Commerce | 33.0 | 59.0 | 23.0 | 39.0 |
| Ploughing | 6.0 | 7.0 | 4.0 | 6.0 |
| Transport | 21.0 | 20.0 | 5.0 | 16.0 |
| Government support (multiple responses admitted) | | | | |
| Emergency-relief allowance | 35.0 | 35.0 | 41.0 | 37.0 |
| Family allowance | 48.0 | 46.0 | 53.0 | 49.0 |
| Federal-provisioned pensions | 16.0 | 17.0 | 22.0 | 18.0 |
| Households with savings | 40.0 | 46.0 | 16.0 | 34.0 |
| Households with institutional loans | 30.0 | 23.0 | 26.0 | 26.0 |
| Purpose of loan (multiple responses admitted) | | | | |
| Purchase agriculture and livestock inputs | 58.0 | 83.0 | 40.0 | 60.0 |
| Purchase tools or farm equipment | 44.0 | 11.0 | 54.0 | 36.0 |
| Purchase food and water | 12.0 | 8.0 | 27.0 | 16.0 |
| Pay for social event | 24.0 | 17.0 | 10.0 | 17.0 |
| Pay medical expenses | 39.0 | 19.0 | 28.0 | 29.0 |
| Start non-farm activity | 21.0 | 35.0 | 48.0 | 35.0 |

Source: Compiled from the field interviews in the research site, 2014 (n=90). Figures indicate % of households with access to each form of capital

Table 6.6 shows that over half of households owned livestock. Field interviews revealed that livestock is one of the most important assets for sample households in rural Irauçuba. In the district of Caxitore, 96% of respondents mentioned that the cattle and poultry produce are for household consumption. Livestock is also employed in other activities. Of the respondents in the sample, 6% use farm animals for draught power and for manure, which is recycled onto the farm or sold to other farmers. Some households access the use of livestock on an exchange basis. A bull can be borrowed to plough the land in exchange of human labour. The agreement in place determines the rate of exchange. This is a traditional practice between poorer farmers and their neighbours who owned cattle. There were also free loans of cattle for ploughing between relatives.

Livestock is also an asset that can be sold, providing emergency financial relief. During the 2010-13 drought, the importance of livestock as a commodity increased sharply. Because of the dwindling natural and financial resources and the drying out of local dams, farmers sold their animals (Figure 6.5) and allocated the funds to basic household needs such as food, water and medication.



Figure 6.5 Herd of goats in Missi. Livestock is a key household asset

The field interviews revealed that a few households had access to livestock through different institutional, commercial, or private agreements that allowed them to manage, keep and use livestock they did not possess. Such forms of commercial arrangements were predominantly found in the district of Missi, where a dairy company, which has several large farms across the region, proposed a shared profit scheme. The terms of this agreement were described by one respondent:

“The dairy company loaned the cattle for my family to keep, with the financial gains divided between the firm and us” (Respondent from the district of Missi, 2014)

The criterion for participation in the scheme was the capacity to keep cattle which included ownership of an animal shed, and access to grazing land and labour. The capacity of the household to meet these requirements determined the number of cattle loaned. Smallholders

who wanted to join in the arrangement had to obtain a guarantee in the form of a letter stating their current land tenure from the local council, but they were not required to provide insurance.

Federal government welfare support is a fundamental part of the financial capital available to households in rural Irauçuba. These programmes aim to improve the overall quality of life of families in the long-term, and involve very poor and poor households receiving money from the government on a monthly basis, as a complementary source of income, or, in some cases, the main source of income. Reliance on some form of cash-transfer programme was recorded in all three research localities, although it was not possible to establish the precise extent of the dependence within each household's overall budget. Welfare policies can be divided into three categories: emergency-relief financial support; federal-provisioned pensions and the widespread family allowance conditional cash-transfer. The latter, which was introduced in 2003 with the unification of four existing conditional and unconditional programmes, was cited as being the primary welfare benefit by 49% of the interviewed households. Families with children up to seventeen years of age and/or a pregnant woman with up to a maximum of three children can apply for the benefit. Emergency-relief policies and federal pensions comprised 37% and 18% respectively. Compared to Missi and Jua, households in the district of Caxitore were more dependent on welfare benefits.

Many policy interventions aimed at reducing vulnerability to adverse circumstances concentrate their efforts on increasing the access of poor people to institutional credit. This strategy enables investment in physical capital to increase the efficiency of assets, provides financial capacity for the purchase of agriculture and livestock inputs, and allows individuals and households to acquire essential consumption goods (Marr 1999). Field data revealed that institutional loans are an important part of household financial capital. Households can access credit from formal financial institutions such as the *Banco do Nordeste* (Northeast Bank) and the *Banco do Brasil* (Bank of Brazil), or through informal networks such as private creditors and family members. However, the procedure for acquiring a loan from private institutions is often convoluted. Rural residents needed collateral for the loan, as well as a business plan specifying what they would employ the money for and how they could repay the lending institution.

Households used the loans for a range of activities. Across the three research sites, 60% of households invested the money in agricultural and livestock inputs that enabled the farm to minimise losses resulting from rainfall uncertainty, particularly during long dry spells. Of the

interviewees, 36% also bought tools and farm equipment, while 35% acquired the loan to start a non-farm activity which, in most cases, was associated with artisanal and handcraft enterprises. This is particularly significant in Caxitore, where the already dwindling agricultural activities were severely impacted by the 2010-2013 drought, forcing many households to pursue alternative activities to generate income.

As noted earlier, the sensitivity of questions related to financial resources precluded the household survey from establishing a detailed breakdown of financial capital in a way that allows the relative importance of each form in each household to be identified. However, it is clear that the most important financial asset in rural Irauçuba is the assistance from government, as it guarantees a monthly income for the beneficiaries of these programmes. However, livestock is the most prevalent financial asset among households. Funds obtained through loans are an important form of financial asset which enables households to diversify livelihood strategies and purchase basic necessities. Household financial capital distribution varied between the three study sites. Compared to the other two districts, livestock ownership is higher in Caxitore. However, most households in the district use farm animals to provide basic sustenance. Conversely, over half of livestock-owners in Missi sell their production at local markets. The data also revealed that households in Caxitore are more welfare dependent and on average have lower capacity to hold savings, reflecting the observed lower socioeconomic status of the district compared to both Missi and Jua.

6.3.4 Natural capital

Natural capital encompasses all aspects of the environment that are useful for the livelihood of people, excluding the value added to these materials. This definition is best understood as the group of natural assets, from which resource flows are derived, including the landscape, soil, biodiversity and water (Carney 1998; Davies 1996). In Northeast Brazil, natural capital plays a pivotal role in the livelihood of its inhabitants. Rennie and Singh (1996, p.9) suggested that, “predominantly the poor depend directly on natural resources, through cultivation, herding, collecting or hunting for their livelihoods. Therefore, for the livelihoods to be sustainable, access to the natural resources must be sustained”.

In small-scale and subsistence farming systems crop production is heavily dependent on soil fertility. Exhaustion of soil fertility in the course of cultivation is often the main cause for

abandonment of agricultural activity (Tiessen, Salcedo and Sampaio 1992). The soils in the semi-arid region of Northeast Brazil are known for their limited productive capacity largely resulting from the irregular rainfall regime, and the limited use of fertiliser due to the lack of financial resources and inadequate return on fertiliser investment.

Figure 6.6 displays the type of soils across the region. Access to local council maps combined with Global Positioning System points collected at key locations, enabled the creation of maps displaying the location of households on a base map obtained from secondary sources. This approach was complemented with field observations and household interviews.

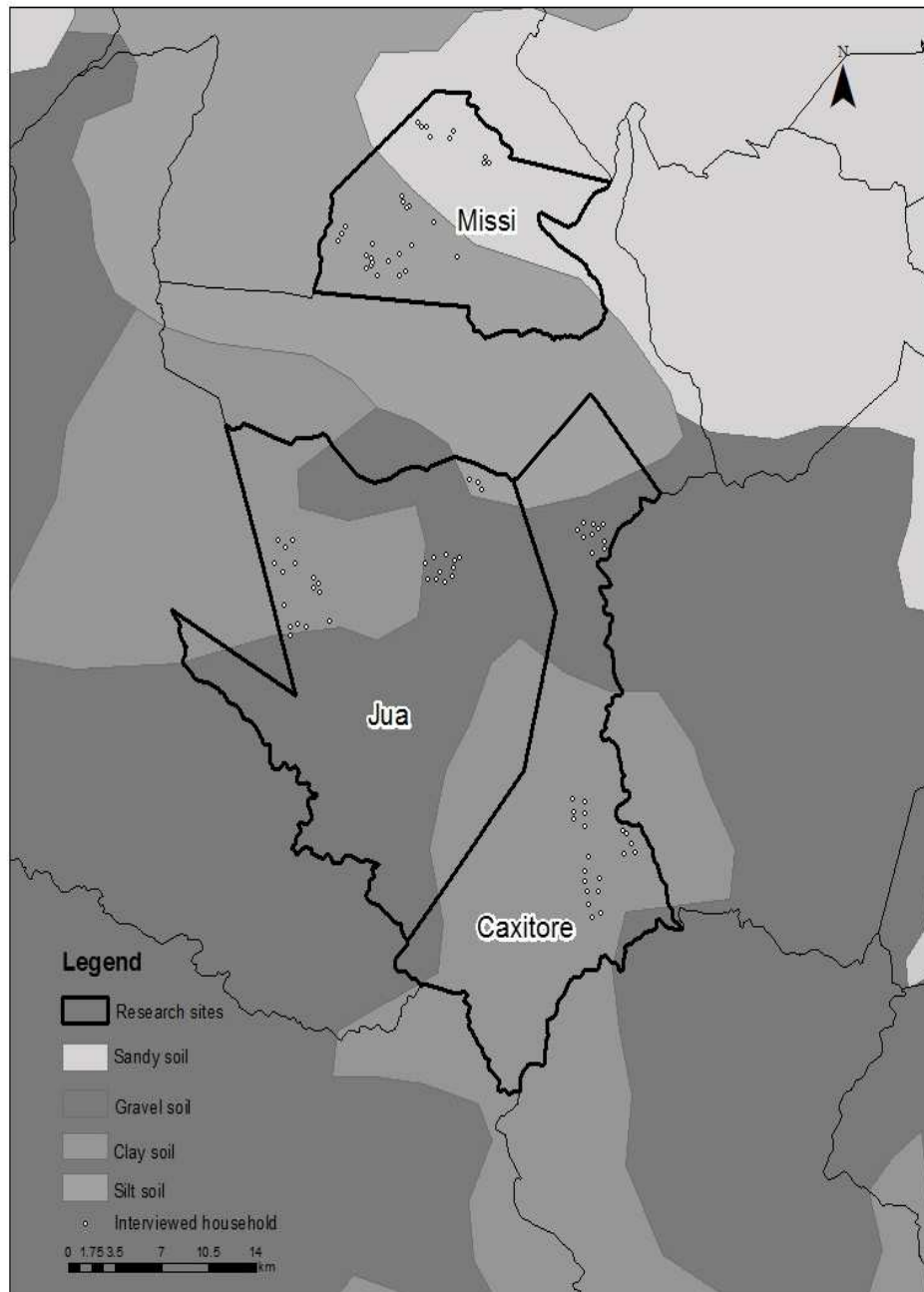


Figure 6.6 Soil types in the municipality of Irauçuba. Own elaboration based on data recovered from IBGE (2014)

Of the households interviewed in Missi, 43% plant their crops on sandy soils. These respondents reported that the decline in productivity between rainy seasons is a significant difficulty, as this type of soil has poor water-holding capacity. Clay, silt and gravel soils, which are the main soil types elsewhere in Jua and Caxitore, can retain water for longer periods and are therefore more suitable for agriculture. However, households planting on these soils

reported that some areas of rural Irauçuba contain overly compacted soils, making it difficult for roots to penetrate the soil. One of the main concerns of the slash and burn cultivation practice observed at all three study sites lies with the fact that, if adequate fallow periods are not observed, this technique is known to deplete the nutrients of fertile soils. As with many other parts of rural Northeast Brazil, the municipal council has no means to supervise the practice which leads to occasional bushfires and further degradation of soil. Figure 6.7 shows damaged sandy soils around a dried out dam.



Figure 6.7 Dried out dam and damaged soil in the district of Jua

Respondents in rural Irauçuba reported that yields have shown a marked decline in recent years and also believed that without appropriate investment their farms have become less productive. Understanding of the natural processes of fertility decline between cropping cycles, or the recovery of soil fertility in the course of fallow cycles in semi-arid Northeast Brazil remain a challenge (Tiessen, Salcedo and Sampaio 1992). Previous studies indicate that the turnover of organic material from the primary vegetation, combined with the restoration of litter and widespread root biomass, were critical factors in the nutrient cycling in shifting cultivation employed by smallholder agricultural activity (Machado, Barros and Sampaio 1997). With regard to cultivated sites, a respondent commented:

“Some farmers have been instructed to introduce slower growing crops in conjunction with native species, which can be used for wood and fuel, and help maintain nutrients in the soil” (Respondent from the district of Jua, 2014)

The vegetation cover in rural Irauçuba takes the form of *caatinga* forests. In the northern part of the municipality where the district of Missi is located, the native vegetation has been intensely altered, with few remnants indicating the presence of denser vegetation in the past. In other parts of the municipality, including the districts of Jua and Caxitore, the vegetation is predominantly dominated by *caatinga*, with and without shrubs. Figure 6.8 identifies the characteristics of the vegetation in the area.

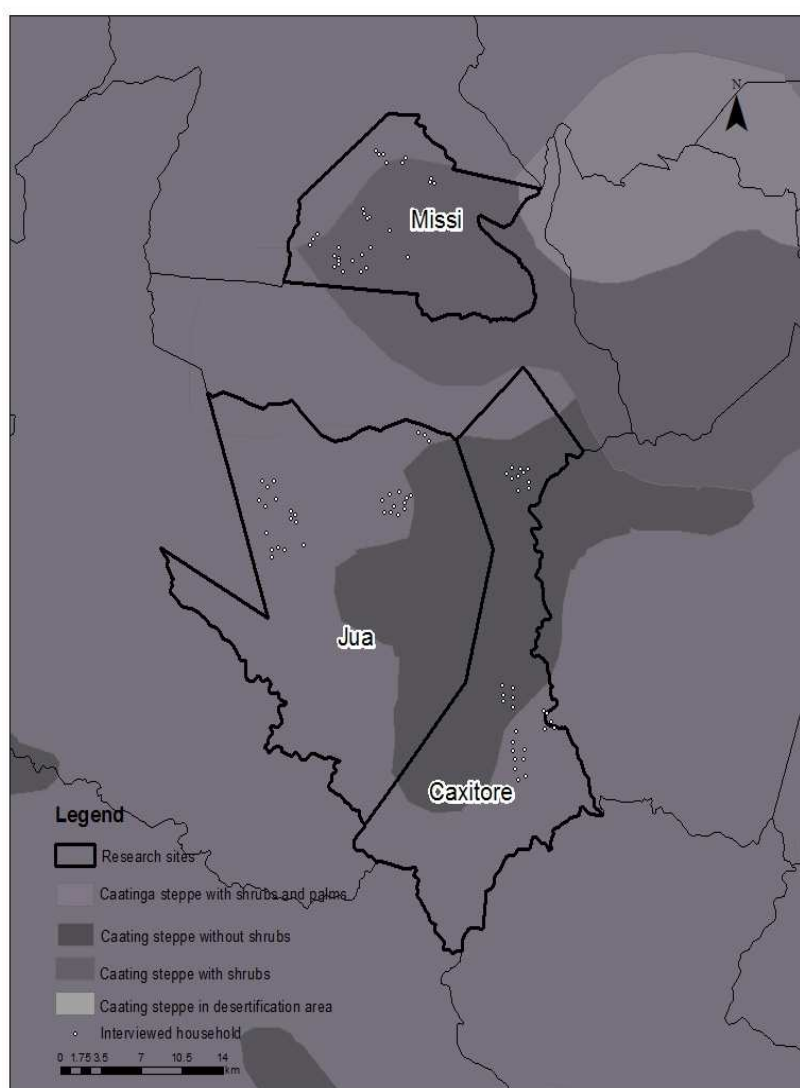


Figure 6.8 Vegetation cover in the municipality of Irauçuba. Own elaboration based on data recovered from IBGE (2014)

All households in the study are located on the *caatinga* biome with a mixture of residual primary and secondary vegetation. However, extensive parts of the ecosystem have been cleared for agriculture, while livestock have used large fragments of the remaining vegetation as pasture. Respondents in all three study sites reported that, due to the successive droughts, the vegetation is in a fragile state and shrubs have dried out, leaving limited forage for animals. The fragility of local ecological conditions is well-defined (Santos et al. 2011), but field observations detected that the majority of residents have shown little concern for the current state of shrubs and palms that remains in the *caatinga*. In other words, the region's residents have not been able to engage in sustainable alternatives to assure the maintenance of native vegetation and improve soil nutrition, which, in turn, contributes to the overall degradation of the environment and of subsistence agriculture. Table 6.9 reveals the distribution of natural capital in the three study areas.

Table 6.7: Household natural capital

| Natural capital (%) | Jua | Missi | Caxitore | Total |
|--|-------|-------|----------|-------|
| Distance from source of water | | | | |
| Less than 30 minutes | 83.0 | 90.0 | 83.0 | 85.0 |
| More than 30 minutes | 17.0 | 10.0 | 17.0 | 15.0 |
| Total | 100 | 100 | 100 | 100 |
| Type of soil | | | | |
| Sandy soil | - | 43.0 | - | 14.0 |
| Gravel soil | 36.0 | - | 36.0 | 23.0 |
| Clay soil | 54.0 | - | 64.0 | 39.0 |
| Silt soil | 10.0 | 57.0 | - | 22.0 |
| Total | 100 | 100 | 100 | 100 |
| Topography | | | | |
| Hilly topography | 20.0 | 23.0 | 13.0 | 19.0 |
| Flat topography | 80.0 | 76.0 | 86.0 | 81.0 |
| Total | 100 | 100 | 100 | 100 |
| Vegetation | | | | |
| <i>Caatinga</i> steppe with shrubs | - | 83.3 | - | 27.7 |
| <i>Caatinga</i> steppe with shrubs and palms | 100.0 | 16.7 | 50.0 | 55.6 |
| <i>Caatinga</i> steppe without shrubs | - | - | 50.0 | 16.7 |
| Total | 100 | 100 | 100 | 100 |

Source: Field interviews (n=90), Brazilian agricultural census (2006/2009), and the council of the municipality of Irauçuba (2014). Figures indicate % of households according to the environmental characteristics of their location

Proximity to water is the most important asset for smallholder households in semi-arid Northeast Brazil. Of the respondents 85% live less than 30 minutes on foot from one of the several small dams spread across rural Irauçuba. These dams are locally called “açudes” have different sizes and purposes. Water holding capacity ranges from 5,000 cubic meters (also called “barreiro”), mainly used for human consumption; to 300,000 cubic meters, which is a perennial reservoir able to guarantee water supply during a dry season. Figure 6.9 shows children, who are often members collecting water for household consumption, in a “barreiro” in the district of Missi.



Figure 6.9 Children collecting water from a “barreiro”

Almost all interviewees reported that they struggle with adverse environmental conditions which affect agricultural land for both subsistence and commercial production. For example, respondents in Caxitore reported that several areas of the district have become unsuitable for cash-crops such as castor beans. Respondents who farm on clay, silt and gravel soils reported that soil capacity under appropriate rainfall conditions is adequate. However after several years of planting on sites cleared of *caatinga* vegetation, combined with the cyclical droughts impacting the area, agricultural output has been reducing due to impoverished soils and dwindling vegetation cover.

In summary, the fragility of the *caatinga* ecosystem means that natural capital for crop cultivation and animal grazing decreased during the 2010-2013 drought, which indicates that households with access to other forms of capital were better placed to deploy alternative livelihood strategies. Smallholder farmers with limited financial and physical capital remained involved in the production of subsistence crops with short growing cycles that require little investment.

6.3.5 Social capital

Social capital is defined as “the ability of actors to secure benefits by virtue of membership in social networks or other social structures” (Portes 1998, p. 6). Included in this definition are household relations, social networks and a range of different associations established in the community. As a relational concept, social capital cannot be measured in its own right, and assessment relies on proxy indicators (Portes 1998). In practical terms, it is defined to include the perception of trust and unity, membership and participation in community associations and other forms of social network (Rakodi 2002).

Tradition and local culture are important in Northeast Brazil (Wanderley 2004). Among these traditions, the reciprocity of duties is common between households. This is one of the most basic forms of social capital. Goods, resources and labour, in the form of help on the farm, are the common elements in the interchange. This tradition is practiced among neighbours and relatives. Table 6.8 shows the types of networks and forms of assistance in the three research sites.

Table 6.8: Household social capital

| Social capital (%). Multiple responses permitted | Jua | Missi | Caxitore | Total |
|--|------|-------|----------|-------|
| Local community membership | 92.0 | 62.0 | 64.0 | 73.0 |
| Local church community association | 89.0 | 80.0 | 83.0 | 84.0 |
| Relatives living in the same district | 22.0 | 17.0 | 35.0 | 25.0 |
| Relatives living in the same municipality | 68.0 | 79.0 | 78.0 | 75.0 |
| Relatives living in Fortaleza | 75.0 | 54.0 | 75.0 | 68.0 |
| Household receiving any direct assistance (%) | 84.0 | 74.0 | 93.0 | 84.0 |
| Form of assistance (%) | | | | |
| Water | 23.0 | 18.0 | 15.0 | 19.0 |
| Food | 36.0 | 12.0 | 16.0 | 22.0 |
| Seeds | 10.0 | 3.0 | 5.0 | 6.0 |
| Raw materials | 8.0 | 5.0 | 1.0 | 5.0 |
| Money | 22.0 | 25.0 | 28.0 | 25.0 |
| Emotional and social support | 43.0 | 38.0 | 78.0 | 53.0 |
| Help in the farm | 36.0 | 32.0 | 43.0 | 37.0 |
| Assistance provider (%) | | | | |
| Family | 40.0 | 44.0 | 48.0 | 45.0 |
| Friends | 24.0 | 14.0 | 12.0 | 17.0 |
| Community group | 20.0 | 12.0 | 15.0 | 16.0 |
| Church association | 12.0 | 11.0 | 15.0 | 13.0 |

Source: Compiled from the field interviews in the research site, 2014 (n=90). Figures indicate % of households with access to assistance and by assistance provider

Table 6.8 reveals evidence of strong social networks in each of the three localities, manifest in the high percentage of respondents involved with local associations of both a secular and a religious nature, corroborating previous findings that social capital in rural Irauçuba is bonding, bridging, and linking (Sales 2003). These culturally appropriate forms of social capital have the potential to aid rural households in mitigating the impacts of climate uncertainty, and increase resilience through production linkages and other direct forms of assistance. Local connections, measured in the survey by reference to relatives living in the same district, were particularly high in Caxitore, where 35% of households had relatives living locally. This can be explained in part by the high incidence of nuclear extended households in the district as shown table 6.1 in the household composition section of this chapter.

The relevance of social capital becomes evident through the various forms of direct assistance upon which households can call. The most common benefit captured in the interviews was emotional and social support. This form of assistance is particularly prominent in Caxitore, due

to the more marginal socioeconomic and environmental characteristics of the district, and the larger network of related households. One respondent described the type of support received during adverse conditions:

“I spend a lot of time with my sister when her husband is away for work. Sometimes I make corn cake and pack some for her. She does not like to be alone and she needs help to fetch water for the house” (Respondent from the district of Caxitore, 2014)

Households also relied on the help of friends and relatives to meet seasonal increases in demand for labour at the farm. Of the respondents in the sample, 37% mentioned that they are dependent on aid to look after livestock when the main farm worker is away. Assistance is usually provided by relatives (45%) and friends (16%). In addition to intangible forms of assistance, respondents revealed that water (19%) and food (22%), along with other basic household necessities, is benefits directly associated with established social networks.

Moser (1998) classifies social capital, such as household relationships, as a form of intangible asset which is influenced by household composition and structure, and it varies over time according to stage of the family life cycle. While household demographic composition has already been established, it is relevant to give emphasis to the effects of household structure on the size and strength of household relationships and community networks. Among the households interviewed in the sample, nuclear extended households could call upon a wider network of support compared to the other types, due to the internal dynamic of these households. Nuclear extended household members participated in various community organisations. On the other hand, single person, nuclear incomplete and nuclear household types reported fewer social contacts within the community, corroborating Forni et al. (1991) who suggested that nuclear extended households have advantages over other household types because of the pooling of labour and relationships for production and reproduction.

Kin networks, consisting of relatives living in the same district, in the municipality or in the capital city of Ceará, also appeared as a relevant component of social capital among the sample households. The percentage of respondents who have relatives living within the municipality is high and similar across all localities. In addition, 68% of households in the sample identified relatives living in Fortaleza, the capital city of Ceará. They were important in two respects. First,

some households relied on the help of non-resident relatives for non-farm waged work opportunities. One respondent reported:

“I would not have been able to get the job at the shoe factory if my uncle did not live in Irauçuba. I have a place to stay during the work week before I can return home on Friday” (Respondent from the district of Missi, 2014)

Through these connections, household members found part-time jobs in local businesses or were made aware of potential council employment. Second, the viability of temporary mobility as a livelihood diversification strategy in the urban centre of the municipality or in Fortaleza as depended in part on connections with relatives living in the destination area. The importance of these networks will be more fully examined in detail in Chapter 8.

In summary, sample households in rural Irauçuba generally had two forms of social support systems, one from informal social networks, the other from formal organizations such as community groups and church associations. Due to close family connections in Northeast Brazil, the informal social support system played a more important role than the formal social support system during the 2010-2013 drought. However, most initial support took the form of intangible emotional support followed by more basic needs such as provision of food and water at the beginning of the recovery period, because most of the social networks were locally based and also severely impacted by the drought. Emotional support was particularly important in Caxitore, where 78% of household heads reported that this form of assistance was important in coping with the impacts of the 2010-2013 drought

Summary of capital endowment in rural Irauçuba

Previous profiles of rural communities in Northeast Brazil indicate a level of homogeneity in terms of income, overall quality of life and access to the five types of capital (Valdes and Mistiaen 2003). The analysis of the field data adds further nuance to this view by underlining the differences in access to capital assets.

Field interviews revealed that land ownership, livestock, welfare and proximity to water are the most important assets for households in rural Irauçuba. In addition, social capital, in the form of material and non-material support, gains added significance when households face adversities such as the 2010-2013 drought. The most readily available form of financial capital

in all three study areas is livestock, which is either employed as a source of sustenance or sold at local markets. Livestock form the largest asset base from which rural households can draw, by converting farm animals into cash as an immediate coping strategy when a drought occurs in the area.

Availability of human capital was highest in the district of Caxitore, however employment in the non-farm sector was lower than in Jua or Missi. Labour force composition recorded stark differences in regard to household size. Smaller nuclear, and nuclear complete households had a more balanced proportion of farm and non-farm workers. Conversely large nuclear extended households, particularly in the district of Caxitore, recorded a large contingent of members engaged in subsistence agricultural activities.

The quality of physical capital assets in terms of housing and household infrastructure was higher in Missi and Jua than in Caxitore. The economic value of these assets is limited. Nonetheless, they are central to household dynamics in the study area. Families who own the land they live on seemed to have been better prepared to respond to the impacts of the 2010-2013 drought, as they did not have to divert their dwindling earnings to rental payments. Caxitore also recorded a higher proportion of households relying on welfare payments for the purchase of basic necessities compared to the other two districts. There were few savings, and household heads in Caxitore have low education and training. These indicators, combined with low access to physical capital and poorly developed public infrastructure, account for the increased level of vulnerability to climatic events such as the 2010-13 drought in Caxitore.

6.4. Household typology in rural Irauçuba

The previous sections of this chapter have established differences in household composition, access to assets, and livelihood strategies, among households in the rural districts of Jua, Missi and Caxitore. For smaller households in Missi and Jua, non-farm work tends to be more prevalent. Conversely, households in Caxitore, irrespective of size, tend to have most labour power engaged in subsistence agriculture. In addition, it is possible to recognise that the main source of income for households in Caxitore derives from welfare benefits. On the other hand, non-farm work and market-oriented livestock activity are more prevalent in the other two districts. These findings suggest a socially diverse and spatially heterogeneous study area.

While a comparison of districts provides some insights into regional livelihoods, a typology combining household characteristics, capital assets and livelihood strategies is needed to provide a more nuanced view of how households respond to climatic events. This section aims to develop a typology of households that captures the diversity of smallholder farms in rural Irauçuba. Mettrick (2003) argues that structural typologies contribute to the understanding of livelihood strategies and the dynamics of household production. This should contribute to understanding of responses to the 2010-2013 drought, particularly with respect to spatial mobility patterns and behaviour. Functional typologies of farms have been developed for parts of East Africa (Carter 1997; Kruseman et al. 2006; Tiftonell et al. 2010) employing a range of techniques to categorize households for specific purposes. A common approach is the use of cluster analysis (Brown et al. 2006).

Cluster analysis is a research strategy for classifying agents into various discrete types. The primary use of cluster analysis is to find optimal groupings of entities which are similar, so that each group has a high degree of natural association within its group and maximises differences between groups (Romesburg 2004). Technical details of clustering methods can be found in Hansen & Jaumard (1997). Following Hansen and Jaumard (1997), the analysis proceeds in the following steps: First, observations are selected from the sample = {O1, O2, O3, O4,... ON} of N observations where O represents an individual household. This was followed by identifying a suite of variables on which to cluster these entities. We then apply cluster analysis by selecting the types of clustering and specifying the criteria for selecting the appropriate cluster levels. Hierarchical partitions and K-means partitions are two commonly used clustering methods. Cluster analysis is an important tool, particularly for populations which cannot be differentiated by the 'naked eye' (Atlas and Overall 1994), which is the case in the three study sites, since all households undertake subsistence agriculture activities, but with different household and personal characteristics, access to assets and mix of income-generating activities.

The cluster analysis was performed using the following approach. First, a hierarchical cluster analysis centred on squared Euclidean distances using Ward's algorithm determined the number of clusters. The Ward's algorithm ensures that differences within clusters are minimized, thus avoiding issues with chaining, whereby clusters end up being long and untidy (Hansen and Jaumard 1997). In addition, one of the selected variables, namely

'Annual_income', has a much wider range than others, which can introduce bias in the clustering of entities. To overcome this problem, each variable used in the clustering process was standardised (converted to Z-scores).

A limitation of hierarchical approaches is that an entity cannot be removed from the cluster to which it is allocated, potentially resulting in sub-optimal clustering (Hansen and Jaumard 1997). To address this concern, Romesburg (2004) suggests that once the number of clusters is established, a *K*-means cluster analysis should be completed to define the optimal cluster partitioning. In order to detect optimal cluster breaks, the percentage change in the clustering coefficients was calculated. Small changes in coefficients indicate that moderately analogous clusters are being combined. Conversely, large changes in coefficients mean that two contrasting clusters are being combined. The most significant percentage change in agglomeration coefficient to the next level was obtained when moving from two clusters to one cluster. It is important to note that the aim of the cluster analysis is to determine differences in household livelihood strategies, and to obtain a more diverse typology, several clusters are needed. The four cluster solution was selected due to the considerable acceleration in the agglomeration coefficient moving from four clusters to three. In figure 6.10, the scree plot shows a large increase in the cluster coefficients after stage 86.

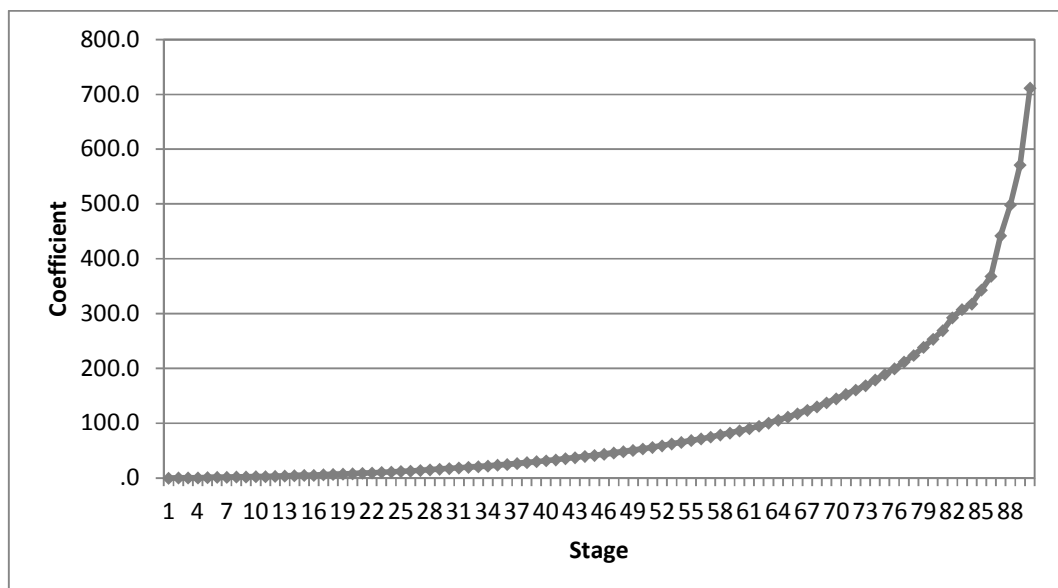


Figure 6.10 Scree plot of cluster coefficients by stage

Selection of variables is a fundamental step in cluster analysis (Kobrich et al. 2003). Table 6.9 summarises the variables which were selected for the current study. Variables were selected to capture meaningful socioeconomic and structural characteristics of smallholder farms in the study area, reflecting access to assets, household characteristics and estimated annual income. Three discrete variables were chosen to represent household composition: household size; age of household head; and the period of time the household head has resided in the current dwelling. These variables were selected because they encompass social and kinship characteristics that have a direct impact in facilitating different livelihood portfolios. For example, across the study area, smaller households with younger household heads tend to have proportionally larger number of members engaged in non-farm work. Furthermore, it is important to ascertain if there are substantial differences between recently established and more traditional households.

Variables measuring capital assets include: labour power size and type; absent members; formal education of the household head; area of land; ownership or management of livestock; financial support from government; and distance to nearest source of water. These variables characterise the ownership and access to assets which mediate livelihood strategies and reflect the general capacity of a household to respond to external shocks such as the 2010-2013 drought. This, in turn, enables the identification of the more dominant production system within households.

The income variable is very important for the characterisation of households in the study area. For this cluster analysis, only the estimated annual income was included. Because the questionnaire did not include a question regarding the proportion of income by source, the estimated annual income includes funds from cash-transfer grants, non-farm waged-work, remittances and casual non-farm and off-farm employment. Because estimated annual income can be associated with the main income-generating activity captured in the household questionnaire, it enables a *post-hoc* identification of livelihood strategies in the household typology.

Table 6.9: Variables in the typology of sample households in the study area

| Category of variable | Variable name | Variable description |
|---------------------------|-------------------|---|
| Household characteristics | Household_size | Total number of members |
| | HouseholdHead_age | Age of household head at the time of interview |
| | Household_time | Period of time the household head has resided in the current dwelling |
| Capital assets | Nonfarm_workers | Number of members engaged in full-time work within and outside the municipality |
| | Farm_workers | Number of members engaged in subsistence agriculture |
| | Absent_members | Number of absent numbers engaged in an economic activity outside the municipality |
| | Size_land | In acres |
| | Distance_water | In minutes to nearest dam |
| Livelihood | Annual_income | Estimated annual income |

6.4.1 Results of the cluster analysis

Determined by the statistical results from a hierarchical and a *K*-means cluster analysis, four clusters were identified, representing four discrete household types. The final *K*-means cluster centres are showed in table 6.10

Table 6.10: Final *K*-means cluster centres

| Variable name | Household cluster 1 | Household cluster 2 | Household cluster 3 | Household cluster 4 |
|---|---------------------|---------------------|---------------------|---------------------|
| Total households in group | 44 | 21 | 15 | 10 |
| Household characteristics | | | | |
| Household size (people) | 4 | 3 | 4 | 5 |
| Household head age | 46 | 32 | 42 | 53 |
| Period of time the household head has resided in the current dwelling (years) | 22 | 10 | 19 | 27 |
| Capital assets | | | | |
| # non-farm workers | 0 | 0 | 1 | 2 |
| # farm workers | 2 | 2 | 2 | 3 |
| # absent members | 0 | 0 | 1 | 1 |
| Size of land (acres) | 4 | 3 | 2 | 5 |
| Distance to water (min.) | 29 | 21 | 22 | 10 |
| Livelihood | | | | |
| Annual income (US\$) | \$2,367 | \$3,208 | \$4,628 | \$6,391 |

Cluster analysis combined with a *post-hoc* assessment of main source of income revealed four distinctive household groups: (1) welfare-dependent; (2) mixed livelihood strategies; (3) predominantly non-farming and (4) predominantly market-oriented livestock raising. The spatial distribution of the four household types across field sites reveals that almost 57% of all welfare-dependent household are located in the district of Caxitore. This corroborates previous findings of this chapter which established the district as the poorest in rural Irauçuba. Missi recorded the highest proportion of commercial livestock-oriented and mixed livelihood households, with 70% and 52% respectively. Conversely, it recorded the second largest proportion of welfare-

dependent households with 30%. Jua displays a balanced distribution across all four household types, with non-farming households being the most predominant type with 40%. Table 6.11 show the characteristics of each group.

Table 6.11: Key elements of a functional typology for household categorisation in rural Irauçuba

| Household group | Total households | Asset endowment and livelihood orientation | Main characteristics |
|-------------------------------|------------------|--|--|
| Welfare-dependent | 44 | Low asset endowment, predominantly subsistence oriented with occasional non-farm income, mainly welfare dependent | Average age of household head is 46, average household size is four members in a predominantly nuclear complete with some nuclear incomplete households on medium area of land but without resources to invest in productive farming; no absent members or members engaged in non-farm work |
| Mixed livelihood | 21 | Mix of subsistence and low-input market oriented, complementary income from small enterprises, occasional non-farm work and welfare assistance | Average age of household head is 34 , average household size is three members in a predominantly nuclear complete households in expansion along with few single person households on a small area of land; occasional agricultural surplus is sold at farmers' markets, complementary income derived from other sources; no absent member but with sporadic seasonal day-labourers |
| Non-farming | 15 | Non-farm source of income with agricultural activity mainly dedicated to own consumption | Average age of household head is 42, average household size is four members in a predominantly nuclear complete with few nuclear expanded households on a small area of land; one or more members engaged in non-farm activities with current absent members working elsewhere |
| Commercial livestock activity | 10 | Livestock market oriented, with permanent source of non-farm income including pensioners | Average age of household head is 53, large number of members often formed by traditional nuclear extended households on large area of land near a perennial source of water; constant livestock production sold at farmers' market; with up to two members engaged in a full-time non-farm job within or outside the municipality |

Source: Compiled from the field interviews in the research sites (2014) (N=90)

The first household group, (cluster 1), **welfare-dependent**, is the largest (N=44) and poorest group. Households in this group rely exclusively on welfare grants in the form of monthly cash transfers as their main source of income. This category of households consists of people who seem to be very much constrained from engaging in any form of livelihood strategy outside subsistence farming, due to a lack of capital assets. Each smallholder has a small garden by the homestead where they cultivate beans, maize and cassava on a subsistence basis. These households only marginally engage in any form of market-oriented agricultural activity, non-farm work or small enterprises. Of the 44 households in this group, only three said they were able to sell some farm surplus during the 2010-13 drought, while five had a member who worked as a day labourer. Ownership of livestock, captured in the household questionnaire, is low across all farms in this group.

The second household group, (cluster 2), is characterised by **mixed livelihood** strategies. Households in this group employ the most variety of livelihood strategies across the sample. This is partly explained by the fact that these households are largely headed by relatively young adults compared to the other three groups (average age of household head is 31) who have been living at the same address for an average of 10 years. Consistent with the literature, these young households tend to engage in a range of activities to diversify livelihoods, as they seek to establish their households amidst the uncertainties of external factors in developing countries (Kamanga, Vedeld and Sjaastad 2009). The 21 households in this group have several income sources, including occasional non-farm work performed within or outside the municipality, agriculture, small-enterprises and welfare grants. Most households in this group grow crops on the farm and 57% reported they raise small quantities of livestock. The agricultural production is mainly for subsistence, but some families are able to sell the surplus at the local market.

In the third household group, (cluster 3), **non-farming** activities provide the main source of income. These households have at least one member permanently engaged in a non-farm activity, with several identifying a second member engaged in a part-time job. Additional income derives from small enterprises and remittances. Subsistence activities are pursued by household members who work on the farm and any eventual surplus is sold at the local farmers' market. In most cases, the husband or spouse has non-farm work outside the community, either in the local council or as a labourer in one of the shoe factories located in the central district of Irauçuba. A household member may also be engaged in non-farm work outside the municipality, thus sending remittances to the household. Households in this group are of the nuclear complete or nuclear expanded type and accommodate four

members on average, mostly adults and school aged children able to help on the farm. Livestock ownership is very low and mainly dedicated to subsistence. Smallholders in this group grow crops in a garden or on a small plot of arable land with low yields. In line with these observations, farming activities therefore are not a key source of income.

The fourth household group, (cluster 4), is formed by households engaged in **commercial livestock-oriented activity**. The smallholders included in this category are the most affluent in rural Irauçuba. Of the ten households in this group five have at least one member who is receiving a pension on top of agricultural and non-farm income. In addition to that, all households in this group have at least one member permanently working in a non-farm activity or a currently absent member engaged in waged work outside the municipality. Livestock activities takes top priority in this group with farmers selling dairy produce either at local markets or working in partnership with dairy companies in the region. A small proportion of the production reverts back to the farm in the form of subsistence. All households in this group are of the nuclear extended type and accommodate five members on average. Average age of household head and time living in the same household recorded the highest values among sample households.

Further analysis of the data captured in the household questionnaire reveals that commercial livestock-oriented farms represent wealthier smallholders owning relatively large quantities of livestock, as well as a range of farm improvements. Welfare dependent households, on the other hand, are less well-endowed with financial and physical capital, constituting the poorest group in rural Irauçuba. The lack of capital endowments exacerbates the many hardships this group has to overcome in order to secure their livelihood. Wealthier households relying on non-farm livelihood strategies, which provide adequate income to secure access to food and water regardless of seasonality or the occurrence of climatic events, reported that when subsistence agriculture fails, they have sufficient funds to purchase food. On the other hand, welfare dependent households are heavily reliant on subsistence crops for their self-sufficiency given that the funds received via cash-transfer programmes do not guarantee monthly food security for the household. During the 2010-13 drought, these households reported that a significant amount of food and water was obtained through relatives, friends and occasional food parcel deliveries by the state and federal governments. Table 6.12 shows characteristics of the four household types and elaborates the statistical measures captured in the typology.

Table 6.12: Indicators of asset ownership, food sufficiency and main source of income

| Household type | Total households | Farm improvements (%) | Livestock ownership (%) | Savings (%) | Food self-sufficiency (%) | Main source of income |
|----------------------|------------------|-----------------------|-------------------------|-------------|---------------------------|-----------------------|
| Welfare-dependent | 44 | 23 | 34 | 25 | 37 | Welfare |
| Mixed livelihood | 21 | 57 | 57 | 38 | 61 | Non-farm + welfare |
| Non-farming | 15 | 66 | 40 | 60 | 80 | Non-farm |
| Commercial livestock | 10 | 100 | 100 | 100 | 100 | Commercial livestock |

Source: Field survey (2014)

For example, the variable farm improvements, which includes ownership of a cistern, fences and a shed, indicates that commercial livestock-oriented and non-farming households are well endowed with regard to physical assets. Commercial livestock households also have access to a savings account and are able to invest, and are able to secure basic household needs (water and food). On the other hand, welfare-dependent households have low access to key capital assets across all selected variables, with less than a quarter owning farm improvements and only a quarter with access to a savings account. These households had to divert their earnings to purchase food because their farms were not able to produce enough food for their sustenance during the 2010-13 drought.

Expanding on Tittonell et al.'s (2010) framework on livelihoods and agricultural systems in East Africa, Fig. 6.11, positions the four household clusters on a diagram which identifies the relationship between asset endowment, forms of income and welfare dependency. Households are encircled in a dashed line indicating that livelihood strategies are not mutually exclusive. Welfare-dependent, non-farming and commercial livestock oriented households have clearly defined main sources of income, while mixed livelihood households exhibited wider variation in terms of livelihood strategies. Commercial livestock-oriented households are positioned on the upper right-hand side of the diagram, which represents high access to capital assets, low dependency on welfare benefits and greater self-sufficiency in food compared to other household types. It is important to note that, as indicated in Table 6.15, in addition to revenue derived from livestock selling, commercial livestock-oriented households have at least one member engaged in a full-time non-farm

employment contributing to the annual income. At the other end of the spectrum, welfare-dependent households, suffer from low capital assets endowment and, therefore, have limited opportunities to expand their livelihood portfolio, relying heavily on some form of federal welfare cash-transfer policy for self-sufficiency.

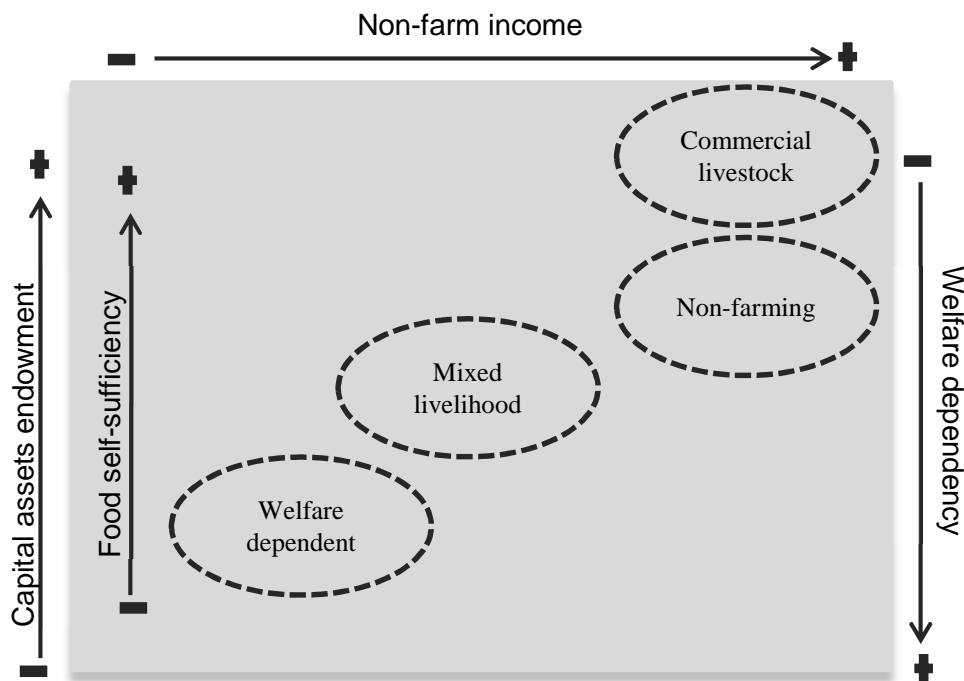


Figure 6.11 Household typology in rural Irauçuba based on a multidimensional approach
Modified after Tittonel et al. 2010.

6.4.2 Summary of livelihood strategies in rural Irauçuba

In spite of the diversity of asset endowment and livelihood portfolio between farms in the sample, all smallholders in this study can be considered resource-poor. Differences in access to assets and in livelihood strategies have implications for the design of target-specific local policy and for the implementation of technical innovations (Otsuka 2000). For example, non-farming households are not dependent on agriculture as a source of income, and therefore are less likely to benefit from the application of policies towards that industry. Alternatively, commercial-oriented livestock raisers would benefit from policy and research towards agriculture, as their income is intimately associated with agricultural surplus.

In welfare-dependent households, constraints with regard to access to capital limit any form of upward mobility. The lack of financial capacity to engage in technological innovation or to implement basic farm improvements is reflected in their dependence of federal welfare

grants to provide basic level of income. On the other hand, the group of mixed livelihoods households is focused on diversifying livelihoods and optimizing outputs from both farm and non-farm activities in place of dependence on cash-transfer policies. Due to their demographic composition, households in this group appear to be in a position to cross the extreme poverty threshold towards a more stable livelihood portfolio.

The typology of household livelihood strategies proposed in this section, which might be generalised consistently across rural areas of the state of Ceará, demonstrates that limited access to assets, and certain household characteristics, acts as limiting factors in livelihood strategies (Thornton et al. 2007). In rural Irauçuba, this manifests as higher dependency on welfare programmes. Access to a wider range of capital assets improves the livelihood portfolio of households. Engagement in non-farm work was observed in farms which have greater access to capital which improved their overall capacity to respond to the impacts of the 2010-2013 drought.

6.5 Conclusion

This chapter focussed on the livelihoods of rural households through the analysis of their socio-demographic characteristics, their access to assets represented by five types of capital, and to their livelihood strategies. Notwithstanding differences with regard to access to capital and livelihood portfolios, the field data revealed that rural households in Irauçuba also display diverse characteristics with regard to their size and composition across the three field localities. Households in the study area adopt a multiplicity of livelihood strategies to cope with a difficult environment. However, much of the success of these strategies in diversifying sources of income, reducing risk and mediating the impact of severe climatic events, is conditional on the level of access to capital, particularly in the district of Caxitore.

Because the focus of this thesis is on rural smallholder farms in a semi-arid marginal region of Northeast Brazil, it seemed judicious to expect that land and water, on the one hand, and the availability of labour which enables livelihood diversification, on the other, would be the most relevant assets within the five discrete categories of capital. For households in rural Irauçuba, agriculture and livestock keeping may be the most common activities, but in terms of capacity to generate income they are not the most dependable. The majority of the cultivated area is devoted to subsistence agriculture. In addition, the distance to markets and cyclical droughts cause this activity to frequently be less profitable or stable than non-farm employment.

The number of household members able to join the labour market makes a significant difference in the well-being of families, depending on their qualifications. However, the realisation of this advantage is intrinsically dependent on the household's life cycle stage and the individual human capital of each member as well as on external factors acting in the local labour market. Given the relatively high unemployment rate in the municipality of Irauçuba, compared to that of the state of Ceará, in several households in the sample the extra adult members were a burden and not an advantage. This situation particularly affected younger adults who were not able to find non-farm employment, and whose hands were not needed on the farm due to the low productivity of the land during the 2010-13 drought.

According to the responses collected in the field and the unemployment figures, finding non-farm work was a challenging task for the inhabitants of the study area. Possible explanations for this are related to the small size and diversification of the labour market, which cannot accommodate labour supply. As a result, underemployment and high rates of unemployment were factors constantly present in the lives of the interviewees, undermining the efficacy of livelihood diversification strategies based on income derived from non-farm activities.

The four household types identified in rural Irauçuba differed in capital endowment and livelihood strategies, which has an influence on level of income and overall quality of life. In the majority of welfare-dependent and mixed livelihood households, interviewees expressed the desire to engage in a non-farm activity. This may be indicative of households trying to reduce their dependency on agriculture or abandon agricultural activity entirely as an income-generating activity in response to the cyclical droughts and rainfall uncertainty in the region.

Although many households make an effort to diversify their livelihood strategies, the financial situation of the majority of the families seemed precarious. Livelihoods in the study area are both limited and facing increasing challenges brought about by the recurrent droughts. The field interviews and observations lent credence to the impression that some households had reached the limits of their capacity to cope with the impacts of the 2010-13 drought. This may have impacted on the nature and characteristics of spatial mobility within livelihood strategies in general, and people's everyday lives in particular. An indication of this is the small number of people who are able to maintain a stable source of income through their farmland, or who are able to find employment in the non-farm sector in the municipality of

Irauçuba. The next chapter will examine in more detail the relationship between livelihoods and perceptions of issues impacting households in the three study areas, further exploring the impact of the 2010-13 drought on the rationale of behind spatial mobility in the study area.

Chapter 7. Perceptions and experiences of climatic events, and environmental and socioeconomic issues in rural Irauçuba

7.1 Introduction

Bilsborrow (1992) suggests that a range of environmental factors may influence the spatial mobility of members of a household, and that they are likely to do so in three discrete ways: a) by affecting income; b) by increasing risk or c) by making the environment where people live less pleasant or, in some cases, life threatening. Chapter 6 examined the distribution of capital assets and livelihood strategies of households in the context of the 2010-2013 drought. These aspects are related to Bilsborrow's key elements (a) and (b) respectively. Chapter 7 focuses on element (c) - the effect of environmental stresses, in addition to a number of other socioeconomic pressures on the everyday life of the inhabitants of the three study sites.

In regions where the distribution of annual rainfall is highly variable and cyclical droughts are common, the impact of climate on the livelihoods of rural inhabitants is often taken for granted. However, everyday life is not only impacted by environmental factors but also by a range of socioeconomic, cultural and political conditions. This chapter first seeks to identify respondent perceptions of issues affecting household livelihoods in the three research locations, in order to provide insight into the embeddedness of the 2010-2013 drought in a broader socioeconomic and environmental context. It has to be acknowledged that people's actions reflect people's perceptions, so that perceptions of the environment which surrounds them might be as important as the reality itself for their livelihood decision-making. This approach, combined with the analysis of capital assets and livelihood strategies, further establishes the context – the occurrence of a severe climatic event, and the socioeconomic factors acting at the household level of analysis – which shape mobility decisions.

The chapter is organised as follows: Section 7.2 examines the perception of local issues in rural Irauçuba. Section 7.3 investigates perceptions of environmental and socioeconomic issues by household type. Section 7.4 examines the local climate in the three study sites. Section 7.5 explores perceptions of long term changes in the local climate by household type. Section 7.6 then examines household perceptions of recent changes in the local climate to determine if there are different views of the phenomena. Section 7.7 investigates the perceived impact of climate on livelihood in the research locations. Section 7.8 summarises the main conclusions of the chapter.

7.2 Perceptions of issues concerning the local community

In regions of the world impacted by cyclical climatic events, the view that environmental factors play a major role in livelihoods in general, and in spatial mobility in particular, is widely inferred. However, a strong case has been made as to the importance of identifying how environmental issues sit among the broad range of socioeconomic and other forces affecting household livelihoods and individual wellbeing, and the way these are perceived by local inhabitants and impact on communities (Henry, Boyle and Lambin 2003; Kitula 2006).

Local perception refers to people's attitudes and understandings that reflect their customary way of life (Quinn, Hubby, Kiwasilla and Lovett 2003). In order to examine the major concerns and risks to livelihoods faced by sample households in the study area, the field questionnaire employed a Likert-scale measure on which respondents were asked to rank the issues impacting their locality. Figure 7.1 displays the average score on each category across all 90 respondents. Results range from 0 (no concern) to 5 (very high level of concern).

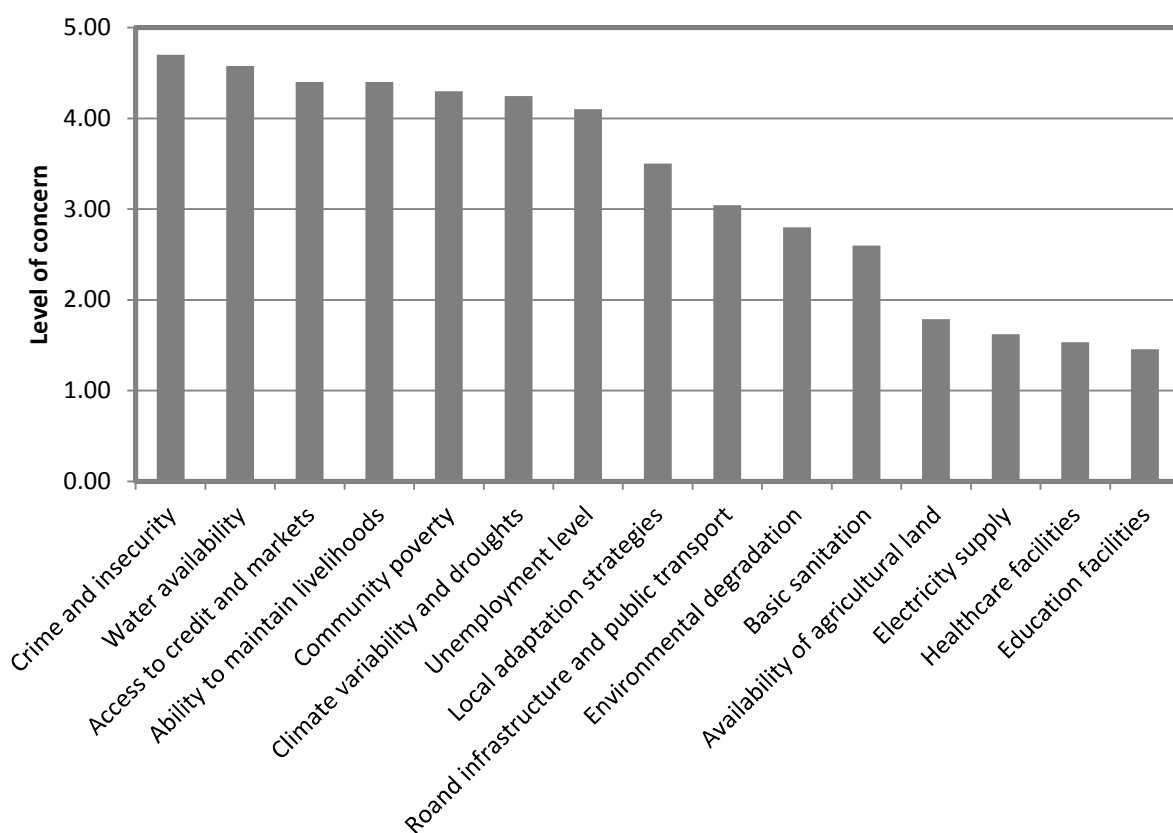


Figure 7.1 Level of concern of issues impacting rural Irauçuba (n=90). Source: Compiled from field interviews, 2014

Figure 7.1 reveals that the issue of most concern to respondents is crime and insecurity. This is associated with the uneven distribution of income, poverty and unemployment across Brazil and in the rural semi-arid Northeast in particular (Saschida, Caetano and Albuquerque 2010). The majority of respondents were well aware of the problem and its consequences. The immediate effect on everyday life is the increased stress among residents of remote areas of the municipality. As reported by one respondent:

“That [insecurity] is something new in Irauçuba. Crime has existed forever, but it was most in the city centre. Now many young people are getting involved with drugs, which are brought here by people from Fortaleza, and because they do not have the money to buy it they steal from those who have very little in the rural areas of the municipality. They steal livestock or farm utensils, and even rob people in broad daylight” (Respondent from Jua, 2014)

An increase in criminal acts in the study area is more likely to occur in periods of hardship. Previous work investigating the relationship between drought and crime in semi-arid Northeast Brazil established a positive correlation between the two phenomena (Buchmann 1998; Nunes, 2009). Buchmann (1998), examining the impact of the 1991-1993 drought on social indicators, found that an increase in the crime rate in the affected states occurred during the phenomenon. Nunes (2009), in his study of archival records describing the humanitarian efforts during the 1887 drought argued that, beside the famine, malnourishment and spread of diseases, crime had also increased considerably over the years 1877, 1878 and 1879 due to the scarcity of resources available in the impacted communities.

Another issue which ranked higher than most other problems across all three research sites was availability of water. Several studies have examined how these cumulative hydrological deficits related to drought events impact smallholder and subsistence farming activities in semi-arid parts of Brazil (Jones and Thornton 2003; Lobell et al. 2008; Simoes et al. 2010). The findings of these studies indicate diminishing yields for traditional subsistence crops including beans and cassava. This is significant as per hectare productivity is already marginal in Northeast Brazil (Simoes et al. 2010). The impact of water shortages in the study area was widely acknowledged among sample households. As established in chapter 6, the majority of households depend to a large extent on subsistence agriculture. Approximately 60% of respondents who indicated that water availability was a major concern to their livelihoods also reported that life has become more difficult because successive crop failures have forced them to purchase food. While climate variability and droughts are the main

factors causing water shortage in the study area, this ranked as the sixth most concerning issue for sample households. This corroborates previous findings suggesting that climate and other environmental problems need to be considered as part of the whole range of difficulties confronting people in marginal rural communities, not just considered as isolated issues (Henry, Boyle and Lambin 2003).

Perceived issues related to access to credit and markets, the ability to maintain livelihoods, community poverty and employment level were also reported in the three districts of rural Iruçuba, and ranked consistently high among respondents. Concern over these issues has also been identified in rural communities in the African Sahel. The households interviewed in a study in Senegal attributed negative impacts on a range of livelihood-related activities to climate factors (Mertz et al. 2009). The findings in that study suggest that drought and erratic spatiotemporal distribution of rain were directly related to perceived reduction of employment opportunities in the agricultural sector, declining yields and loss of livestock. These findings support the view that climate variability might have a pervasive impact on various aspects of the everyday life in marginal rural communities, but that the effects are transmitted to other aspects of life and it is those factors that are perceived as the major issues in the lives of households and individuals.

Figure 7.1 shows a clear split between the first seven issues, the next four and the final four issues reported by respondents. One possible explanation for this division relates to the fact that, of the first seven issues, six are derivative of environmental stress brought about by the 2010-2013 drought (access to credit and markets depend on political and macroeconomic factors). The majority of the remaining issues are indicative of structural socioeconomic aspects which might not be directly impacted by climatic events. To examine these relationships, a contingency table was constructed comparing two groups of respondents according to whether they perceived climatic conditions had deteriorated over the 2010-2013 period. The analysis was based on their response to the question “Could you list three aspects of your community and of your livelihood that have generally worsened.” Respondents were classified according to perceived deteriorating climatic conditions in their response. The results are presented in Figure 7.2

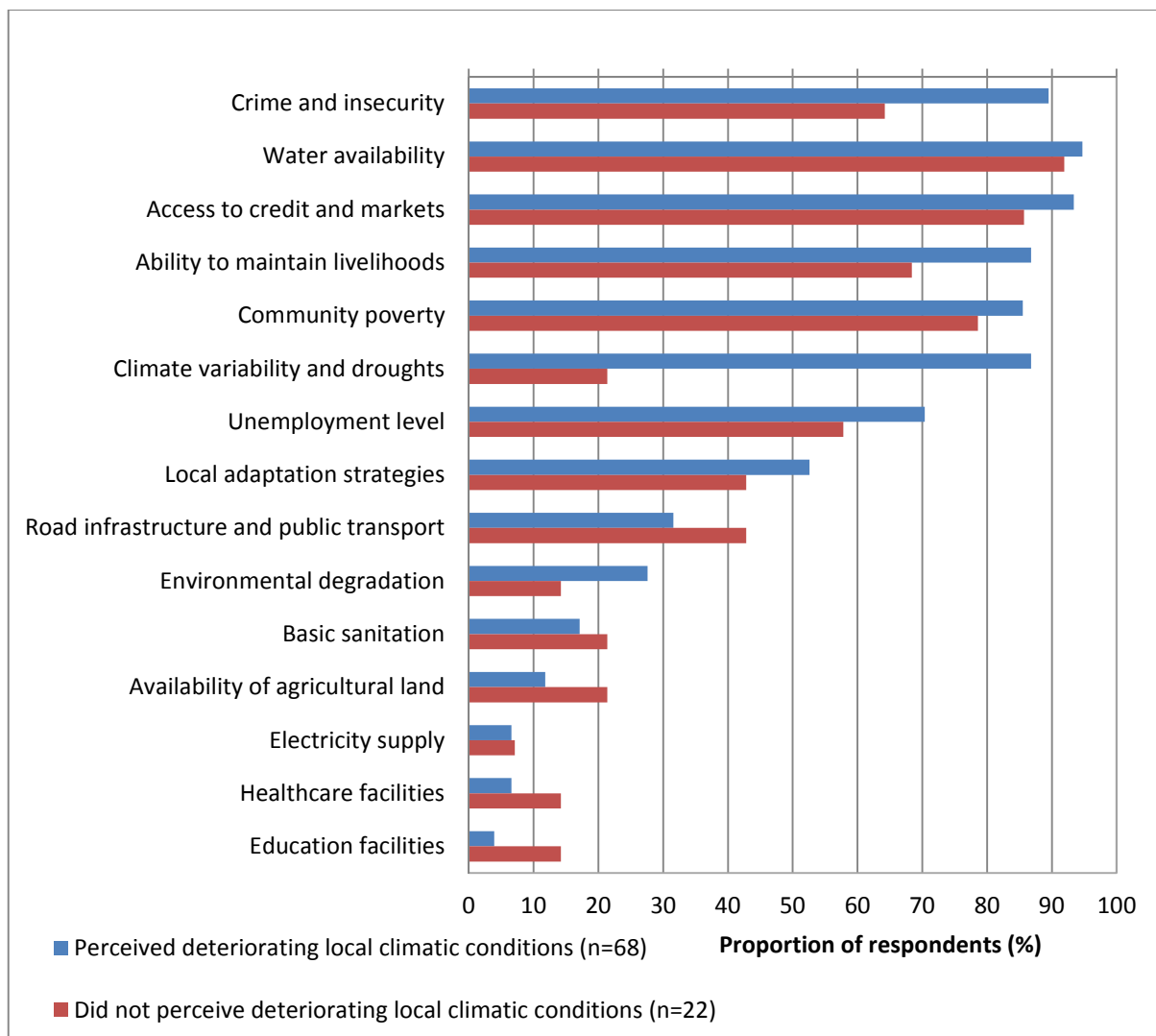


Figure 7.2 Rating of local issues according to perception of deteriorating climatic conditions. Source: Field survey (2014)

The findings in Figure 7.2 do seem to support the view that respondents who perceived that climatic conditions were deteriorating also recorded higher levels of concern regarding the first seven issues presented in figure 7.1. As previously identified, issues such as crime and insecurity, water availability, ability to maintain livelihoods, community poverty, climate variability and droughts, and unemployment, appear to have a strong association with climatic events in the study area. Therefore, it can be argued that the perceptions might have been influenced by the impacts of the recent drought. A series of chi-square tests were completed to examine these relationships among households which did or did not report deterioration in the climate in 2010-2013, and households which did or did not report concern over each issue identified in Figure 7.2. Significant differences ($p < .005$) were found between perceived deterioration of climatic conditions and perceived increase in crime and insecurity $X^2(1, N=90) = 8.946, p = .003$, in reduced capacity to maintain livelihood X^2

(1, N=90) = 8.014, $p = .004$, in increased community poverty $X^2(1, N=90) = 8.975, p = .003$ and unemployment $X^2(1, N=90) = 8.079, p = .003$. Highly significant differences were found ($p < .001$) between households that reported deteriorating climatic conditions and worsened availability of water $X^2(1, N=90) = 8.946, p = .001$. The results of these tests lend support to the notion that negative perception of socioeconomic issues in the 2010-2013 were affected by the perception of worsened climate in the study area in the same period. Among the small number of respondents who did not perceive any significant deterioration in the local climate, frontline services such as healthcare and education facilities, basic sanitation, road infrastructure and transport were of greater concern. A possible explanation is that, for this group of respondents, cyclical drought and recurring climate variability is an intrinsic part of their life (Silva 2006). Hence, other socioeconomic factors impacting their local community were more relevant.

This added complexity in the association between climatic events and other local concerns reflects heterogeneity in perceptions in the study area. The impact of climatic events is felt with more or less intensity according to the socioeconomic and environmental characteristics of the three sites. A breakdown of Figure 7.1 by study site shows the differences in perception of key issues. Although poverty is ranked high for all three communities, the level of concern is higher in Caxitore (Figure 7.3). The household typology presented in Chapter 6 showed that this district has a greater concentration of low income households than Jua or Missi, and greater reliance on federal welfare programs. Caxitore also recorded a higher score for concern about road infrastructure and public transport as a result of the distance, and the poorer condition of the road connecting the district to the urban centre of the municipality.

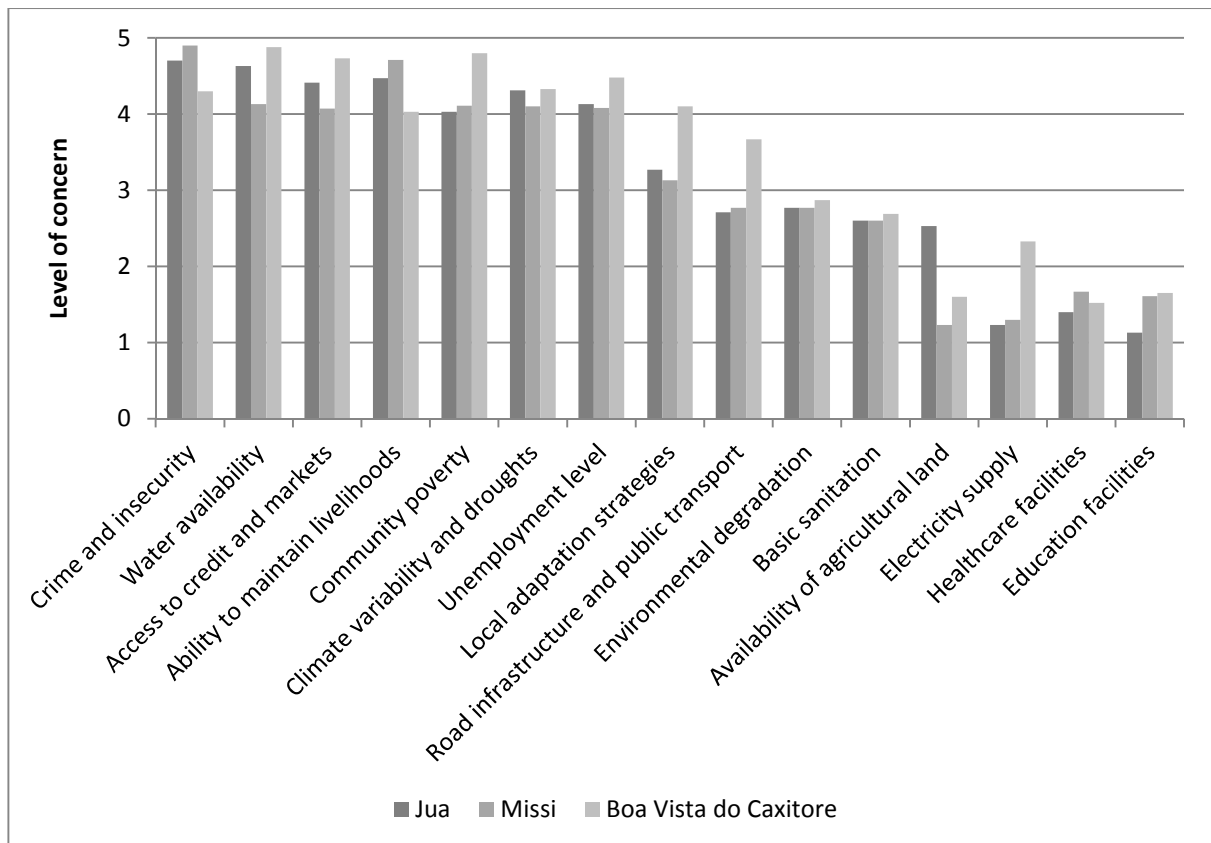


Figure 7.3 Level of concern of issues impacting Jua (n=30), Missi (n=30) and Caxitore (n=30) Source: Compiled from field interviews, 2014

Figure 7.3 shows that for the district of Missi, a high level of concern regarding both the capacity to maintain livelihoods and unemployment was recorded, reflecting the greater percentage of non-farming and commercial livestock oriented households, activities that can be impacted by the pervasive effects of droughts in the region (Gutierrez et al. 2014). With less access to water sources, livestock farmers rely on seasonal movement of cattle to overcome rainfall uncertainty. Nevertheless, at times, they may not be able to find grazing areas and are forced to divert the income from non-farm work to feed the cattle, or sell the animals. In contrast, the inhabitants of Missi displayed lower levels of concern compared to the other two districts, due to a more diverse livelihood portfolio. Concern as to the reduction in water availability ranked higher in both Caxitore and Jua, reflecting the lower mean annual rainfall in these two districts compared with Missi. In addition, “açudes” (small dams) located in Jua and Caxitore dried out during the 2010-2013 drought, whereas “cacimbas” (water wells) and one “açude” in Missi were still providing water. Compared to respondents in the other two districts, household heads in Jua reported a high level of concern regarding availability of agricultural land because several residents were yet to receive their land title, despite having settled on their current land as a result of the Brazilian agrarian reform instituted in 1988.

Table 7.1 describes the effects of socioeconomic and environmental issues identified in Figure 7.1 on the everyday life of sample households as reported by household heads. For example, respondents described the lack of drinkable water as a major concern, since its availability is strongly dependent on rain to fill cisterns, local dams and water holes. The result was increased household expenditure to secure access to drinkable water. Regarding the impact of the 2010-2013 drought on subsistence agriculture and livestock, the consequences included loss of crops and animals, as well as increased demand on farm labour because of the need to move remaining livestock to whatever water source was still available.

Access to credit and markets ranked high for all respondents. In spite of farmers' knowledge about credit, few have managed to obtain a personal loan that could improve household capacity to cope with the recurring climatic events in the study area. According to respondents, this was attributed to the inflexible demands in place in the credit sector. Limited credit reduces the possibility of generating additional income through the acquisition of livestock. Several respondents indicated their intention to raise commercial livestock, but the lack of financial capital has prevented many people from joining the activity, while forcing others to sell their animals and abandon the enterprise.

Table 7.1: Summary of perceived environmental and socioeconomic problems and their effects

| Environmental/socioeconomic concern | Effect on everyday life |
|--|--|
| Crime and insecurity | Loss of assets, stress and apprehension, breaking of social cohesion |
| Availability of water | Lack of drinkable water, increases household expenditure due to impossibility of growing subsistence crops or keeping livestock |
| Access to credit and markets | Lack of access to credit and markets might lead to abandonment of agriculture activities and increase reliance of welfare benefits and support from family and friends |
| Capacity to maintain livelihoods | Increase reliance of welfare benefits and support from family and friends |
| Poverty | Increase reliance of welfare benefits and support from family and friends, no upward social mobility, increased criminality |
| Climate uncertainty and droughts | Lack of water in local dams and water holes, discomfort due to extreme heat, loss of crops and livestock |
| Unemployment | Decreases household income, increased criminality |
| Lack of local adaptation strategies | Stress and apprehension due to reduced resilience to external stressors |
| Road infrastructure and public transport | Distance to non-farm work opportunities and access to markets |
| Environmental degradation | Loss of vegetation cover and soil quality |
| Basic sanitation | Threat to overall health condition and quality of life, rotten crops and animal disease |
| Availability of agricultural land | Stress and apprehension |
| Electricity supply | Lack of entertainment, loss of perishables |
| Healthcare facilities | Threat to health condition and quality of life, loss of labour power |
| Education facilities | Children's future is jeopardised, decreased chance of upward social mobility |

Source: Compiled from field interviews, 2014

7.3 Household perceptions of issues concerning rural Irauçuba

A breakdown of respondent concerns by household type shows some differentiation in perception of issues confronting local residents. To display the level of concern by household type, an incidence index was computed by calculating the proportion of respondents who identified a particular issue (Smith, Barrett and Box 2000). The incidence index ranges from 0 (least mentioned) to 1 (most frequently mentioned). Figure 7.4 reveals that crop failure and livestock loss due to water shortages are more serious concerns for mixed livelihood households, the second largest group of households types (predominantly located in Missi), and also for commercial livestock-oriented households, the smallest group (predominantly located in Missi and Jua), than for other household types. Access to credit and markets also recorded higher incidence indexes for these household types. The largest group of households in the typology introduced in Chapter 6, welfare-dependent households (predominantly located in Caxitore), ranked the capacity to maintain livelihoods higher than the other three groups, as availability of food through subsistence agriculture is fundamental for their survival. Non-farming households expressed a strong concern with unemployment and only limited concern with availability of agricultural land, as their main income derives from waged non-farm work.

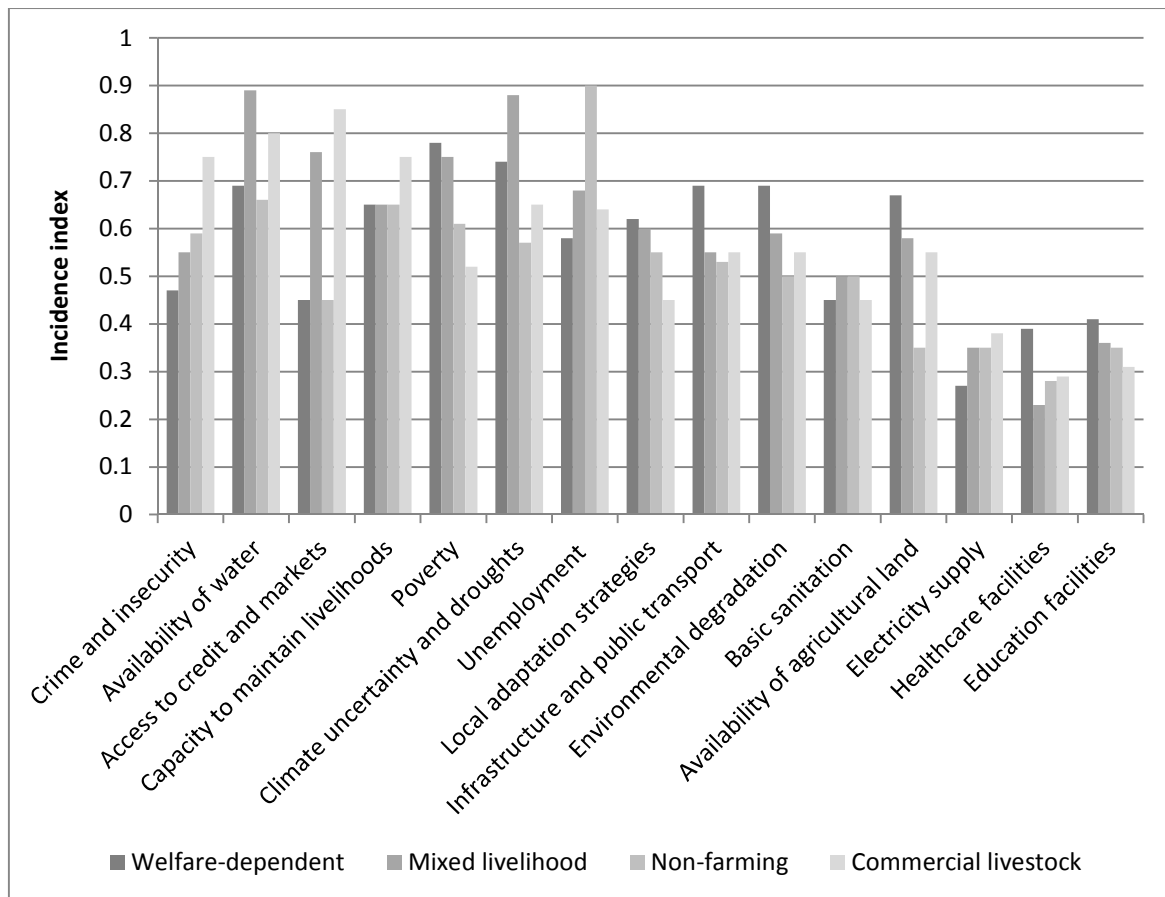


Figure 7.4 Perception of issues by household type. The index ranges from 0 (no incidence) to 1 (most frequently mentioned) Source: Compiled from field interviews, 2014

Further analysis of Figure 7.4 shows that crime and insecurity was a major concern for the non-farming households (predominantly located in Missi and Jua) and commercial livestock-oriented households. These two household types generate higher income than welfare-dependent or mixed livelihood households, and are therefore considered moderately affluent by their peers. People in semi-arid northeast Brazil do not lose livestock only to droughts, but also through theft and robbery. Households which generate income through non-farm work reported that they are more exposed to criminal action due to a steady monthly flow of cash in the form of wages. Non-farming households also ranked unemployment higher than all other groups.

Availability of agricultural land is particularly important for the three household types which have their livelihoods linked to agricultural activities. Several households in the three study sites are beneficiaries of Brazil's land reform act, which has been in force since 1969 (Deininger 1999). However, some of these beneficiaries are still waiting for their permanent land title, along with the financial support to purchase agricultural inputs that will enable them to continue to work on the land without fear of losing the investment made so far. Access to

electricity, healthcare and education facilities were among the least mentioned issues by all household types, indicating that these essential services are being adequately provided. These findings are consistent with Chapter 6 which reported that 83% of sample households are served by the electricity network. Data provided by the Secretary of Health of Irauçuba indicate that in 2013, the proportion of doctors per 1.000 habitants was 0.66, which is lower than the 1.19 recorded in the State of Ceará, but higher than in neighbouring municipalities such as Miraíma (0.55) or Canindé (0.61). However, it is important to note that welfare-dependent households ranked access to schools higher than the other two groups. This is not unusual when considering that their livelihoods, and any potential social upward mobility, can be highly dependent on formal education and acquisition of new skills.

These findings demonstrate that there are differences in perception of local issues by households according to their livelihood strategy. For example, water availability was consistently ranked as the highest concern by all groups, but non-farming households ranked water shortages somewhat lower than the other three groups. One explanation may be that non-farming household livelihood strategies are not directly linked to water-demanding agricultural activities. Respondents from this household type also had the financial capacity to purchase water during the 2010-2013 drought. Conversely, climate variability and drought problems appear as high risks for welfare-dependent and for mixed livelihood household type, the second largest group of households, as both types depend on rain-fed agriculture for subsistence farming. The ranking of crime and insecurity was directly proportional to the overall wealth of household types. Access to assets and greater annual income, as identified in Chapter 6, explain this relationship. Commercial livestock-oriented households and non-farming households were found to be the wealthier household types in the study area. Not surprisingly, respondents from these two groups reported high levels of concern with regard to crime and insecurity.

The discussion above presents evidence of different perceptions among the four household types with regard to environmental and other socioeconomic issues. However, it is important to ascertain if these differences are statistically significant. To do this, a one-way ANOVA (Analysis of Variance) was completed to determine whether significance differences existed among the means of the reported levels of concern of each issue reported by households in the study area. This approach involves the comparison of the means of the scores attributed to the different household concerns reported above (Table 7.2).

Table 7.2: One-way ANOVA test between all four household types

| Reported Issue | Between household types | | | |
|-------------------------------------|-------------------------|----------|---------------|----------------|
| | <i>df</i> | <i>F</i> | <i>F crit</i> | <i>P-value</i> |
| Crime and insecurity | 3 | 1.674 | 2.710 | .178 |
| Water availability | 3 | 15.650 | 2.699 | .002* |
| Access to credit and markets | 3 | 1.207 | 2.710 | .311 |
| Ability to maintain livelihoods | 3 | 13.046 | 2.711 | .004* |
| Poverty | 3 | 14.240 | 2.715 | .001** |
| Climate uncertainty and droughts | 3 | 14.373 | 2.709 | .001** |
| Unemployment level | 3 | 4.131 | 2.710 | .005* |
| Local adaptation strategies | 3 | 1.105 | 2.713 | .351 |
| Infrastructure and public transport | 3 | 0.129 | 2.711 | .942 |
| Environmental degradation | 3 | 2.709 | 2.711 | .053 |
| Basic sanitation | 3 | 4.822 | 2.715 | .003* |
| Availability of agricultural land | 3 | 0.571 | 2.710 | .635 |
| Electricity supply | 3 | 0.477 | 2.709 | .698 |
| Healthcare facilities | 3 | 0.598 | 2.710 | .617 |
| Education facilities | 3 | 1.926 | 2.710 | .131 |

Source: Field survey (2014). The * p is significant at $<.005$, ** p is significant at $<.001$

Table 7.2 shows that there was statistically significant variance between the four household types with regard to mean scores across six issues. For example, the variance computed for water availability ($p <.005$) suggests an association with the main livelihood and financial capacity to purchase water during the drought. Non-farming households reported the least level of concern with regard to water shortage because, in contrast to commercial livestock-oriented households, their main source of income does not depend on the continuous supply of water. In addition, this group has the financial capacity to purchase water for household consumption. Conversely, the significant variance in the level of concern with unemployment ($p <.005$) indicates that, for household types such as the non-farming group, which reported the highest level of concern in this category, this is a significant issue which directly impacts on their livelihood. Commercial livestock-oriented households, which primarily rely on income obtained from agricultural production, reported a lower level of concern. Highly significant results were obtained in two categories: poverty ($p <.001$) and climate variability and drought ($p <.001$). One possible explanation is related to the level of access of capital issues and main source of income. Chapter 6 established that Welfare-dependent and

Mixed-livelihood groups are the most vulnerable households in the study area. Not surprisingly, these two groups reported the highest level of concern with regard to poverty among all four household types. This finding shows that the level of concern accurately matches the limited access to assets and reduced income captured in the field survey. The significant variance in the level of concern regarding climate uncertainty and droughts also indicate the importance of capital assets and a regular source of income in mediating the impacts of the 2010-2013 drought. The more asset-endowed households (non-farming and commercial-livestock-oriented) are better equipped to respond to the impacts of climatic events, which was reflected in the much lower means regarding this issue compared to the other two groups.

The empirical evidence provides some scope for analysing the ways in which climatic events and other environmental issues link to other factors that affect livelihoods. In practice, the key aspects of this relationship may be best represented graphically instead of summary statistics. One of the key features of the conceptual model introduced in Chapter 4 is the assumption that climatic events such as the 2010-2013 drought permeate the entire spectrum of factors affecting household livelihood outcomes in the study area. One way in which this is evidenced is through the household perception of issues which is one of the endogenous elements which determine livelihood outcomes. The recent drought impacted not only the capital assets and the livelihoods of households in the study area, but also a range of other direct and indirect factors within which households are embedded, such as unemployment and water shortages. As a result, households which perceived deterioration in local climate conditions may also have perceived worsening conditions in aspects directly associated with their livelihood. Figure 7.5 illustrates this relationship.

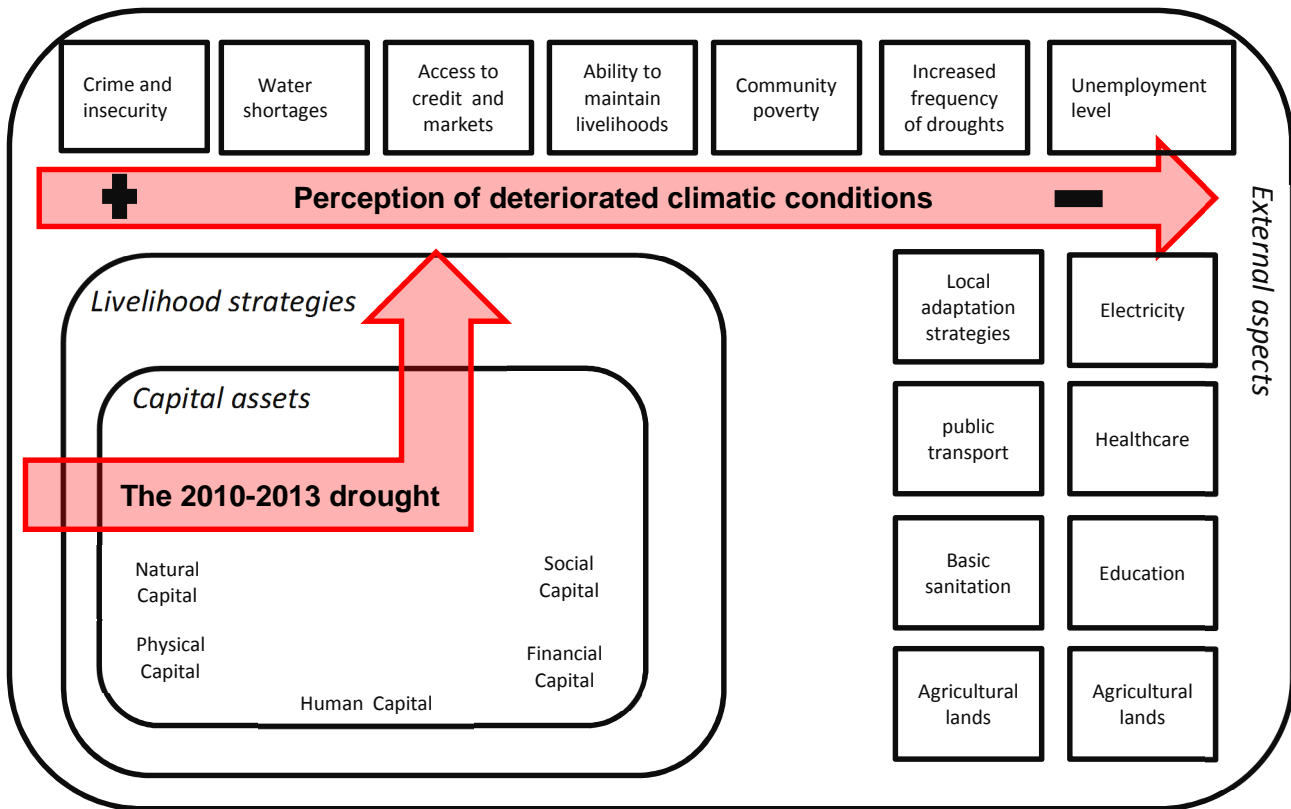


Figure 7.5 The impact of the 2010-2013 drought and household perceptions

The diagram shows the impact of the 2010-2013 drought on household capital assets and livelihood strategies. The arrow representing the drought permeates all three panels, and the arrow tracing the perception of climatic conditions indicates the strength of the relationship with key aspects of household livelihoods. The empirical evidence suggests that households which perceived worsened climatic conditions also reported high levels of concern with regard to the issues located at the top of the diagram. The position of these issues reflects the direct link to the recent drought, whereas the issues displayed on the right-hand side of the diagram are not directly affected by it.

The empirical evidence lends support to the conceptual model introduced in Chapter 4. Climatic events are the underlying cause behind deteriorating broader socioeconomic circumstances of rural Irauçuba. Problems such as crime and community poverty might have recorded a lower level of concern in the absence of the 2010-2013 drought. In fact, the literature suggests that an increase in these problems is closely associated with climate variability in the region. Results of the statistical tests corroborate the notion set out in the conceptual model, demonstrating significant variance between the four household types with regard to six of the key issues reported by households. This directly reflects the

distinctive livelihood strategies and access to capital assets of the residents of the three districts

7.4 Local climate in rural Irauçuba

As established in Chapter 5, climatic events in rural Northeast Brazil are mainly related to rainfall spatiotemporal variability and droughts (Hanstenrath and Heller 1977; Liu and Juárez 2001). Cyclical droughts most severely affect the central-west parts of the region in which semi-arid conditions are prevalent. In the state of Ceará specifically, rainfall variability is towards the highest among developing countries, having a concentrated rainy season that starts in January and finishes in May, accounting for about 70 percent of the annual precipitation (Moura and Shukla 1981).

The most recent drought started with a very dry year in 2010, followed by a relatively normal year of rainfall distribution in 2011, which allowed a positive year of agricultural production. This was followed by another very dry year in 2012 through to the beginning months of 2013. Even though rainfall was higher than average between May and July 2013, which helped alleviate some of the impacts on the livestock and agricultural sector, the first half of the year recorded rainfall significantly below the annual average. The hydrological systems were severely depleted, with many local reservoirs below 10 percent capacity (Gutierrez et al. 2014). The drought has been attributed to a slight increase in the sea surface temperature, between 0.5 °C and 1.5 °C in the Central and East E quatorial Pacific Ocean, which indicates an El Niño Southern Oscillation (ENSO) phenomenon (Gutiérrez et al. 2014)

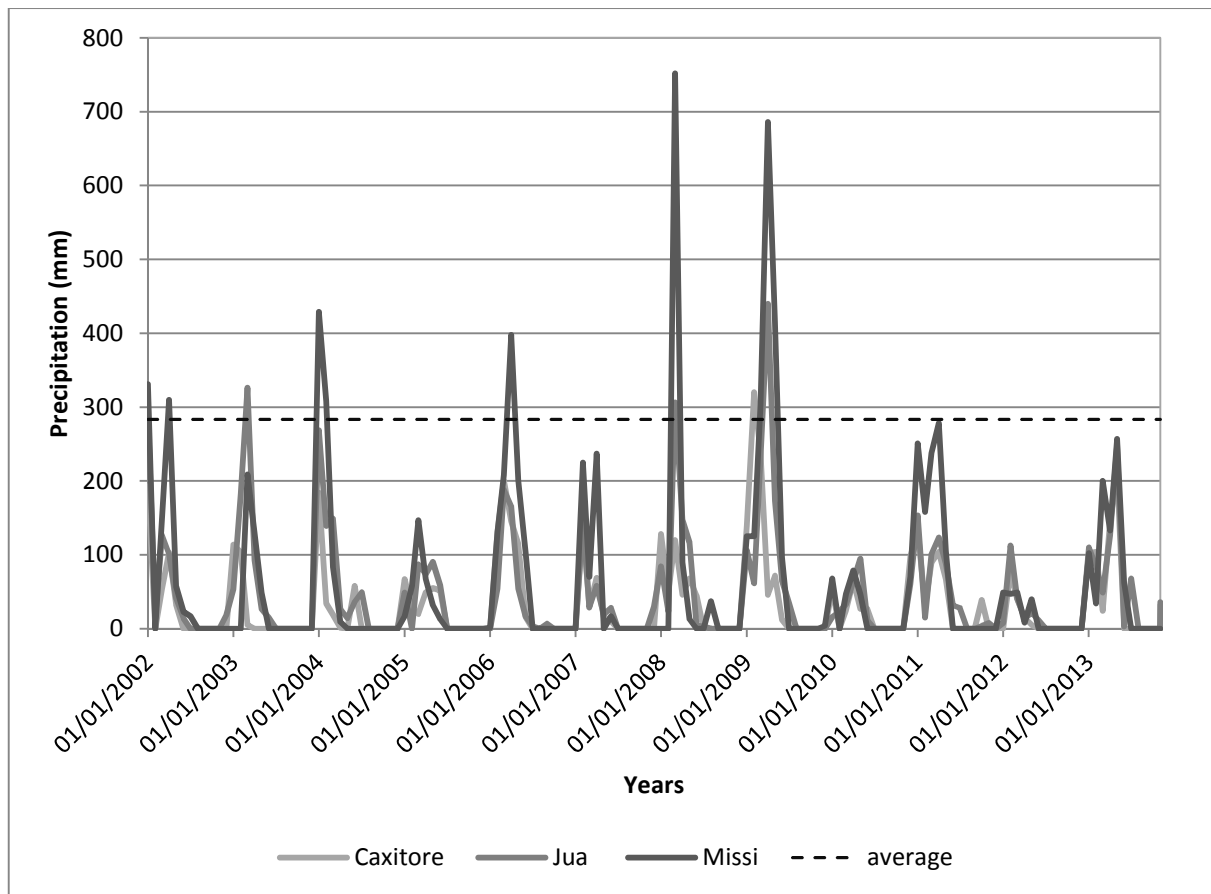


Figure 7.6 Mean monthly precipitation 2002-2013 in the three research sites (STDV = 85.79)

The natural fluctuations of climate between 2002 and 2013, for three rural districts of Irauçuba, can be observed in Figure 7.5. Frequent droughts, longer dry spells, delayed rainy season onsets, and greater spatiotemporal variation in rainfall have become frequent in the lives of inhabitants of these districts. The impact of these climatic events is particularly felt in the district of Caxitore, which is subject to lower total rainfall in comparison to the other two research sites, with an average of 237mm annual precipitation in the period from 2002 to 2013, compared with 311mm in Jua and 392mm in Missi.

7.5 Household perceptions of change in the local climate

The local communities in the study area have a clear memory of the extreme climatic conditions which led to disturbances of their livelihoods and production of smallholder farms. Of the 90 household heads interviewed, one third had been living in the study area for 30 years. Over this period of time, seven droughts have occurred in semi-arid Northeast Brazil, accompanied by other events associated with climatic variability (Marengo 2008). In order to capture the perception of changes in the climate parameters over this long period of time,

the household questionnaire included the following question: “Have you noticed any changes in the local climate since you have been living here? If yes, what are they?” Analysis revealed that 90 percent of respondents had noted changes in the local climate. The majority identified an increase in the length of the dry season. The second and third most frequent responses indicated that rainy seasons had become shorter, and that droughts had become more frequent. Figure 7.7 shows the types of change in the local climate and the proportion of each household type which identified them. The incidence index ranges from 0 (least mentioned) to 1 (most frequently mentioned).

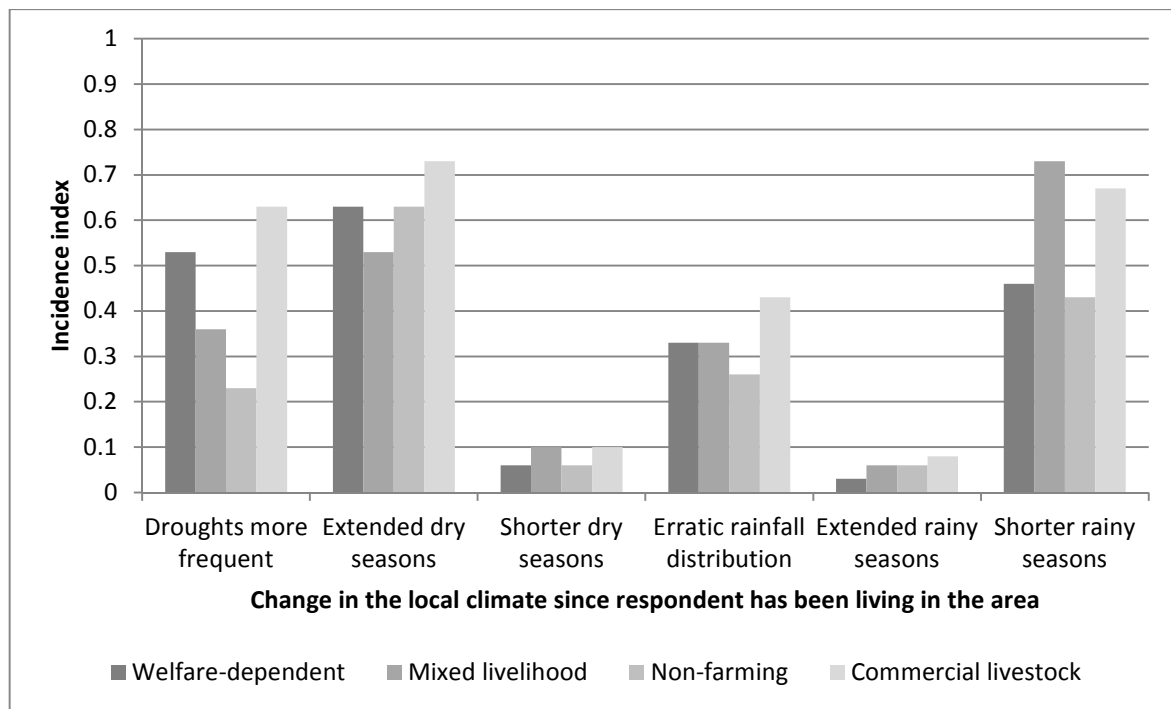


Figure 7.7 Perception of change in the local climate since establishing residence in the study area (multiple responses accepted). Source: Compiled from field interviews, 2014 (n=90)

The measures displayed in Figure 7.7 capture the strength of the perceived impact by household type. According to respondents, the duration of annual rainy seasons, with some degree of variation between household types, has decreased across the three study sites. However, the climate data shown in Figure 7.6 indicate that the annual distribution of rainfall does not support this conclusion. In fact, it can be observed that over the 2002-2013 periods, the seasonality of rainfall remained unaltered despite lower precipitation totals. These perceptions could to some extent be explained by the fact that people refer to the high annual rainfall recorded between 2008-2009, before the onset of the most recent drought, and take this level as the ‘normal’ situation in the area. The incidence index for mixed

livelihood and for commercial livestock-oriented households was particularly high compared to that of the other two household types. As established in Chapter 6, mixed livelihood households partly rely on rain-fed subsistence agriculture for their sustenance while commercial livestock-oriented households have their main source of income tied to the wellbeing of their animals. The large proportion of respondents of these two household types indicating concern about lower rainfall, corresponds to the increased drying out of local dams and water holes for cattle, even during rainy seasons.

With regard to the frequency of droughts, the findings reveal substantial differences in perception across the four household types. Commercial livestock-oriented households perceived an increase in droughts over a long period of time compared with the other household types. Changes in the length of dry seasons also recorded a very high incidence index across all four household types. Respondents reported that the interval between rainy seasons had increased, often by unexpected long dry spells, which made it difficult for farmers to plan ahead. In various cases, this caused the abandonment of some agricultural activities, as reported by one interviewee:

“Now that the few animals I had are all gone, I will go look for work somewhere. Maybe rain will come back soon, but I will not be able to try raising livestock again until I have made enough money [...] by then it might be all dry again.” (Respondent in the district of Missi, 2014)

7.6 Households perceptions of change in the local climate over the 2010-2013 period

Having established the perception of changes in the local climate over a long period of time, it was important to examine residents' perceptions of more recent changes, specifically over the 2010-2013 period. The climate data in figure 7.3 showed that precipitation in this interval was the lowest recorded over the period 2002-2013. In addition, extended dry seasons linked with untimely and erratic rainfall patterns over the same period were reported by key informants prior to the field activity. The questionnaire asked ‘Looking back specifically at the past three years (2010-2013), have you perceived any changes in the local climate?’ The results suggest that residents were aware of the recent drying in climatic conditions in the study area. The increased frequency of droughts was most cited by all four household types. Figure 7.8 shows perceptions of change in the local climate over the period 2010-2013.

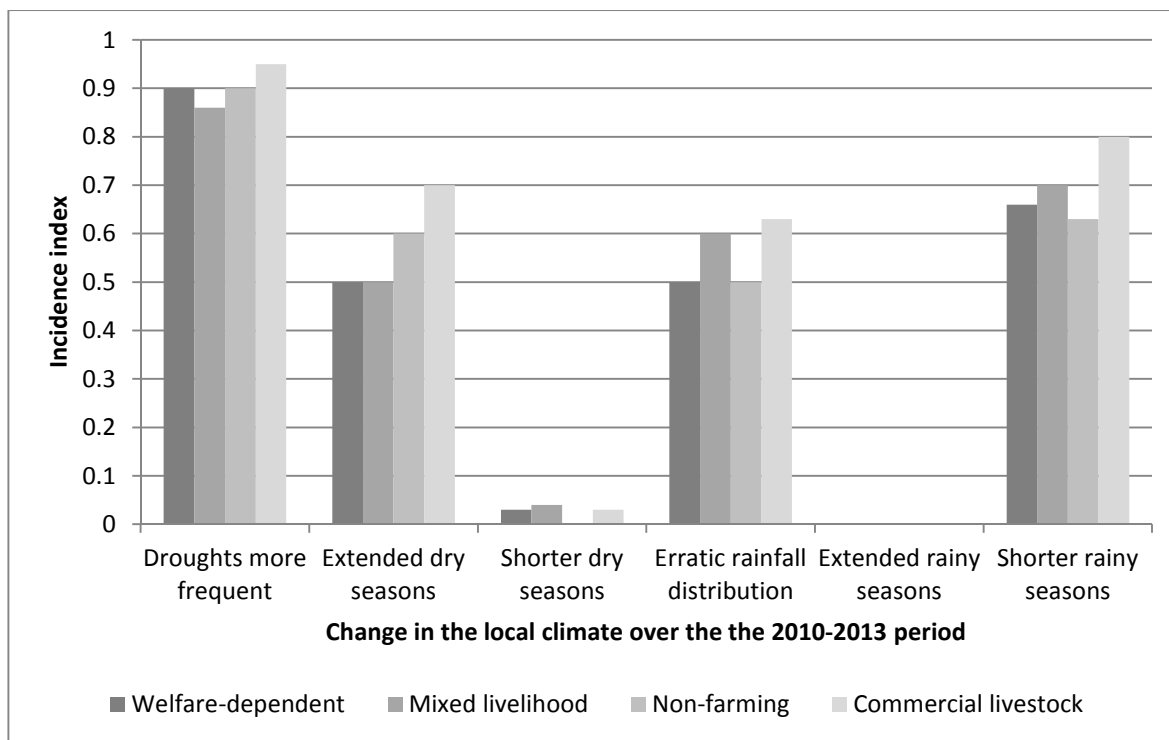


Figure 7.8 Perception of change in the local climate in the last three years (multiple responses accepted). The index ranges from 0 (no incidence) to 1 (most frequently mentioned). Source: Compiled from field interviews, 2014 (n=90)

Figure 7.8 reveals that rainfall has been perceived to be interrupted by longer than usual dry seasons in the region. This supports the findings of recent studies indicating an increase in both the hydrological deficit, and in the occurrence of droughts in semi-arid Northeast Brazil (Seneviratne et al. 2012). Participants also believed that precipitation ended earlier than had been normal in two of the past three seasons. These results were likely to be influenced by the degree to which household livelihoods were affected by 2010-13 drought, particularly the extent of damage to subsistence crops and livestock. This was more evident for the three household types for which agriculture forms a significant part of the livelihood. Not surprisingly, no respondent indicated that the length of rainy seasons had increased in the 2010-2013 period. Figure 7.9 show the impacts of the 2010-2013 on the landscape in the district of Missi.



Figure 7.9 Impact of the drought on the landscape of Missi

The findings suggest that respondent views of changes in the local climate over the long term and the recent past are congruent. The data indicate residents in the study area perceived an overall drying climate, with shorter rainy seasons and an increase in the drought events. Although the climate data suggests that the cyclical pattern of precipitation in the study area has not changed, it should be noted that respondents have reported an increase in the unpredictability of rainfalls over the most recent period. This evidence tends to show that, overly influenced by recent climatic events, respondents were likely to exaggerate the levels of concern in their own minds. Nevertheless, these findings indicate that the residents of the three rural districts were well aware of changes in the local climate over both long and short terms.

7.7 Household perceptions of impacts of the 2010-2013 drought

Prior to application of the field questionnaire, key informants reported various forms of impact of the 2010-13 drought on the livelihoods of residents in the three research sites. For example, they thought that the low precipitation had led to shortages in food production due to a diminishing availability of water for crops and livestock. To investigate these relationships, household heads were asked 'How do climatic events affect your household?' The responses are presented in Figure 7.10 The form of impact varied according to household type, but almost all respondents identified water shortages as the main impact of

the 2010-13 drought because the majority of the traditional *açudes* (small dams), where water is stored, had dried out, leading to crop failure and livestock losses.

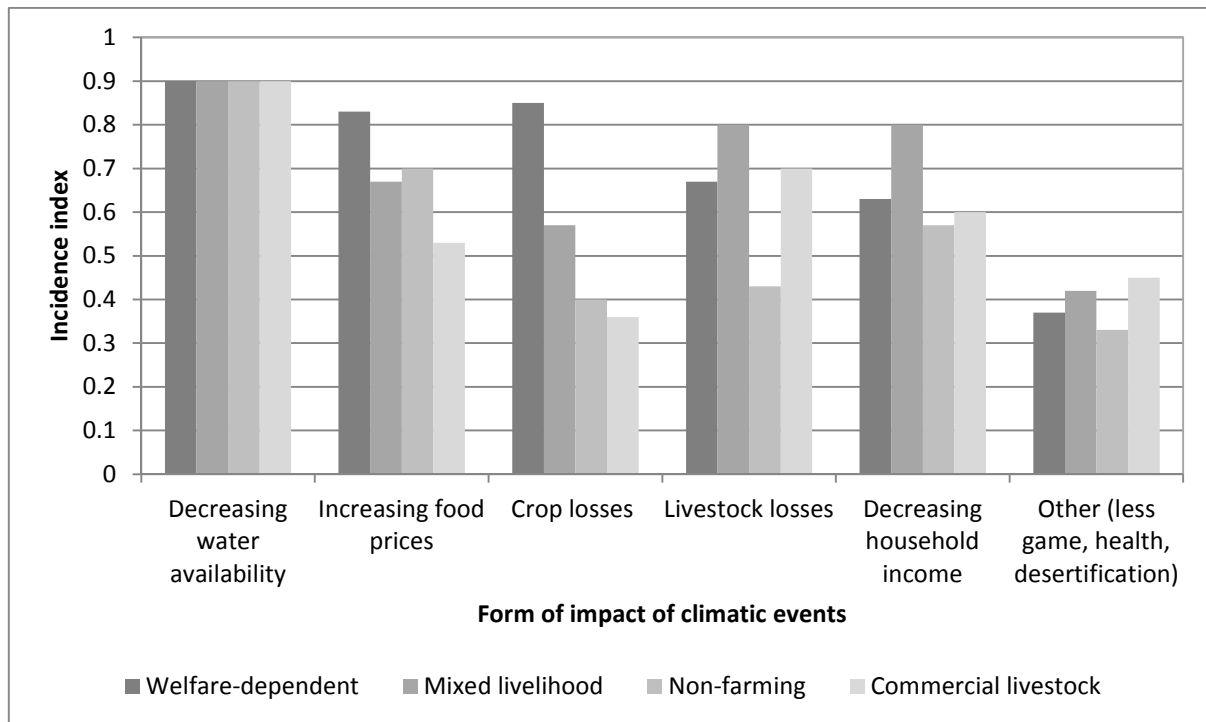


Figure 7.10 The form of impact of the 2010-13 drought on livelihood strategies (multiple responses accepted). The index ranges from 0 (no incidence) to 1 (most frequently mentioned) Source: Compiled from field interviews, 2014 (n=90)

The impacts of the 2010-2013 drought, as well as many previous climatic events in the region, are not only manifest in the breakdown of the fragile economy of rural Irauçuba. Field interviews revealed that it also exacerbated existing social problems such as criminality, lack of basic infrastructure, overall health conditions, disease and malnutrition as reported by these respondents:

“Life has gotten worse since the start of the drought. The animals are dying. [...] My cousin had two goats stolen from his farm. The crops we grow are yielding less food. [...] life has gotten worse.” (Respondent in the district of Missi, 2014)

“It is always hard when a drought hits Irauçuba. The local dams dry out and we cannot get water from larger dams in the region. There have been talks about the construction of water pipes to bring water from the Jerimum Dam, but nothing has happened yet” (Respondent in the district of Jua, 2014)

Agriculture and livestock activities, which depend on the availability of water, suffered the most during the 2010-2013 drought. Figure 7.6 shows that welfare-dependent households and mixed livelihood households, which are more dependent on subsistence crops, ranked crop losses higher than the other two groups. Mixed livelihood households ranked livestock losses higher than commercial livestock-oriented households. This can be attributed to the relative wealth difference between these two household types. While commercial-oriented livestock households can divert income from other sources to recover from animal losses, livestock provides income and is the main source of food for the financially less well-endowed mixed livelihood households. Across all four household types, respondents indicated that the lack of adequate rainfall severely affects the capacity to sustain farm animals, leading to livestock losses or abandonment of the activity. Conversely, crop and livestock losses trigger increasing food prices in the region, which impact the more vulnerable welfare-dependent households the most. Figure 7.11 show a deteriorated pasture in Missi on which animals feed.



Figure 7.11 Livestock seek refuge in the shade of a tree in the district of Missi

Since the livelihoods of the majority of inhabitants of rural semi-arid Northeast Brazil have historically been mediated by climatic events, (Gutiérrez et al. 2014; Kenny 2002), it is likely that the perceived decline in household income is linked to poor economic performance of the agricultural sector during the 2010-2013 drought. This is felt with more intensity by members of mixed livelihood households, which lost livestock or had fewer opportunities to engage in casual off-farm work, as reported by a respondent from the district of Jua.

“The conditions have changed a lot for us. I was able to do some off-farm work in Itapajé but the cattle station does not need many farm hands these days. I have tried to find work in the shoe factory but they are not hiring anyone” (Respondent in the district of Missi, 2014)

People’s perceptions of drier climatic conditions over the last decade in the local climate are not necessarily congruent with data retrieved from climate monitoring, which reveals a cyclical pattern oscillating between wetter and drier years. However, the answers captured in the study area for the period from 2010-2013 accurately reflect changes which are directly linked to livelihoods. Examples are the perceived decrease of rainy seasons and increased length of dry seasons reducing water availability for cattle by commercial livestock-oriented households, as well as the amplified frequency of droughts which affects subsistence agriculture for welfare-dependent households. Livestock losses are an acute problem for commercial livestock-oriented households, which have this activity as a main source of income; and for mixed livelihood strategies households for which financial gains derived from small livestock production are a supplementary income-generating activity. Concern among the other two household types was lower. Increasing food prices were perceived a severe problem for welfare-dependent households due to the already limited financial resources available to them. However, there were similarities between all four household types, for example, in their concern as to the decrease of water availability, an essential necessity for sustaining livelihoods in rural Irauçuba.

Perceptions of changes in local climate seem to be central for understanding the resulting coping and adaptation responses to hardship brought about by environmental stressors. These perceptions are shaped by personal experience and by the extent of the impact on household livelihood strategies and are important for understanding the nexus between climatic events and spatial mobility in the study site.

7.8 Conclusion

The empirical evidence revealed that perceptions of environmental and socioeconomic issues include a number of concerns that affect everyday life of the residents of the study area in different ways and to differencing extents. Moreover, the findings indicate that climatic events such as the 2010-2013 drought are linked to other socioeconomic factors that affect livelihoods. The analysis revealed that the recent drought acted as an underlying factor in the reported increase in crime, water shortages, decline in crop and livestock production and overall community poverty. This was reflected in the statistical tests which found that respondents who perceived deteriorated climatic conditions also indicated concern with regard to issues that directly affect their households.

With regard to the perceived aspects of the local climate, it is clear that residents of the region had a distorted understanding of the real nature of climate variability. Analysis of the rainfall data from 2002-2013 in rural Irauçuba showed a cyclical pattern in the annual distribution of rain. However, when asked about changes in the local climate over a long period, the majority of respondents reported a gradual drying of the climate, reflected in longer dry season and shorter rainy season. While the perceptions reported by residents for the 2010-2013 period are in line with the rainfall data, particularly the shortened, later onset of rain, they tended to overstate the occurrence of droughts. This may well be a product of being overly influenced by the individual and household losses in capital assets, which impact people's livelihood and overall sense of security over the course of the recent drought. These impacts reflected increased food prices, decline in household income limited availability of water.

Household perceptions and the strength and form of impact of the 2010-2013 drought reflects the capital assets and livelihood strategies of each household type in the study area. The one-way ANOVA test revealed statistically significant difference in the level of concern regarding environmental and other socioeconomic issues impacting households and communities. The analysis suggests that these differences reflect distinct ownership of capital assets, and in the main source of income among household types.

Climatic events such as the 2010-2013 drought in Northeast Brazil are triggers that can lead to impacts across a range of socioeconomic and environmental factors. However, the realisation of these impacts on households is mediated by the perception and level of concern of issues affecting households and communities. The findings presented in this

chapter suggest that the more direct the effects of the recent drought on immediate factors impacting livelihood and everyday aspects of life in their community, the greater they are perceived by households. These perceptions depend on access to capital assets and livelihood strategies and also impact on the way individuals and households respond to severe climatic events. The empirical evidence discussed in this chapter allowed the refining of the conceptual model guiding this study to include perceptions of local issues, which form, along with access to capital assets and livelihood strategies, part of household endogenous processes mediating responses to climatic adversities.

Chapter 8. Permanent out-migration and seasonal migration in rural Irauçuba

8.1 Introduction

Different forms of spatial mobility are widely recognised as mechanisms to maintain livelihoods and adapt to severe climatic events and other stressful situations, particularly in rural communities in the developing world. However, the attribution of population movements to environmental factors, and to climatic events in particular, is a complex task (Suhrke 1994; Black et al. 2011). Chapter 2 identified two forms of spatial mobility which are recurrently cited in the environment-migration literature, and which are described as permanent and seasonal moves. These types of population movement are part of the full continuum of spatial mobility in space of time, but have distinct spatiotemporal characteristics (Bell and Ward 2000). Permanent out-migration is defined as movements which result in a permanent change of address. Seasonal migration is part of the broad spectrum of temporary moves; that is, moves that do not entail a permanent change of address, usually on a regular, periodic cycle. Seasonal migrants spend part of the time at home and part of the time elsewhere each year, often involved in economic activities as part of the livelihood strategies of households (Rogaly 2003).

Recent studies of environmentally-induced migration are beginning to construct a clearer picture of this relationship, teasing out the way migration decisions vary between households and communities (Hunter et al. 2015; Martin et al. 2014). Underpinning this empirical work has been substantial progress in conceptualising the relationship between the environment and migration. Key developments include the production of frameworks exploring the links between climate change, natural hazards and individual migration decisions (Hunter 2005; Perch-Nielsen et al. 2008). Conceptual models now position the environment among four other primary drivers of migration – political, demographic, economic and social. Climatic events and other forms of environmental change influence migration outcomes through impacts on the other drivers (Black et al. 2011). Research has also recognised the diversity of environmental stressors, categorising these as either ‘sudden-onset’ (Belcher and Bates 1983; Paul 2005) or ‘slow-onset’ (Findley 1994; McGranaham, Balk and Anderson 2007), each triggering discrete spatiotemporal patterns of mobility. At the same time, links are being made between migration and access to various forms of capital asset. This current study argues that the role played by mobility as a response to climate events depends heavily on

the duration, intensity and nature of the stimulus, as well as the composition and assets of households, their previous experience and the networks to which they belong.

Consistent with the above findings, the conceptual model introduced in Chapter 4 indicated that spatial mobility does not happen in a vacuum, isolated from other events and processes. This model establishes that spatial mobility related to livelihoods is embedded in a multidimensional context represented analytically by a range of mediators. These mediators include macro political and economic factors and institutional responses, as well as micro level aspects such as household livelihood strategies and access to different types of capital. Previous chapters have explored each of these forces. Chapter 5 examined the exogenous context within which spatial mobility occurs in semi-arid Northeast Brazil, by investigating the structural climatic and socioeconomic factors driving migration in the region. Chapter 6 focused on household livelihoods and access to capital assets in the study area. Chapter 7 then examined local perceptions of change in the local climate, and household and communities issues which may influence the way in which households respond to livelihood stressors.

Previous studies argue that a certain degree of compulsion is present in environmentally-driven migration. That is to say, 'push' factors in the place of origin - including slow-onset environmental hazards such as drought - are more important than 'pull' factors in the destination area (Suhrke 1994; Myers 2002). In the case of semi-arid Northeast Brazil, migration has traditionally been considered to be the first response employed by people facing the impacts of the recurring droughts which impact the area (Finan and Nelson 2001; Kenny 2002; Nelson and Finan 2009). In order to examine if the 2010-2013 drought developed a new or distinct pattern of out-migration and seasonal moves, Chapter 8 focuses on the composition of flows, motivations and migrant destinations in order to examine the breadth of mobility responses, how they differ and how they fit within livelihood strategies of household in the study area. Discussion on the direction of flows and the characteristics of migrants is framed against the regional trends established in Chapter 5.

Chapter 8 is based on the analysis of survey data obtained from rural smallholder households in three research sites impacted by the most recent drought (2010-2013), which collected information on out-migration and seasonal labour mobility. The chapter is organised as follows: Section 8.2 examines out-migration from rural Irauçuba. It does so by analysing the key characteristics of migration such as the composition, motivations and flows of migrants. Section 8.3 examines seasonal migration using the same approach.

Section 8.4 then contrasts these two forms of spatial mobility and positions the findings in the study area in the context of other places affected by climatic events. Section 8.5 summarises the main conclusions.

8.2 Out-migration from rural Irauçuba

The general patterns of migration in the study areas should be understood in the broader context of internal migration in the state of Ceará, and across Brazil, presented in Chapter 5. There are two common types of migration from rural semi-arid Northeast Brazil. These are out-migration from the hinterland towards the more economically developed Atlantic Coast, and temporary moves, which do not entail in a change of address, connected to off-farm and non-farm work opportunities in other rural locations or in regional centres. These two flows have determined much of the current spatial distribution of population in Northeast Brazil (Graham 1970; Tannen 1991).

The individual characteristics of migrants are important dimensions in the analysis of migration and livelihoods. Although migration is not limited to any specific age or gender, it is an activity that tends to be undertaken primarily by young adults (Bernard, Bell & Charles-Edwards 2014). Migrants often have attained higher formal education, are generally more achievement-oriented, and have developed a broad network through personal communication skills (Todaro 1970).

To obtain data about out-migration in the study area, the questionnaire asked the following question: “Over the past five years (2008-2013), has any member of your household moved away to live elsewhere?” Of the 90 household interviewed in rural Irauçuba, 41% had at least one former member who had moved away over the period 2008-2013. Of the total of 58 out-migrants, half were males and half were females, with some household heads reporting multiple out-migrants. Previous studies have established that gender is an important form of social differentiation that influences migration in developing countries (Boyle and Halfacree 2002). Over past decades, migration streams have included an increasing participation of women. The gender balance in outflows from the study area, however, obscures an important difference with regard to the nature of migration. In a patriarchal society such as rural semi-arid Northeast Brazil, the majority of females moved to start a new household after marriage, or to accompany the partner due to work relocation. On the other hand, the majority of males moved for employment. It should be noted,

however, that household heads reported that most of the women who migrated with their partners subsequently joined the labour market at the destination.

When asked about the timing of migration, household heads reported that 20% had occurred before the onset of the 2010-2013 drought, while the second largest group included those who migrated in 2011. The median age of out migrants was 26 years. Young adults aged 15-29 years formed the largest group of migrants (74%). The age distribution at the time of departure is presented in figure 8.1.

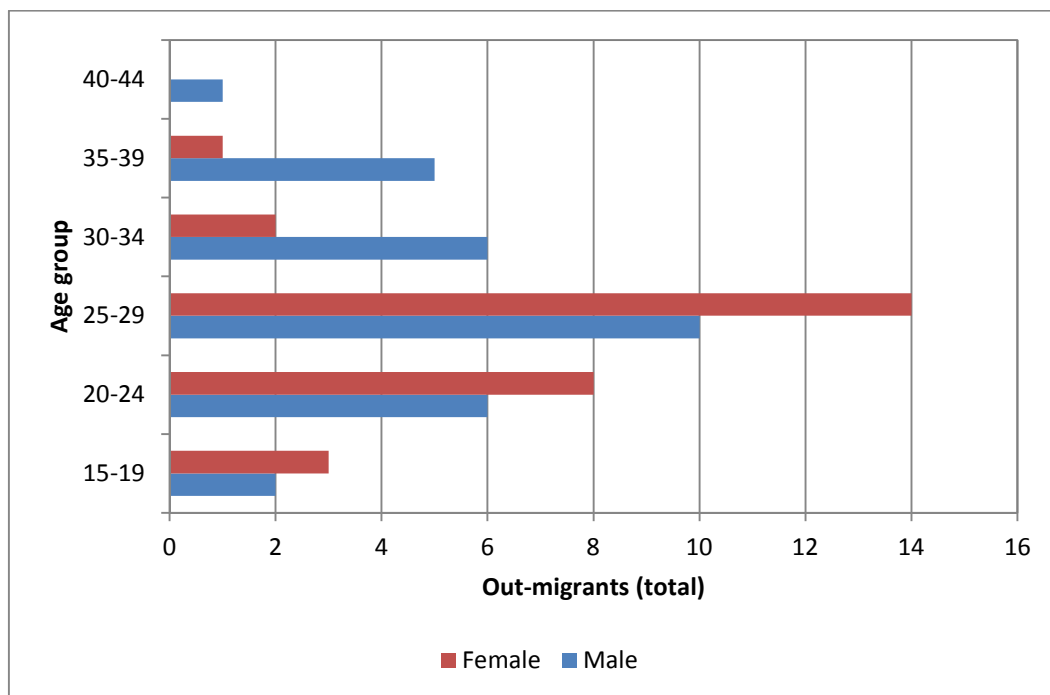


Figure 8.1 Age distribution of out-migrants at time of departure

Figure 8.1 shows that the proportion of out-migrants decreased with age. For example, of the total 58 people who had moved away, 8 were in the 30-34 group. This fell to 6 and 1 from the 35-39 and the 40-44 age groups respectively. With regard to the gender split, the data indicate a marginal predominance of migrant women within young age groups, while men form the majority of out-migrants in later stages of life. These older migrants were mainly single men who lived in nuclear extended households and moved to the regional centre of Sobral in search of non-farm work opportunities. This gender selectivity suggests that women are more mobile at early stages of their life-cycle. Of the 28 female migrants, only 10% were aged 30-44, as opposed to 40% computed for men within the same age group.

Previous studies have argued that migration is positively related to household size, with migrants originating mainly from large households (Anh et al. 2003). Chapter 6 revealed that households in rural Irauçuba are predominantly composed of nuclear complete and nuclear extended types. The data shows that of the 37 households that reported out-migration of at least one member, 65% have more than 3 adult members remaining.

Understanding of spatial mobility dynamics needs to identify the potential drivers of migration in the three researched communities. The conceptual framework presented in chapter 4 indicated that these drivers can be connected to external stressors such as the 2010-13 drought. Although the individual reasons for out-migration varied, specific themes were captured in the interviews with household heads. Of the households with out-migrants, 62% reported that the main reason behind migration from rural Irauçuba was economic, with the majority of migrants moving in search of better employment opportunities. The second most frequently mentioned reason related to marriage, with 24% of respondents reporting that the migrant left to form a new household with his or her partner. Four households reported that one member moved away to pursue tertiary education. Of the 37 households with migrants, only three stated directly that the main reason behind the migrant's decision to move was the 2010-2013 drought (Figure 8.2). However, as discussed in Chapter 7, the decision to move is a complex network of reasoning in which the stated cause is not necessarily the ultimate or primary motivation.

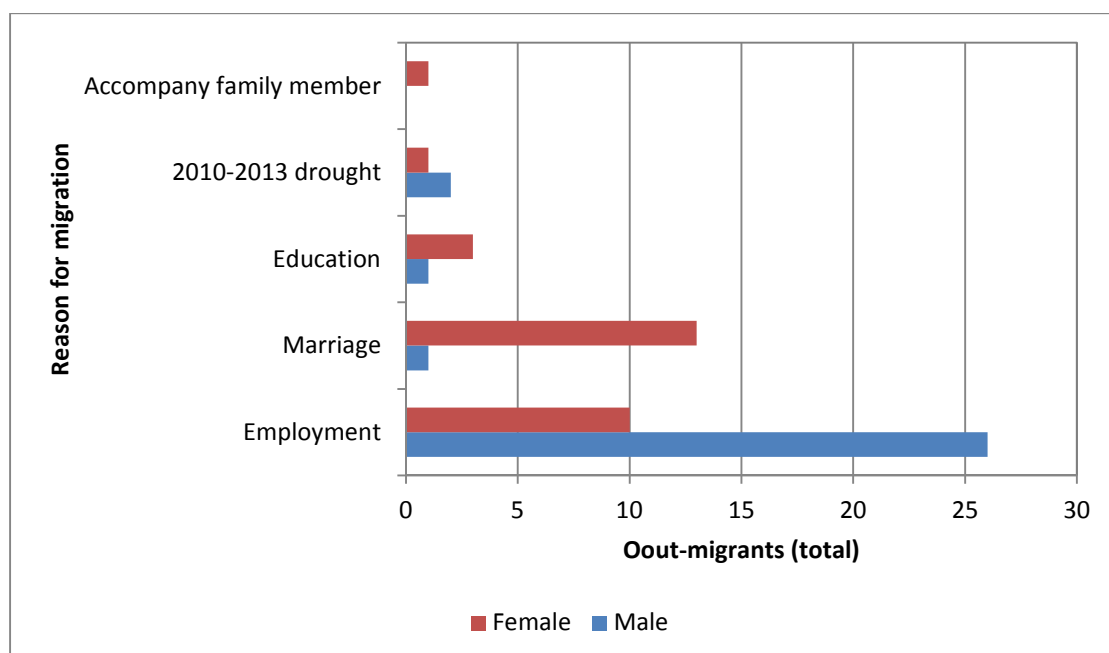


Figure 8.2 Reasons for migration from rural Irauçuba

Breakdown of the data by sex indicate that women's motives for migration are predominantly associated with family responsibilities (50%), whereas the overwhelming majority of male out-migration related to employment opportunities elsewhere. This gender split is indicative of the importance of family formation in mobility processes in the study area, painting a general portrait of women as 'associational' migrants in Latin America, as suggested by Kanaiaupuni (2000).

A further explanation for the findings reported in Figure 8.2 relates to the discussion presented in Chapter 6, which identified that the majority of households in rural Irauçuba traditionally live mainly from subsistence agriculture and from raising small quantities of livestock, with monetary income deriving from welfare grants and limited non-farm work. Respondents in all three study sites reported that subsistence farming and small scale commercial livestock production have become more strenuous due to rainfall variability and the cyclical droughts. Smallholders have become discouraged from farming for the purpose of generating income. In addition to not being profitable and being highly susceptible to the climate vagaries which occur in the region, many respondents reported that agriculture is not an attractive livelihood. Young people in particular, believe that their aspirations cannot be met under these circumstances, and are leaving rural areas seeking work elsewhere, as captured in a field interview:

"My son went to Fortaleza to look for a job. Before that, he used to work on the farm, and sometimes he also worked moving cattle for the dairy company. But then our farm was harvesting less and less, and Castor bean was not a good business anymore. I cannot pay him any money if we are not selling Castor beans, so he went to Fortaleza and there he found a job in civil construction. He has been there for over two years now" (Respondent from the district of Caxitore, 2014)

Marriage was reported as the second most frequent motive for migration in the study area. Newly formed nuclear households have great financial difficulties which cannot be met by occasional non-farm work and diminishing financial returns derived from agriculture activities and welfare grants. In the cases reported by household heads, the combination of these factors led to relocation to large urban areas. The most frequently reported reason was one of the spouses finding work elsewhere and moving with the whole family, as indicated by this respondent:

"My daughter's husband found work in the port in Caucaia, and they moved there last year. They wanted to stay here close to their families but there are very few jobs in Irauçuba, and my daughter is expecting a child. They needed to increase their income" (Respondent from the district of Caxitore, 2014)

The third most frequent motive for migration was education. The municipality of Irauçuba does not offer education beyond secondary school, and people wishing to pursue higher education have to relocate to larger urban centres in the State. Household heads reported that two people moved to Fortaleza and two to Sobral to enrol in a university. Respondents reported that it is difficult for these migrants to return, since the labour market in Irauçuba does not match their new qualifications. This was illustrated by a respondent in the field interviews:

“There are only secondary schools here. If you want to go to university you have to go to Fortaleza...now there is one in Sobral too, which is closer to Irauçuba. My son decided to go there so that he could visit us more frequently, but I don’t think he wishes to return home to live with us” (Respondent from the district of Missi, 2014)

Fewer than expected household heads reported climatic factors as a direct cause for out-migration. Of the 58 out migrants, only three had moved as a direct result of rainfall uncertainty and the droughts which impact the study area. This was associated with the inability of impacted households to sustain subsistence agriculture and livestock in their once productive farm, as reported in one interview:

“There were years of extended dry seasons before, when the farm stopped producing and several animals died. My brother went to Fortaleza to find work. When the rain returned, he came back for a while, but then this drought began and he decided to move back to Fortaleza to work in civil construction. He left in 2011 and has started a family there” (Respondent from the district of Jua, 2014)

These findings lend credence to the body of theories that suggest the complexity in the environment-migration relationship. As noted in the responses provided by respondents, there is a clear interaction between socioeconomic and environmental factors. This is more evident with regard to the decline in farm productivity due to the 2010-2013 drought. However, besides the indirect impacts associated with the reduction of off-farm and non-farm work opportunities, migration decisions are clearly influenced by a broad range factors, and environmental aspects cannot be studied in isolation from other explanatory variables. To examine the differences between perceived climatic deterioration and out-migration, a chi-square test was completed. The climatic perceptions in 2010-2013 of households with or without permanent migrants were compared, to examine whether significant differences were present (Table 8.1).

Table 8.1: Permanent out-migration and household perception of deteriorating climate

| Observed cases | Perceived deteriorating climate | Did not perceive deteriorating climate | Total |
|--|------------------------------------|---|-------|
| Households with permanent migrants | 29 | 8 | 37 |
| Households without permanent migrants | 39 | 14 | 53 |
| Total | 68 | 22 | 90 |

Source: Field survey (2014)

No relationship was found between perceived drying of the climate and permanent out-migration, $X^2(1, N=90) = .271, p = .602$. This result suggests a greater level of complexity in the relationship between slow-onset climatic events and out-migration in the study area. For example, external factors such as the conditional cash-transfer programmes, which are central to the robust federal welfare system, offer alternative forms of *in-situ* response to the cyclical droughts that impact semi-arid Northeast Brazil other than permanent relocation of households.

Having examined the reported reasons behind out-migration, we now turn to the destination of migrants. The findings of chapter 5 indicated that the direction of flows in both 2000 and 2010 censuses, in the state of Ceará, continue to be from the less developed semi-arid hinterland to the more economically advanced Atlantic coast, particularly areas surrounding the capital Fortaleza. Besides a large prospect for employment, the unmatched opportunities for education, health services and economic development in those places make them more attractive to migrants. Figure 8.3 show the destinations of out-migrants from rural Irauçuba.

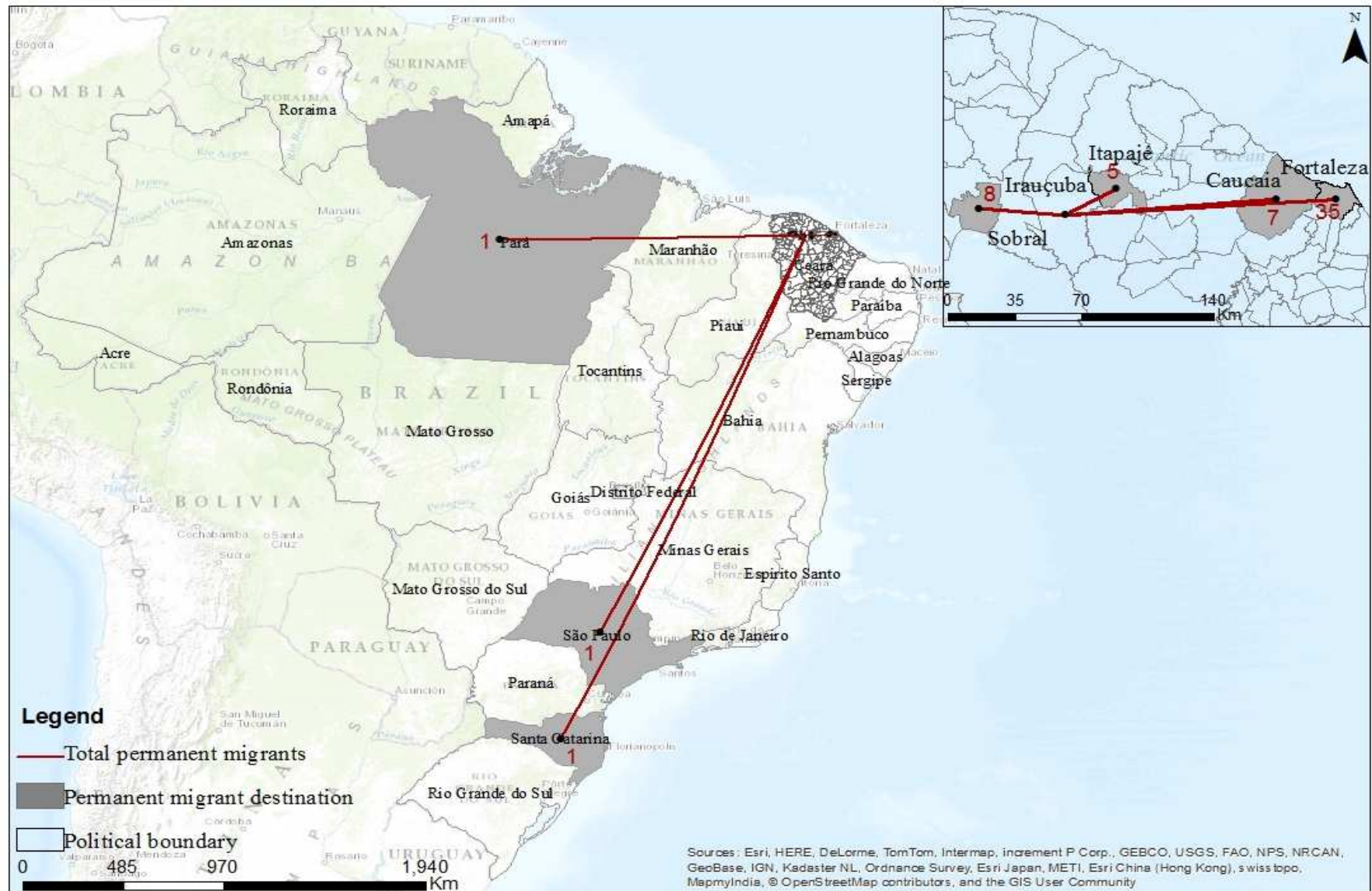


Figure 8.3 Destination of out-migrants

Figure 8.3 reveals that Fortaleza is the preferred destination for the majority of migrants from the study area. This preference for the capital of the State can be attributed to the greater opportunities for employment and education as well as access to the amenities for modern living. The relatively short distance between Irauçuba and Fortaleza (150km), compared to other major urban centres in Northeast Brazil, is also an attractive factor. Apart from the socioeconomic development of Fortaleza, the metropolitan area and the surrounding municipalities like Caucaia house the majority of manufacturing industries, ports, government institutions and multi-national companies which frequently advertise employment opportunities. Sobral, a large regional centre, 80km distant from Irauçuba, is another preferred destination of out-migrants due to a burgeoning manufacturing and services sectors.

Although socioeconomic conditions in Northeast Brazil have improved over the last three decades, they are still lagging behind other regions of the country, and non-farm work in the formal sector is not readily available in the large urban centres of the region (Araujo, Souza and Lima 1997). Despite this, migrants continue to travel to those areas hoping for a more dynamic environment than that of economically stagnating rural areas. Of the 58 out-migrants from rural Irauçuba, 51 were reported as being economically active or engaged in a student-worker activity. These migrants were mainly engaged in the civil construction and in the retail industries. Table 8.2 shows the occupation of migrants at the destination.

Table 8.2: Occupation of out-migrants at destination

| Occupation | Place of residence | | | | | | |
|---------------------|--------------------|--------|-----------|---------------|---------|-----------|--------|
| | Belém | Caucaí | Fortaleza | Florianópolis | Itapajé | São Paulo | Sobral |
| Construction worker | - | 2 | 15 | - | - | - | 2 |
| Retail worker | 1 | - | 12 | - | 3 | - | 2 |
| Hospitality worker | - | - | - | 1 | - | 1 | - |
| Factory worker | - | 3 | 1 | - | - | - | 2 |
| Professional | - | - | 2 | - | 1 | - | - |
| Full-time Student | - | - | 2 | - | - | - | 1 |
| Unemployed | - | 2 | 3 | - | 1 | - | 1 |
| Total | 1 | 7 | 35 | 1 | 5 | 1 | 8 |

Source: Field survey (2014)

Out-migrants engage in a range of non-farm work at their destination. Of the 35 people living in Fortaleza, 43% are working in civil construction while 34% work in the retail industry. In Sobral, 40% of migrants from the study area are employed in these two sectors. Unemployment among migrants is 12%, and 5% are full time university students. The disaggregation of the results by gender shows that of the 51 people who are employed full-time at their destination, 63% are males compared to 37% of females. This distribution could be attributed to the position of some female migrants as housewives or as the primary caretaker of children. Of the women who are engaged in full-time work, most are employed in the retail and hospitality industries. However, it should be noted that all three migrants who have been reported as professionals were females.

Andersson (2002) argues that most rural migrants do not permanently sever ties with their origin community. In the study area, the majority of respondents reported that the migrants maintain a close connection with their former household. Of the 37 households which reported out-migration, 35 are in regular contact with former members who live elsewhere. Despite the tight connection with their homeland, the extent to which migrants contribute to the income of their households of origin is remarkably low. Indeed, the data indicate that, of the 58 out-migrants, only 30% provide financial support in the form of remittances or small

gifts to their former household. The likely explanation for the low prevalence of remittance practices is related to migrant financial conditions at their destination, where the cost of living is usually much higher than that of their community of origin.

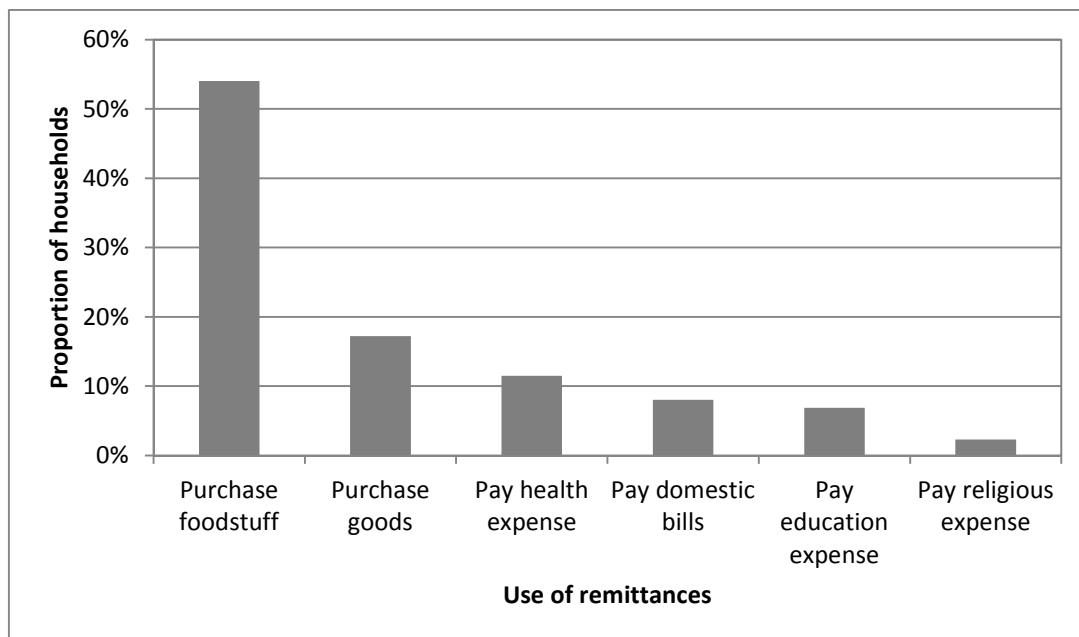


Figure 8.4 Use of remittances by households at the place of origin

With regard to the use of remittances, the findings indicated that purchasing foodstuff is the most frequent use followed by the purchase of household goods, and by health-related expenses (Figure 8.4). No respondent indicated that remittances were employed to buy livestock, seeds or other farm improvements that could increase agricultural production. This finding suggest that for households that reported them, remittances were a supplementary form of income used mainly to support consumption needs of the household rather than being invested or converted into productive capital. Consistent with the literature (Ellis 1998; Rosenzweig and Stark 1989; Warner and Afifi 2014), the low economic role of remittances found in the sample suggests that the most immediate benefit to households is the reduction of domestic consumption, particularly for vulnerable households. Figure 8.5 seems to support this notion by indicating that the majority of permanent out-migrants originated from welfare-dependent and mixed livelihoods household types. Chapter 6 identified that these two household types reported the lowest annual income on average. Additionally, welfare-dependent households recorded the second largest household size with regard to the number of occupants. Without the same level of access to capital assets, the evidence above suggest that out-migration might be a response internally arranged to facilitate

domestic consumption smoothing in an environment characterised by constant risk to water and food security.

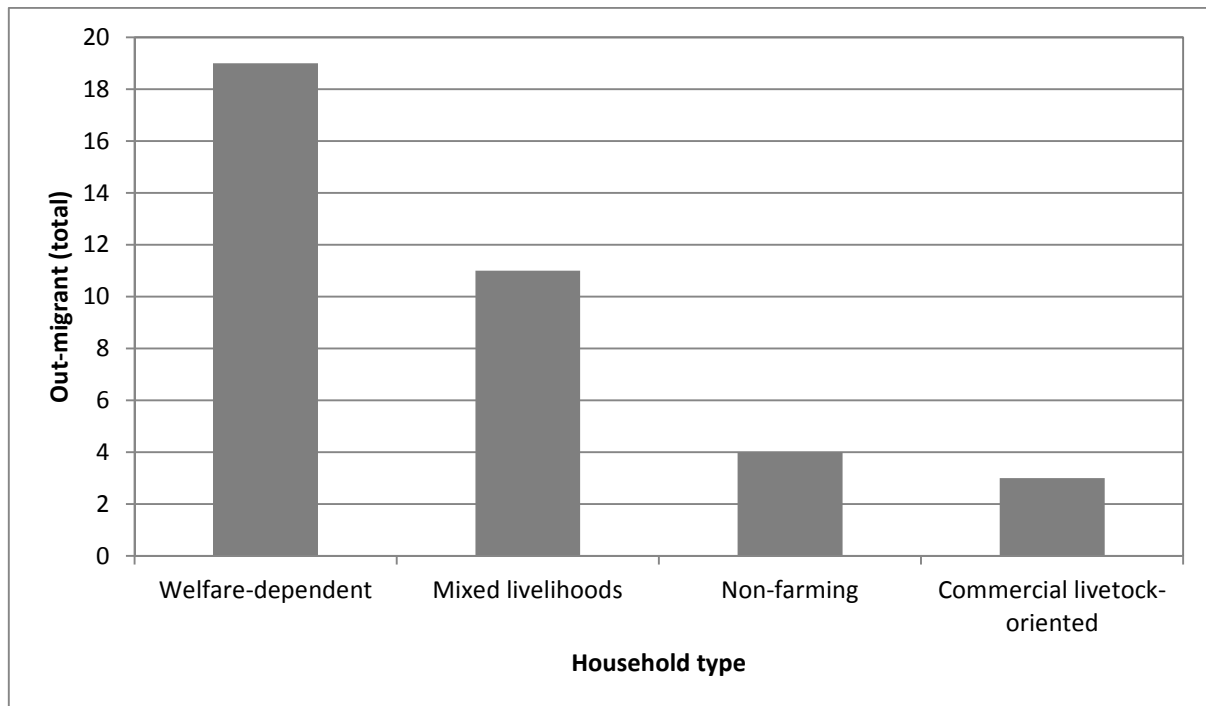


Figure 8.5 Out-migrant origins by household type

A recurring theme in contemporary studies of spatial mobility in Brazil is the phenomenon of return migration. The questionnaire sought to collect information about intention to return in the form of the following question: “Does the migrated member intend to return to his place of origin?” Of the 58 out-migrants, household heads reported that one third wished to return. This finding lends support to recent studies which suggested that return migration is an option for social mobility in contemporary Brazil, particularly for migrants from peripheries of metropolitan areas in the Northeast who settled in the large urban centres of the Southeast region (Brito 2009). Most of these migrants have attained skills which are now in demand in metropolitan areas of the Northeast, as economic development continues to gain traction in the region. Brito (2009) further suggests that contemporary return migration is also related to existing cultural and social ties in the sending area, and many respondents perceived that it is this affective connection which would be critical in the migrant’s decision to return. However, it is important to note that return migrants may increase the overall domestic expenditure, particularly if the return migrant is unable to financially contribute to the household income.

Overall, the characteristics of out-migration in sample households reflect to a large extent the contemporary features of migration in the Northeast region, and in Brazil. Migrants tend to be young adults who move away in search of wider employment and education opportunities available in large urban centres. The findings also suggest that out-migration is an important livelihood strategy for recently formed families. Contrary to findings in other drought-prone regions of the world such as the African Sahel, remittances do not seem to contribute to the overall wellbeing of households with out-migrants. In fact, households seem to benefit the most from the reduction in domestic consumption after members move away. With regard to environmental factors driving out-migration, the findings do not support the view that climatic events are a direct and principal determinant of migration away from rural Irauçuba. In the sample households, only a small percentage reported the 2010-2013 drought as the main reason for the departure of a household member, and statistical tests revealed no relationship between out-migration and household perception of deteriorating local climate. However, as the conceptual framework guiding this study suggests, the impact of climatic events may operate through other factors. For example, the decline in local economic activity may cause businesses to fail and increase the unemployment rate as a consequence.

8.3 Seasonal labour migration in rural Irauçuba

The New Economics of Labour Migration (NELM), discussed in detail in Chapter 2, stressed that migration decisions are not only made by an individual but also by the household to which he or she belongs (Stark 1991). The NELM approach interprets spatial mobility as a risk-spreading mechanism for households. Migrants form part of an overall household strategy of diversifying livelihoods to build up security against external risks such as climatic events. The strong focus placed on income in the form of remittances, integral to this labour migration in general, largely disregards considerations that seasonal migration can be an insurance measure to reduce internal consumption of a household during the absence of one or more members. With regard to rural livelihoods, seasonal labour migration has been identified as an important diversification strategy (Kelly 2011). Ellis (2000) identified that seasonal migration might occur in response to the agricultural calendar, which enables movement of people during the low agricultural season, and in response to the demand for non-farm work elsewhere. The focus of this section is on these two categories identified by Ellis (2000)

In Northeast Brazil, seasonal migration has often been represented in a deterministic way within which droughts were seen the main driver of temporary spatial mobility in the region (Neves 2002). Persistent droughts, combined with limited economic development, contribute to loss of livelihood and to an increased sense of vulnerability which creates an army of destitute drought-fleeing migrants called “*retirantes*”. These migrants and their families, a common feature of the landscape of semi-arid Brazil for much of the 19th and the 20th centuries, have been represented as an inexpensive source of labour which moves from town to town in search of any work which would generate income. Several analysts have described the plight of the “*boia-frias*”, seasonal nomadic labourers, cutting sugarcane or working as sharecroppers on large private estates (de Oliveira Andrade 1986). Has the profile of seasonal migration changed in recent years?

Household heads (or their partners) reported that seasonal labour mobility was an important diversification strategy to generate additional income which supplements other livelihood strategies. These responses corroborate the findings of Chapters 6 and 7, which indicated that households perceive their communities as a place where livelihood security cannot be attained through agricultural activities alone. Analysis of the questionnaire data revealed that seasonal mobility is an integral part of the livelihood portfolio of many households in the study area. Of the 90 households, 37% reported at least one temporarily absent member engaged in off-farm or in non-farm work outside the municipality. The stated reasons for the seasonal move included the unreliability of local agricultural activities, household poverty and limited non-farm employment opportunities in Irauçuba.

Examination of the age of seasonal migrants revealed a notable feature of the surveyed households (Figure 8.6). More than half of seasonal migrants were adults aged between 30-44 years. In 63% of the households with a seasonal migrant, the temporarily absent member was the head of household. This is a stark contrast to the findings on out-migration, which reported that the majority of movers were young adults aged 15-29. Breakdown of the data by sex reveal another difference between permanent and seasonal migration in the study area; males form the predominant group across all age groups, while females account for 29% of all seasonal migrants. Like households with out-migrants, seasonal migration seems to occur mainly in large nuclear complete and nuclear extended households. Of the 33 households with at least one member temporarily absent, 54% had more than 3 adult members. The relationship between large households and spatial mobility is made clear in the proportion of (one-third) of sample households with permanent-out migrants also reporting a seasonal migrant. Previous migration experience is an important factor in the

selection of destination and occupation of seasonal migrants. This enables potential migrants to assess the costs and benefits of a temporary move. This is further explored in the discussion of seasonal migrants' occupation.

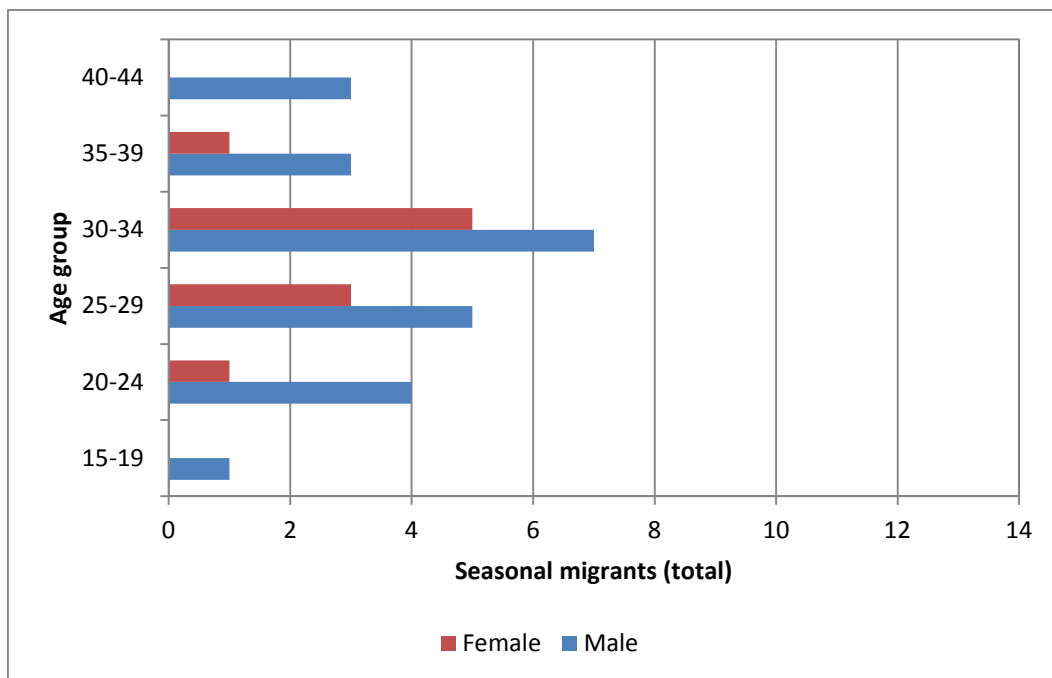


Figure 8.6 Age distribution of seasonal migrants

Analysis of the age profile and composition of households with seasonal migrants in the study area paints a picture similar to that identified in the semi-arid Sahel. Hampshire and Randall (1999) indicate that seasonal migration among different tribes in Burkina Faso is most prevalent among adults aged 28-40. The findings of previous studies in the region also identified that seasonal migrants tend to originate from larger households which can cover the labour deficits in the migrant's absence (Hampshire and Randall 1999; Hampshire 2002).

Having examined the characteristics of seasonal migrants in the study area, their destination is now considered. As indicated in the section on out-migration, flows associated with non-farm work are from the less developed semi-arid hinterland to more economically developed areas on the Atlantic coast, particularly areas surrounding the capital Fortaleza. However, seasonal labour mobility in semi-arid Northeast Brazil, which includes a great proportion of workers engaged in agricultural activities, is focused on rural areas of towns located within the hinterland. Figure 8.7 show the destination of seasonal workers within the state of Ceará (all respondents reported that seasonal migrant destinations were located within the State).

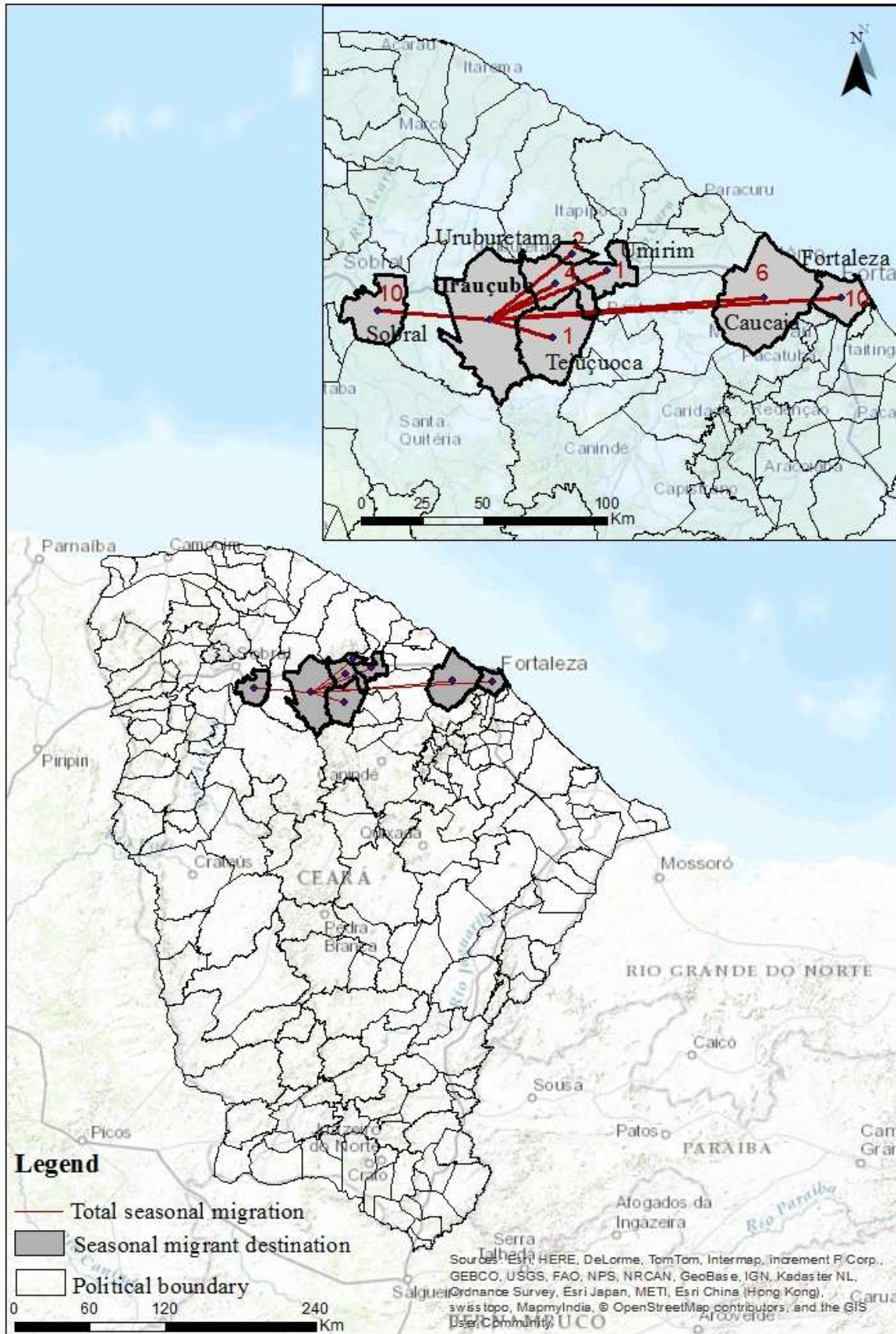


Figure 8.7 Seasonal migrant destinations

According to respondents, seasonal migrants based their decision on where to move primarily on their knowledge of the experiences of members of their network who had worked previously in these areas, or who were currently working and can help them find work and accommodation. Of the 33 households which reported a temporarily absent member, 33% had a history of out-migration. This underlines the importance of social capital for households in the study area. The findings in Chapter 7 revealed that 68% of households had relatives living in Fortaleza, a major destination hub for seasonal migrants. Of the 10 seasonal migrants in that city, 70% originated from households which reported relatives living there. This evidence lends credence to the findings of recent studies which suggest a positive relationship between the networks, which are part of the social capital, and seasonal migration (Görlich and Trebesch 2008).

With regard to the occupation at the destination, all reported seasonal migrants are engaged in unskilled work in the construction, ports and fisheries, manufacturing and agriculture sectors. Those workers engaged in off-farm work have their income based on output, for example, kilograms of sugarcane gathered. Figure 8.8 shows occupation by destination.

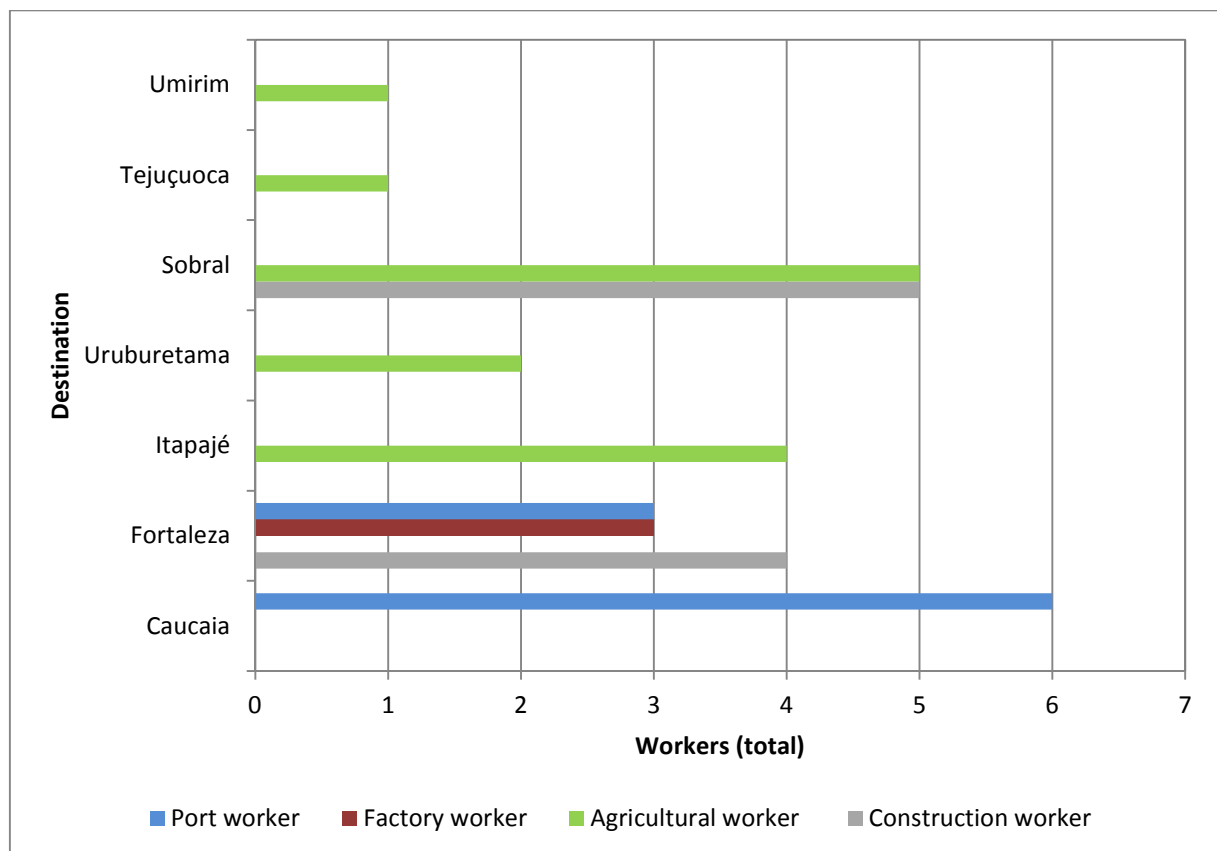


Figure 8.8 Occupation of seasonal migrants at destination. Source: Field survey (2014)

Agriculture accounts for 41% of all reported seasonal occupations. When seasonal migrants were engaged in off-farm work, the most serious problem was labour exploitation. As described above, people in the study area seek off-farm work in the form of agricultural labour. A recent study by de Melo, Tereso and Abrahão (2010), elaborating on the socioeconomic characteristics of the *'boia-frias'*, argued that many people submit to precarious working conditions because it is one of the few opportunities available to unskilled workers to generate income outside their own farms. Of the 13 people employed in agricultural work, the majority worked long hours without having been paid the wages agreed upon with the employer. Labour exploitation in off-farm work in Northeast Brazil, besides low wages, also includes lack of clear disclosure of work conditions. Respondents indicated that off-farm work often includes payment in kind – accommodation, sustenance and transport to work site, which is then deducted from the worker's wage without consent. Figure 8.9 shows a group of seasonal agricultural workers departing from the urban centre of Irauçuba to work in the sugar-cane fields located in the outskirts of Sobral, 80 kilometres distant.



Figure 8.9 Seasonal agriculture workers in transit to work site

Next to these work-related moves, seasonal migration in rural Irauçuba is, to a lesser extent, motivated by the desire to establish a network which could lead to a permanent move. This is particularly relevant for port workers. This was best articulated by the spouse of a seasonal migrant working at the port in the municipality of Caucaia:

“This is the third time my husband is working there (the port). He’s been there for three months and every time he comes home he talks about getting a permanent full-time job at the port. He wants us to move to Caucaia because there are better opportunities for our family there” (Respondent from the district of Missi)

Table 8.3: Occupation of seasonal migrants at destination by household type

| Household type | Occupation | | | | Total |
|-------------------------------|---------------------|---------------------|----------------|-------------|-----------|
| | Construction worker | Agricultural worker | Factory worker | Port worker | |
| Welfare dependent | 1 | 8 | - | - | 9 |
| Mixed livelihood | 5 | 5 | 1 | 2 | 13 |
| Non-farming | 2 | - | 2 | 4 | 8 |
| Commercial livestock-oriented | 1 | - | - | 3 | 4 |
| Total | 9 | 13 | 3 | 9 | 34 |

Source: Field survey (2014)

Table 8.3 shows that seasonal migration is more prevalent among welfare-dependent and mixed livelihood households. These two household types account for 64% of households which reported at least one member temporarily absent. More specifically, of the 44 welfare dependent households identified in Chapter 6, 21% reported the absence of a member engaged in work outside the study area. In the case of mixed livelihood households, the proportion is even greater, with 62% of households reporting a temporarily absent member. These findings suggest the important financial contribution of seasonal migration to the overall livelihood strategy of these two household types.

Occupation data underlines the relationship between main source of income at household level and seasonal migrant occupation. In Table 8.3, factory workers and port workers are more prevalent in non-farming and commercial livestock oriented households. As expected, non-farming households have workers engaged in low-skilled positions within the manufacturing, port and fisheries and construction sectors. Commercial livestock-oriented

households have the lowest number of reported seasonal migrants, with the majority working in the port located in Caucaia. Members of this household type are less likely to engage in temporary absences because of year-round livestock demands. However, a notable feature of this household type relates to the age of seasonal migrants. The four temporary absentees were aged 20-24, which suggests their labour power was not required for the maintenance of livestock farming.

There is a significant difference in the duration of moves based on the occupation at destination. Off-farm work takes place in the harvest high season (February to April), whereas work in the construction, ports and fisheries, and manufacturing sectors occurs all year round according to the local demand for labour. The median length of time spent on seasonal migration is shown in Figure 8.10 It should be noted that length of stay indicates the total amount of time spent away engaged in the activity, including temporary returns home.

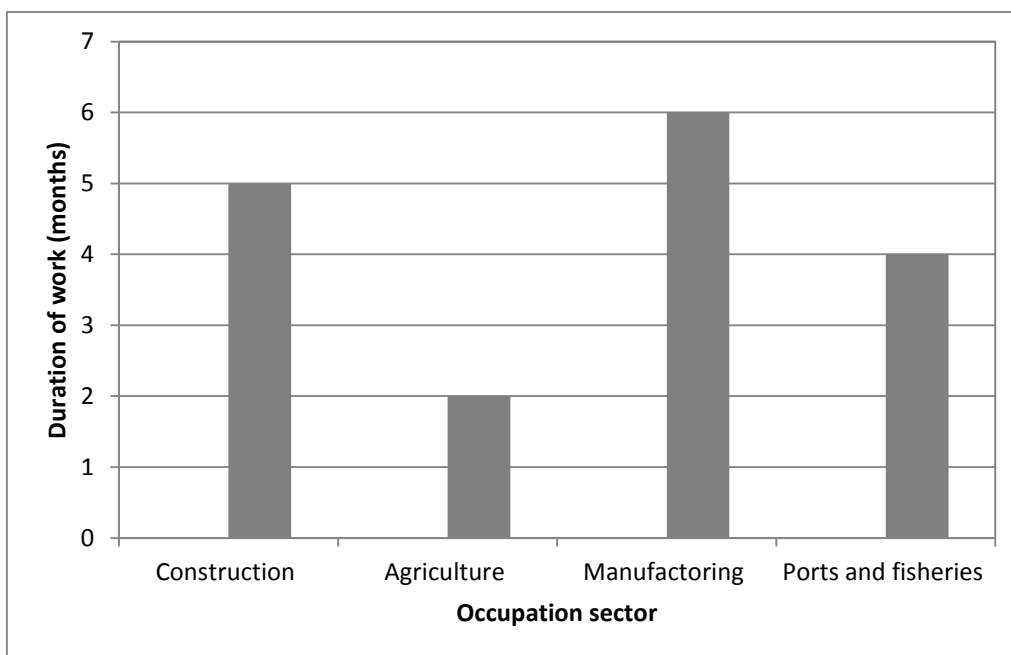


Figure 8.10 Duration of seasonal work by type of occupation

In summary, seasonal migration in the study area occurs mainly for economic reasons. On the one hand, households employ this strategy to find alternate ways to generate income. On the other hand, the temporary absence of a member reduces the overall consumption of a household, which, like permanent out-migration, alleviates the financial burden during adversities such as the 2010-2013 drought. However, seasonal migration in Northeast Brazil

presents a level of complexity greater than the overall representation of starving families roaming across the semi-arid hinterland in search of a source of income.

The review of the literature identified that several studies in the African Sahel focussed on the role of seasonal migration during the hardship brought about by drought. This type of migration, is often refereed as ‘eating the dry season’ (Brown 2007). Migrants engage in periodic trips to urban centres in search of non-farm work which will provide the income to support the household members who stayed in the place of origin. Because of the distinct socioeconomic context in Northeast Brazil, it was important to examine whether a relationship existed between climatic conditions and seasonal migration in the study site. Following the same approach employed in Section 8.2, a Chi-square test was performed. The climatic perceptions in 2010-2013 of households with or without seasonal migrants were compared, to examine whether significant differences were present (Table 8.4).

Table 8.4: Seasonal migration and household perception of deteriorating climate

| Observed cases | Perceived deteriorating climate | Did not perceive deteriorating climate | Total |
|--------------------------------------|---------------------------------|--|-------|
| Households with seasonal migrants | 22 | 2 | 24 |
| Households without seasonal migrants | 46 | 20 | 66 |
| Total | 68 | 22 | 90 |

Source: Field survey (2014)

A significant difference was found between perceived drying of the climate and seasonal migration, $X^2(1, N=90) = 8.32, p = .003$. This result indicates that there is an association between household perception of worsened climatic conditions in the study area and seasonal migration. Like seasonal migration in the African Sahel, this phenomenon in semi-arid Northeast Brazil is associated with the optimisation of security through engagement in income generating activity outside the place of residence (De Haan and Rogaly 2002; Hampshire and Randall 1999). However, contrary to the findings of these studies, seasonal migration in rural Irauçuba was more prevalent among less asset-endowed households. One explanation for this is that commercial livestock-oriented and non-farming household types have their main source of income connected with the place of residence. For example, smallholders engaged in commercial livestock activities are required to be on the farm for

most of the time. For members of this group, seasonal migration might have a negative outcome such as loss of productivity or of animals. Consequently, as the empirical evidence discussed in this section revealed, young adults whose work on the farm was not fundamental were the only household members of this group engaged in seasonal migration. For welfare-dependent and mixed-livelihood households, seasonal migration results in important financial benefits which supplement the income provided by cash-transfer programmes. Members of these two groups are able to engage in wage-work outside their place of residence, while the remaining family members continued to work on the farm, supported by the financial buffer against the effects of the recent drought.

In spite of the harsh environmental and economic forces that are still prevalent in semi-arid Northeast Brazil, contemporary seasonal migration in the study area is a multifaceted and complex phenomenon. The findings presented in this section indicate that labour mobility is selective in terms of age and in the form of main economic activity in households. For example, commercial livestock oriented households require on-farm labour to be available all year-round. Seasonal migrants from this household type were young adults, which indicate that their labour power was not fundamental to the daily activities of the household. The findings also corroborate previous studies characterising seasonal migration in semi-arid parts of Africa as being more prevalent among households with large number of members, and among adults at the peak of their productive capacity. However, contrary to the findings of these studies, seasonal migration in semi-arid Northeast Brazil is more prevalent among less-endowed households. This section also suggests the blurring of rural-to-rural and rural-to-urban patterns. The seasonal movement of people engaged in off-farm work in agricultural land has been a notable feature in Northeast Brazil (Andrade 1981; Ribeiro et al. 2007), and the findings presented here indicate that this process continues to be embedded in contemporary livelihood strategies in the region.

8.4 One strategy fits all? Migration in rural Irauçuba

Chapter 5 established that the movement of people is a recurring demographic feature in much of semi-arid Northeast Brazil. A broad visualisation of this phenomenon suggests that a large proportion of migration occurs from rural to urban areas, although return migration seem to be occurring in some parts of this region. But what are the characteristics of migration in rural Irauçuba? Chapter 8 focused on the forms within which population movement occurs in the study area by examining two discrete streams of spatial mobility in the forms of permanent and seasonal moves. The findings indicate that the majority of

sample households reported some form of population movement. Table 8.5 shows the main characteristics of each of these two types.

Table 8.5: Characteristics of permanent and seasonal migration in rural Irauçuba

| Form of migration | Permanent out-migration | Seasonal migration |
|----------------------------------|---|--|
| Migrant characteristics | Predominantly young adults aged 15-29 of both sexes | Predominantly male adults aged 30-44 |
| Previous migration experience | Of the 37 household which reported out-migration, 16 % have a history of migration | Over of third of households with a seasonal migrant have a history of out-migration |
| Motivation | Employment was the main reason in nearly two thirds of all permanent moves reported. Marriage accounted for 24% and only 5% of respondents reported that the 2010-2013 drought was the main reason for the relocation | Income diversification was the only reason respondents engaged in seasonal migration. The 2010-2013 drought operates as an underlying context in driving seasonal moves. |
| Destination | Predominantly rural-urban, with only 7% moving to another rural location. | More diverse direction of flows. Rural-rural accounts for 38% of seasonal moves |
| Occupation at the destination | The majority of out-migrants are employed in full-time non-farm activity. Unemployment rate is 12%, while 5% of permanent migrants are full-time students. | One-third of seasonal migrants are occupied in off-farm work while two-thirds have full-time non-farm work |
| Type of household at origin | Permanent out-migration occurs mainly from nuclear complete and extended households. Out-migrants originate from welfare dependent or non-farming households | The majority of seasonal-migrants originate from large nuclear complete and nuclear extended households. Seasonal migrants are mainly from mixed livelihood households |
| Role in the household livelihood | Remittances are infrequent and mainly used to purchase foodstuff and household goods. | Income from seasonal migration is an important strategy to diversify livelihoods as a response to external stressors such as the 2010-2013 drought |

Table 8.5 reveals clear differences between these two forms of population movement. Permanent migrants from the study area can be characterised as predominantly young adults from larger households, displaying similar features to those that have been identified in previous studies in developing regions of South-east Asia, Africa and Oceania (Caldwell 1969; Oberai and Singh 1983; Jetley 1984). Permanent migration in rural Irauçuba, however, challenges notions regarding gender selectivity identified in the findings of the studies mentioned above. Females accounted for half of the total reported permanent out-migrants from rural Irauçuba. Notwithstanding the large proportion of female out-migrants, differences in the motivation for the move persist. Female out-migrants predominantly relocated for marriage or to accompany their partner. Seasonal migration in the study area displays similar characteristics to those identified in the semi-arid Sahel (Hampshire and Randall 1999), predominantly involving male migrants originating from older groups. One possible explanation for this difference in composition relates to different stages in the life-cycles of migrants. In the case of permanent out-migrants, analysis of the field data showed a mean age 26 years. The propensity for the young to migrate is reflected in the fact that 74% of all out-migrants moved before the age of thirty. On the other hand, seasonal migrants were mainly household heads aged 30-44.

Household composition is also an important factor in determining the viability of either form of spatial mobility in rural areas due to the demand for labour (Bilsborrow et al. 1987; Blench 2001).

Previous studies suggest that larger households have greater capacity to employ alternative strategies for livelihood diversification (Batterbury 2001; Spaan 1999). The empirical evidence from rural Irauçuba supports this argument; both permanent and seasonal migrants originated from large nuclear or nuclear extended households. The reason for such selectivity is found in the small number of seasonal migrants in commercial livestock-oriented households. Compared to the other three types identified in Chapter 6, households which rely on income derived from the livestock they own, need on-farm labour to be present all year round. The few seasonal migrants in commercial-livestock oriented households were young adults who were not directly part of the labour force working on the farm.

Indicators of household prosperity suggest a differentiation in both the type and the role of migration within livelihood strategies of households in the study area. In his seminal work on household strategies and rural livelihood diversification, Ellis (1998) reported that remittances are one of six categories of income for rural households in Africa and Asia, identifying that the role of remittances is comparatively higher in the Sahel. Critical to this

proposition is that migrants maintain a steady flow of remittances to their original households. Empirical studies show that between 80 to 90% of migrants send remittances home, albeit with a variance in proportion of income and frequency (Hoddinott 1994; De Haan 1999). Contrary to these findings, the analysis of the field data in the study area indicated that only 30% of permanent out-migrants send remittances home, and these funds are invariably employed for consumption purposes. The reasons for this are twofold. Migrants from rural Irauçuba face a much higher cost of living at their destination. Moreover, the public welfare network operating in Brazil provides vulnerable households with increased financial safety compared with Africa or Southeast Asia. In the case of seasonal migrants, the income generated through seasonal migration reverts directly to the family members who stayed at the original locality, and are used in the general maintenance of the household.

Another important difference between permanent and seasonal migration relates to the destination of migrants. With regard to seasonal migration, analysis of the geographic distribution indicates that, while rural-to-rural moves have been, and continue to be, an important destination, the proportion of urban directed moves from the study area indicates the primacy of rural-to-urban seasonal migration for households in rural Irauçuba. On the other hand, permanent out-migration follows similar pattern to that recorded in the State of Ceará, discussed in Chapter 5, that is, from rural areas to economically developed regional centres and the metropolitan area of Fortaleza.

Besides the characteristics reported in this section, Chi-square tests were completed to examine the difference across the four household types with regard to permanent and seasonal migration. Table 8.6 shows the observed data for the groups.

Table 8.6: Permanent and seasonal migration among household types

| | Household type | | | | Total |
|----------------------------|-------------------|------------------|-------------|-------------------------------|-------|
| | Welfare-dependent | Mixed livelihood | Non-farming | Commercial-livestock oriented | |
| Observed data | | | | | |
| With permanent migrants | 19 | 11 | 4 | 3 | 37 |
| Without permanent migrants | 25 | 10 | 11 | 7 | 53 |
| Total | 44 | 21 | 15 | 10 | 90 |
| With seasonal migrants | 9 | 13 | 8 | 4 | 36 |
| Without seasonal migrants | 35 | 8 | 7 | 6 | 54 |
| Total | 44 | 21 | 15 | 10 | 90 |

Source: Field survey (2014)

No relationship was found between household type and permanent out-migration, $X^2(3, N=90) = 2.982, p = .394$. This suggests that permanent out-migration occurs irrespective of household of origin. As discussed in section 8.2, the stage in the life-cycle of household members seems to offer a more compelling explanation for permanent moves compared to access to capital assets or livelihood strategy. The empirical evidence revealed that the fulfilment of individual objectives such as marriage, better education or employment outside the agricultural sector, particularly for young adults aged 15-29, is the main driver of out-migration from the study area, irrespective of household financial capacity or level of access to other capital assets. With regard to seasonal migration, the Chi-square test revealed a statistically significant difference across the four household types, $X^2(3, N=90) = 12.383, p = .005$.

Table 8.5 revealed that mixed livelihood households had the highest total of households with seasonal migrants. The limited level of access of capital assets and main source of income explain this result. Compared to welfare-dependent households, members of the mixed livelihood group recorded a lower level of access to funds derived from cash-transfer policies. As discussed in Chapters 5 and 6, these benefits provide households with a steady, albeit small, source of income which is useful during hardship. In combination with reliance on subsistence agricultural practices, mixed livelihood household members rely on multiple intermittent income-generating activities linked to livestock sales and casual non-farm work, making this group more vulnerable to the impacts of the 2010-2013 drought compared to non-farming and commercial livestock-oriented households.

The contextual factors outlined in this section not only revealed the different characteristics of permanent and seasonal migration among sample households in rural Irauçuba, but also

situated spatial mobility in the study site relative to findings in other marginal areas of the developing world such as Africa and Southeast Asia.

8.4.1 Situating population movement in rural Irauçuba in the context of the 2010-2013 drought

Previous empirical studies examining the impact of droughts and rainfall variation on migration streams have either established that variations in the climate act concomitantly with other socioeconomic drivers (Murali and Afifi, 2014; Van Der Geest, 2011) or have limited or no effect at all (Henry, Schoumaker and Beauchmin 2004). However, the majority of studies seem to agree that temporary and seasonal migration are an important aspect of the livelihoods of households impacted by droughts in Africa (Afifi, Liwenga and Kwezi 2014; Hampshire and Randall 1999; Roncoli et al. 2001), India (Murali and Afifi 2014) and Peru (Milan and Ho 2014). Other streams of research have focused on permanent migration in response to cyclical droughts (Cordell et al. 1996; Findley 1994). These studies suggest that migrants may decide to relocate to wetter or urban areas after consecutive years of poor harvests.

A persistent theme in this study is the role of environmental factors in explaining spatial mobility in rural Irauçuba. Regarding severe climatic events, Findley (1994) argued that migration rates increase both immediately and as an extended response to the threat of periodic droughts, which is the same context within which the current study area is embedded. Because rain-fed agriculture and livestock keeping are key features of livelihood strategies in the study area, it was expected that the 2010-2013 drought would impact population movements within households. However, findings from the field survey suggest that climatic factors have limited direct influence on migration. In fact, of the 37 households which reported out-migration of one or more of its members, only in 5% of cases was the 2010-2013 drought reported as the main cause of relocation. Stronger forces seemed to be at play. The Chi-square test showed no association between household perception of deteriorating climate and out-migration. A potential explanation is that the effect of the drought on permanent out-migration has been ameliorated by the range of welfare programs targeted at the most vulnerable communities in Brazil. These benefits provide financial support which may encourage people to remain in their original localities and endure the hardship. Another explanation is associated with the life cycle stage of individuals and households, which the empirical evidence revealed to be a more determinant factor in

relocation. The findings described in section 8.2 showed that out-migration was associated with young adults relocating for employment and marriage.

With regard to seasonal moves, it is undeniable that, to varied intensity, the 2010-2013 drought impacted all rural households in the study area. The findings in Chapter 7 suggest that this impact has both direct (water shortages) and indirect forms (rise in criminal acts), with 37% of sample households reporting at least one member engaged in an off-farm or non-farm activity outside the municipality. This corroborates the notion that temporary migration is a feasible way to diversify household income in the context of severe climatic events impacting agricultural production, while at the same time reducing household consumption. This was supported by a statistically significant difference in the number of households which reported seasonal migration and the ones which perceived deterioration in the local climate in 2010-2013. Contrary to the findings of previous studies, which suggest that wealthier smallholders form the majority of seasonal migrants (Afifi, Liwenga and Kwezi 2014), the findings in rural Irauçuba revealed that 65% of seasonal migrants originate from poorer household types (welfare-dependent and mixed livelihood). These households face severe adversity in trying to maintain their livelihoods and, therefore, employ seasonal labour mobility to improve their capacity to generate income. This contrasts with non-farming and commercial livestock-oriented households, which had access to a wider range of capital assets to mediate the impacts of the 2010-2013 drought. Seasonal migration in the study site is ultimately seen as a response strategy which is closely associated with household characteristics such as composition and main source of income, with more vulnerable household types engaging in the activity, even with the available welfare support.

8.5 Conclusion

Chapter 8 investigated the spatial mobility landscape in rural Irauçuba, examining the characteristics of out-migrants, the flows, patterns and causes of migration. This chapter also investigated the nature of seasonal labour movements. The majority of interviewed households reported some form of migration, be it seasonal or permanent. Both men and women migrate, although motives and occupations at destinations varied. Overall, permanent out-migration seems to be less related to climatic events than is the case for seasonal moves. Permanent migration is still a frequent phenomenon in the study area, with out-migrants often belonging to large nuclear complete and nuclear expanded households. However, motives for migration are related predominantly to employment opportunities and other events associated with stages in the life-cycle of migrants. A very small percentage of

household heads reported that climatic factors were the main driver behind the relocation of people in rural Irauçuba.

Seasonal movement of people has different characteristics in migrant composition, motivation and destination. Household heads in advanced stages of their life-cycles are the predominant group engaged in seasonal migration. The need for agricultural labour in rural areas of municipalities adjacent to the study area provided opportunities for people who were unable to find non-farm work in Irauçuba, while a range of welfare benefits provide support for household members who stayed behind. Contrary to previous studies in Northeast Brazil, the findings presented in this chapter lend support to the view that seasonal migration in semi-arid Northeast Brazil should be understood as an opportunity to diversify livelihoods in times of hardship rather than a social calamity.

With regard to the impact of the 2010-2013 drought on migration in the context of previous empirical studies, the findings presented in Chapter 8 corroborate the notion that permanent out-migration is less related to cyclical droughts and rainfall conditions. Statistical tests used to examine this relationship showed no difference in permanent-out-migration between households which had or had not reported deteriorating climatic conditions in 2010-2013. On the other hand, the analysis suggests that seasonal migration seem to occur as a household response to both direct and indirect impacts of climatic events. These findings lend credence to the view that the relationship between migration and the environment remains hard to untangle if the focus stays on these two coarse forms of population movement within the full spatial mobility continuum. Chapter 9 extends the analysis into new territory by focusing on the local mobility in the study area prior and during the 2010-2013 drought.

Chapter 9. Customary local mobility in rural Irauçuba

9.1 Introduction

The review of the literature in Chapter 2 established that migration is widely acknowledged as one response to climate variability and other forms of environmental change. However, the scarcity of reliable empirical evidence on this relationship has generated highly politicized disputes. In reality, the review of the literature concluded that spatial mobility is a complex, multi-faceted phenomenon and people respond differently to its various drivers depending on individual characteristics, household composition and their contextual setting. Moreover, migration itself forms just one component in a broad spectrum of mobility behaviour.

Previous studies investigating the relationship between the environment and migration have employed a range of data sources and analytical methods. One line of work has adopted macro-level approaches based on associating ecological indicators with out-migration rates, seeking to identify correlations between climatic events and the incidence of migration (e.g. Ezra and Kiros 2001; Kniverton, Schmidt-Verkerk and Blacksmith 2008). At the other end of the spectrum is the application of micro-level approaches based principally on longitudinal data or retrospective household surveys (Bilsborrow and Henry 2012) and analysed using logistic regression, event history, multi-level and agent-based models (e.g. Henry, Schoumaker and Beauchemin 2004; Smith 2014). Allied to this statistical analysis is a distinctive stream of work based around ethnographic methods, encompassing a suite of techniques including focus groups, mobility maps, seasonality calendars, Venn diagrams and participant observation, grouped broadly under the rubric of Participatory Rural Appraisal (Warner and Afifi 2014).

What these approaches share in common is a primary focus on understanding the causes and consequences of migration decisions, but with comparatively little attention to the underlying spatiotemporal dynamics of mobility itself. The dominant concern has been to tease out the relative importance of particular individual, household and contextual factors in triggering a mobility response to specific environmental circumstances, rather than to trace the resulting population movements. One corollary of this broad categorisation of permanent and seasonal migration is that little attention has been given to other forms of temporary mobility, such as diurnal, weekly and occasional movements. In practice, however, it is the daily round of activities which underpin the livelihood strategies of people

worldwide, and this is particularly the case for smallholder and subsistence farmers living in marginal environmental conditions. Such movements occur for a wide range of reasons, including both for economic or labour (production-related) and for leisure or social (consumption-related) purposes (Bell and Ward 2000).

Chapter 9 examines the interaction between the 2010-13 drought and changes in the pattern of local circulatory movements for the sample households, using quantitative metrics to compare results between the four household types described in Chapter 6 for movements prior and during the drought. The chapter is structured as follows. The next section describes conceptual and measurement issues with regard to temporary forms of mobility. Section 9.3 discusses the theoretical and practical aspects of a new toolkit designed to collect data on the key dimensions of local mobility. Section 9.4 presents the characteristics of local circulation in the study area. Section 9.5 interrogates these data, focusing on the different aspects of local circulation before and during the 2010-2013 drought for each household type identified in the sample. Section 9.6 discusses the impact of capital assets and livelihoods on local mobility. Section 9.7 positions the findings in the context of broad environmentally driven migration concepts, and Section 9.8 concludes this chapter.

9.2 Conceptual and measurement challenges

The denomination 'temporary mobility' encompasses a wide range of human movement but is commonly defined as any form of movement that does not lead to a permanent or semi-permanent change of usual residence (Bell and Ward 2000). Within this broad grouping, one common distinction is between diurnal mobility and moves that involve one or more nights away from the usual residence. For the latter, attention in the developing world has focused particularly on circular migration, where it is recognised as a longstanding form of mobility behaviour (Chapman and Prothero 1983; Prothero and Chapman 2011). Alongside conceptual and empirical development, a number of attempts have been made to develop indices that capture the tempo of such moves. Mitchell (1956) proposed an index of labour stabilisation to measure the shift from circulatory movements to permanent residence, while Alverson (1967) employed longitudinal data to assess the frequency of movement and cumulative length of stay in urban areas. Measures of the balance of movements (Bedford 1973), intensity of circulation (Young 1979) and velocity of circulation (Standing 1982) were also devised to establish the degree of circularity in population mobility. Taylor (1986) extended this work by constructing lifelines tracing patterns of circulation that combined cycles of movement with the duration of time away from home, and later applied this

approach to distinguish different forms of mobility among Indigenous Australians by graphically positioning the frequency and duration of moves on an x-y scattergram (Taylor and Bell, 2012).

While the frequency of moves and their duration emerge as key facets of population movement, Bell (2004) suggested that nine dimensions of temporary mobility could be recognised (Table 9.1). Five of these – movement intensity, duration, frequency, seasonality and periodicity - relate to the temporal dimensions, while the remaining four – distance, direction, connectivity and impact – are concerned with the spatial aspects. These dimensions are fundamentally interwoven but each reflects a particular aspect of temporary mobility and provides a different perspective on the nature of such movement. The challenge is to identify an appropriate mechanism to capture the data needed to measure these dimensions.

Table 9.1: Nine dimensions of temporary mobility

| Dimension | Description |
|----------------|---|
| Intensity | The overall level or prevalence of movement in the population |
| Frequency | The number of cycles of movement during a given interval of time |
| Duration | Length of time away from home |
| Periodicity | Combines frequency and duration to reveal temporal cycles |
| Seasonality | The timing of movement linked to natural or institutional calendar |
| Distance | Displacement from the place of origin |
| Direction | The spatial circuit described by the trip |
| Spatial impact | The extent of population redistribution resulting from the movement |
| Connectivity | The way movement serves to link origins to destinations |

In his pioneering work in the Pacific, Chapman (1975) captured circulatory movements from Melanesian villages by recording the time, date, destination and purpose of every entry and exit involving an overnight absence for each individual over a period of several months, a comprehensive but remarkably labour-intensive procedure (Chapman and Prothero 1983, 2013; Bedford 1973). In sub-Saharan Africa, demographic surveillance systems have the potential to provide similar information (Chandramohan et al. 2008) and in some parts of the world Information Communications Technology (ICT) data, such as mobile phone tracking (Deville et al. 2014), offer emerging alternatives. At finer spatiotemporal scales, activity diaries in which individuals record their sequence of daily pursuits provide a mechanism to track local pathways, but place a heavy burden on respondents to faithfully record each and every move (Chapin 1968; Parkes and Thrift 1980; Belli and Callegaro 2009).

Participatory Rural Appraisal techniques (PRA) which seek the collaboration of local participants provide an alternative that has been found more readily applicable in rural areas of developing countries and especially among semi-literate populations where conventional questionnaire based methods are not easily implemented. One such technique is the mobility map, which is designed to elicit information on the movement patterns of individuals or groups, illustrating where people go and for what purpose (Chambers 1994). Mobility maps are commonly implemented using materials such as stones, seeds, chalks and cards of different colours that are locally available, and readily integrated into the data-gathering process (Kumar 2002). The drawings and diagrams collected in these studies provide valuable insights into preferred destinations and the seasonality of moves. The limitation is that they do not provide a ready facility to record the complex structure of such mobility, particularly with respect to the frequency, timing and sequencing of mobility behaviour. Moreover, the use of context-specific materials imposes serious constraints on systematic measurement of the multiple dimensions of mobility. What is ideally needed is a mechanism to embed the insights from participant-centred approaches, which draw on the respondent's own experiences and reflections, in a more ordered framework that facilitates systematic recording of space-time trajectories in a form that captures the dimensions of mobility identified in Table 9.4. To achieve this aim, this study developed and implemented a new toolkit for data collection, which is described in detail below.

9.3 The MISTIC Toolkit

The Mobility in Space and Time for Individuals and Communities (MISTIC) toolkit, described below, combines the benefits of mobility mapping, adapted from the realm of Participatory Rural Appraisal (PRA), with the tools of spatial and temporal measurement developed in the study of circular mobility. MISTIC formed an integral part of a broader research strategy and was applied in conjunction with the household questionnaire. Central to the MISTIC toolkit is a large standardised base map which provides the platform to capture temporary movements among multiple members of each respondent household. To ensure the capture of the key dimensions of mobility described above, application of the MISTIC toolkit is framed around a set of structured questions that provide a meaningful, context-appropriate, respondent-friendly format. In what follows we introduce each component of the toolkit.

The mapping template

The aim of the toolkit is to capture and record typical routine and discretionary activities that involve temporary movements away from home, with emphasis on the everyday life of respondents. The re-usable mapping template (Figure 9.1) takes the form of a durable, crease-resistant cloth sheet, around 1 metre square, that situates each respondent's house at its centre, and is surrounded by a series of concentric circles representing spatial fields that correspond broadly to local, regional, national and international destinations. With none of the conventional cartographic symbols, the mapping template simply represents a blank canvas onto which respondents can impose their own perception of their environment and spatial activities, including distance and direction. Respondents are asked to identify any form of activity which takes them away from the dwelling, and each of the nominated destinations is represented on the base map by means of a small plastic placeholder, positioned according to its relative location, with its name or purpose identified on an attached card. This format is readily comprehensible by semi-literate populations and engages respondents directly in the information collection process, breaking down some of the barriers that are characteristic of formal interviews. The mapping template facilitates the researcher-subject interaction by drawing on respondents' own mobility experiences and spatial references. Application of the toolkit is typically undertaken with active participation from all members of the household simultaneously, commonly seated around a table, so that the results reflect the activities of the household as a whole, not simply a single respondent. The map and placeholder provide the framework for two other components of the toolkit; the location identifier and the mobility card.

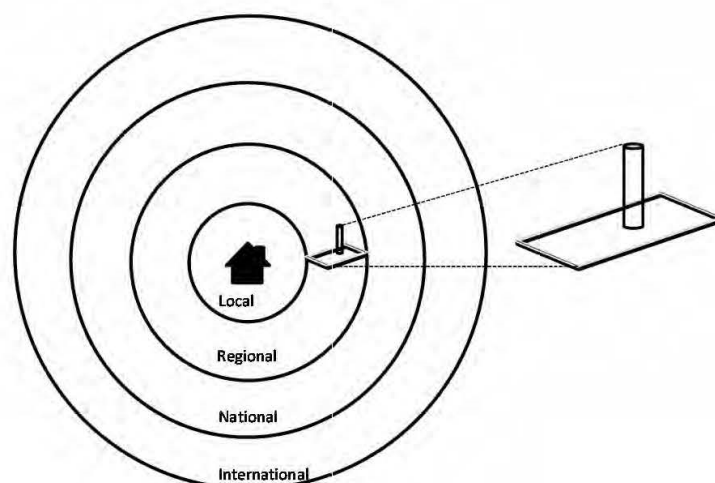


Figure 9.1. Mapping template and accompanying place-holder

The location identifier card

The location identifier card (Figure 9.2) provides the platform to record information about the location, distance from the place of residence, travel time and main mode of transport used to access each identified destination. Once completed through discussion with the respondents, the card is simply slipped over the upright on the place-holder to capture the spatial pattern associated with trips to that destination. This locks in a key component of the information about trips to that location for future storage and coding.

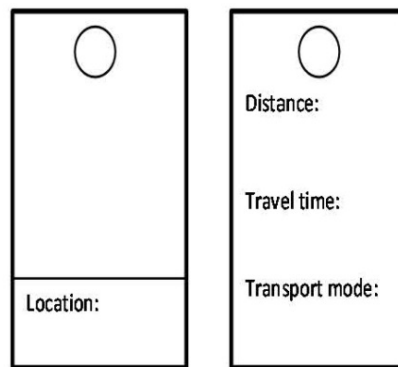


Figure 9.2 Front and reverse of the location identifier card

The mobility card

Each destination may be visited multiple times by individual household members. The mobility card records key information about visits to the destination as indicated by each respondent. The front of the card (Figure 9.3) identifies the household, its location, and distinguishes each respondent by means of a unique personal code. On the reverse side, the purpose, frequency, duration and seasonality of each activity is detailed, providing an individual record of the trips undertaken by each member of the household. The mobility card, or cards, for each household member for that destination are then placed over the place-holder on top of the location identifier card. Multiple mobility cards can be attached to the same place-holder corresponding to discrete members of the household making trips to that destination. The format and shape of the cards is such that the location identifier is still readily visible after the mobility cards are placed on top. Once information for a particular destination is complete, the interviewer repeats the strategy for the next location. When the

mapping process is complete the mobility cards are removed from the place-holder and stapled together with the location identifier for subsequent transcription and analysis.

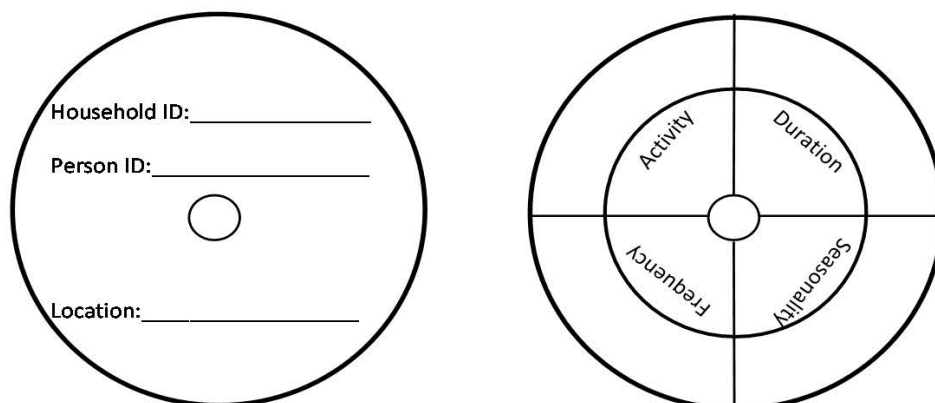


Figure 9.3 Front and reverse of the mobility card

Application of the toolkit

The MISTIC toolkit was used to collect data from 90 smallholder households in three rural localities in the semi-arid region of Northeast Brazil. In introducing the toolkit to respondents, emphasis was given to the focus on learning about their patterns of mobility. Discussion proceeded in two distinct phases. The first part of the interview sought information about their customary movements. Respondents were encouraged to report as many itineraries as they could remember which were deemed important for them. Both sequential and parallel cueing techniques were used to connect events chronologically and form associations across domains. Once completed, the interview moved to the second stage, focusing on changes to their customary circulatory movements brought about by the 2010-13 drought. Ideally, the MISTIC toolkit would be used to collect information on contemporary mobility at specific points in time, rather than record movements retrospectively. Retrospective data, such as that collected in this study, do however, illustrate the utility of MISTIC in capturing shifts in mobility over time. At each stage of the process, discussion focused initially on the head of household, an appropriate strategy in a patriarchal society such as rural northeast Brazil, but other members of the household were then encouraged to contribute. Each interview lasted an average of 35 minutes, with the shortest taking 25 minutes and the longest lasting over 50 minutes. Participants showed considerable enthusiasm for the mapping process and typically the whole household engaged closely with the activity. No adverse reactions were reported in any of the household interviews. Figure 9.4 illustrates the completed MISTIC toolkit at the end of an interview where the household had identified five common destinations at varying distances from their home.

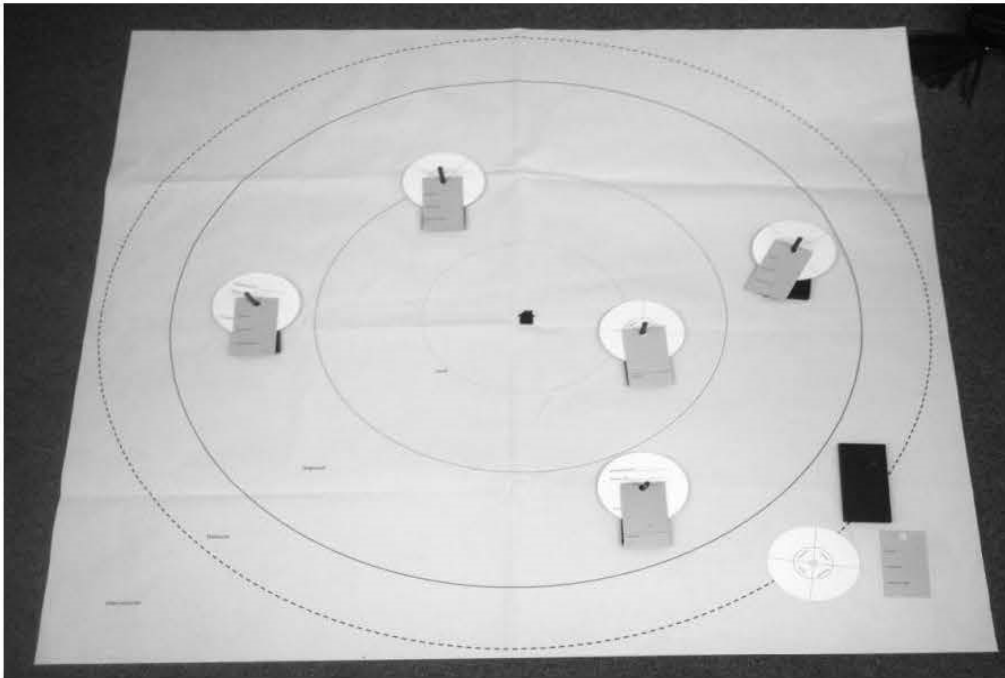


Figure 9.4 Assembled MISTIC toolkit completed in the field

Coding schedule

The MISTIC toolkit effectively captures mobility information in the form of nested relationships: trips by individuals within households. For each respondent, the location identifier card collected data on the location of the trip, distance, travel time and transport mode. The *Household ID*, displayed in the mobility card, anchored the transcription of all information collected in the field regarding the trips to destinations for each respondent of that household. The mobility card also contains the *Person ID*, which assigns each household member a unique code. For each respondent a series of fields representing the purpose of the activity, duration, frequency and seasonality was systematically assigned to a single record, with discrete codes for each variable. The codebook setting out variable names and responses is shown in table 9.2.

Table 9.2: The MISTIC toolkit coding structure

| Field | Variable | Code |
|-------|--------------------|--------------------------------|
| 1 | Household ID | Unique identifier 1 to 90 |
| 2 | Household location | 1 Jua 2 Missi 3 Caxitore |

| | | |
|----|-------------------------|---|
| 3 | Person ID | 1 to <i>n</i> members of the household |
| 4 | Destination | 1 Jua 2 Missi 3 Caxitore “...” |
| 5 | Distance from residence | Numeric transcription of response recorded |
| 6 | Travel time | Numeric transcription of response recorded |
| 7 | Transport mode | 1 Walking 2 Bicycle 3 Motorbike “...” |
| 8 | Activity | 1 Work 2 Sell handcraft in a local market 3 Go to livestock market “...” |
| 9 | Frequency | Numeric transcription of times per month |
| 10 | Duration | Numeric transcription of response recorded |
| 11 | Seasonality | 1 Rainy season 2 Dry season 3 All year round 4 School term |

The assignment of numeric codes for each response enabled conversion of the raw data into quantitative indicators for subsequent analysis in standard statistical packages, including Excel and SPSS version 22, and the subsequent production of frequency distributions and tables, as well as statistical testing. Table 9.3 shows an example of data-entry for a selected household using the recording schedule described above.

Table 9.3: Completed coding schedule for an illustrative household

| Household ID | Household location | Person ID | Destination | Distance from Residence (in Km) | Travel time (in min.) | Transport mode | Activity | Frequency (times per month) | Duration (In hours) | Seasonality |
|--------------|--------------------|-----------|-------------|---------------------------------|-----------------------|----------------|----------|-----------------------------|---------------------|-------------|
| 1 | 1 | 1 | 5 | 25 | 30 | 3 | 1 | 4 | 4 | 3 |
| 1 | 1 | 1 | 7 | 80 | 90 | 6 | 3 | 4 | 4 | 3 |
| 1 | 1 | 1 | 1 | 3 | 5 | 3 | 5 | 8 | 2 | 3 |
| 1 | 1 | 1 | 8 | 150 | 150 | 6 | 17 | 2 | 72 | 3 |
| 1 | 1 | 3 | 4 | 22 | 45 | 3 | 1 | 12 | 8 | 4 |
| 1 | 1 | 3 | 3 | 5 | 40 | 1 | 9 | 8 | 4 | 2 |
| 1 | 1 | 2 | 9 | 10 | 20 | 3 | 11 | 8 | 3 | 3 |

9.4 Local circulation in the study area

Local mobility is an integral part of the lives of the inhabitants of rural Irauçuba. All sample households engage in some form of circulatory movement within the district where they live, but it also entails outings to a range of locations within the municipality and to more distant destinations. Examples of mobility include trips to move livestock and fetch water. A respondent commented on the importance of mobility on the daily aspects of his household:

“In the morning my wife walks the young children to school while I move our goats to the pasture. Then it is time to fetch water for the household [...] so she (oldest daughter) cycles to the cacimba, which is 20 minutes away. If the cacimba is full she does two trips” (Respondent from the district of Missi, 2014)

The interview excerpt above illustrates a recurring theme in mobility research, which is the contrast between production-related and consumption-related mobility (Bell & Ward, 2000). The former include a range of compulsory moves involving, for example, work-related activities, which have a strong seasonal component. The latter comprise discretionary moves, for example, social visits, religious observances and various forms of leisure activity, which vary in distance and time spent away from home. These forms of population movement occur across space and time, with metrics capturing differences across these

two dimensions. Table 9.4 summarises key statistics of production-related mobility patterns, captured using the MISTIC toolkit and combining data from the three research sites.

Table 9.4: Summary statistics for production-related moves (n=339)

| Activity | Total (in %) | Distance (in Km) | Travel time (in min.) | Duration (in hours) | Frequency (cycles per month) | Seasonality |
|---------------------------|-----------------|---------------------|-----------------------------|---------------------------|---------------------------------------|-------------|
| Go to bank | 25.1 | 18.9 | 33.9 | 2.7 | 1.8 | All year |
| Buy water | 18.3 | 15.3 | 28.5 | 2.5 | 8.5 | Dry season |
| Non-farm work | 15.3 | 32.0 | 42.8 | 22.6 | 19.5 | All year |
| Go to livestock market | 7.7 | 33.6 | 44.8 | 4.7 | 2.2 | All year |
| Fetch water | 6.8 | 5.4 | 28.0 | 2.3 | 11.1 | All year |
| All other activities | 26.7 | 50.2 | 64.4 | 16.9 | 3.6 | Varied |

Source: Field interviews (2014)

The data reveal that moves related to basic household necessities such as the acquisition of water, are predominantly local in nature and of relative short duration, with many circuits completed over the period of one month. Figure 9.5 shows children fetching water from a '*cacimba*' (water well), a customary production-related move in semi-arid Northeast Brazil. Non-farm work is mainly in the urban district of Irauçuba, located some 30km from the research sites, with some residual movements to other municipalities so moves related to work are characterised by longer durations. These activities occasionally resulted in an absence from home longer than 24 hours, since many respondents opted to stay closer to their workplaces overnight. Other income-generating activities, such as visits to livestock markets to sell animals, eggs, milk and other produce, displayed similar spatial patterns, albeit at a reduced frequency and duration given the financial resources needed for travelling to the markets.



Figure 9.5 Children collecting water from a '*cacimba*' in the district of Missi

The profile for consumption-related movement reveals substantial differences in the spatial and temporal boundaries associated with the maintenance of social networks and religious activities (Table 9.5). Activities such as visiting friends or playing with children generally occur in the local area, with distances no greater than 5km and relatively short durations, and occur throughout the year. Visits to friends tend to occur quite frequently due to the proximity of dwellings. Time spent playing with children takes place between household and farm chores which is represented by a significantly lower number of cycles per month. On the other hand, trips to visit relatives display a broader spatiotemporal pattern. Many respondents have parents and other relatives living in cities dispersed around the state of Ceará and beyond, resulting in longer distances and increased lengths of time spent away from home.

Table 9.5: Summary statistics for consumption-related moves (n=210)

| Activity | Total (in %) | Distance (in Km) | Travel time (in min.) | Duration (in hours) | Frequency (cycles per month) | Seasonality |
|----------------------------|-----------------|---------------------|-----------------------------|---------------------------|---------------------------------------|-------------|
| Visit friends | 28.6 | 4.2 | 17.9 | 2.5 | 15.9 | All year |
| Go to church | 20.0 | 15.1 | 28.8 | 3.5 | 3.8 | All year |
| Visit relatives | 19.5 | 136.6 | 81.2 | 51.7 | 4.5 | All year |
| Play with children | 8.1 | 4.3 | 22.5 | 4.7 | 2.0 | All year |
| Local community meeting | 6.7 | 23.9 | 39.5 | 7.1 | 1.1 | All year |
| All other activities | 18.6 | 22.5 | 35.0 | 29.7 | 2.0 | Varied |

Source: Field interviews (2014)

The MISTIC toolkit also captured the different modes of transport featured in the local circulation of the inhabitants of the study site. Selection of mode of transport largely depends on the distance and purpose of the trip. Another important characteristic relates to household access to physical assets such as a bicycle, a motorbike or a car, which reflects the level of endowment and overall wealth. Table 9.6 shows the distribution of the modes of transport used per person for selected production and consumption-related moves

Table 9.6: Modes of transport per person per type of activity

| | Mode of transport | | | | |
|----------------------------|-------------------|---------|-----------|---------------|-------|
| | Walking | Bicycle | Motorbike | Intercity bus | Lorry |
| Production-related | | | | | |
| Go to bank | - | 5 | 80 | - | - |
| Buy water | - | 10 | 51 | - | - |
| Non-farm work | 5 | 10 | 28 | 10 | - |
| Go to livestock market | - | - | 4 | - | 20 |
| Fetch water | 15 | 25 | 4 | - | - |
| Total | 20 | 50 | 167 | 10 | 20 |
| Consumption-related | | | | | |
| Visit friends | 33 | 20 | 11 | - | - |
| Go to church | - | 6 | 42 | - | - |
| Visit relatives | 3 | 1 | 16 | 28 | - |
| Play with children | 8 | 4 | 1 | - | - |
| Local community meeting | 2 | 5 | 9 | - | - |
| Total | 46 | 36 | 79 | 28 | - |

Source: Field interviews (2014)

Table 9.6 reveals that walking, bicycle and motorbike are the most common modes of transport in the study area. Production-related moves often involve commuting over long distances, with commuters traveling distances in excess of 20 kilometres. Respondents indicated that personal transport, such as a bicycle or a motorbike, is frequently used for this purpose. Household members who sell agriculture produce at the local farmers' market travel in one of the four municipal lorries provided by the local council. Basic household necessities such as collecting water are performed on foot or by using a bicycle. Consumption-related moves, which involve both long and short distance trips, display a wide variety of modes of transport. Walking is the most common mode of transport for consumption-related activities performed locally, such as leisure time with children. At the other end of the spectrum, the use of inter-municipal public transport in trips to visit relatives who live in other cities was the most frequently mentioned mode of transport. Figure 9.6 shows different modes of transport employed by people returning to their households after a community meeting in Jua.



Figure 9.6 Three common modes of transport in the study area

9.5 Mobility pattern prior and during the 2010-13 drought

The 2010-13 drought in northeast Brazil triggered a number of shifts in the spatiotemporal signature of temporary mobility, and introduced new forms of movement among many households. Non-agricultural diversification activities such as the acquisition of loans and hunting were introduced into the livelihood portfolio of households to mediate the impacts of the drought.

Drawing on techniques developed by Taylor and Bell (2012), this study illustrates key aspects of these movement trajectories on an *x-y* scatter graph. The *x* axis records the number of completed circuits over a period of one month by members of a selected household. The upper-left and lower-left quadrants capture movements which are more frequent, whereas the upper-right and the lower-right quadrants record movements which are less frequent. The data distinguish a wide variety of moves, ranging from essential livelihood strategies at one end of the spectrum to routine leisure activities such as visiting friends at the other.

High variability in movement across households is evident. The data reveal a bimodal distribution of some activities, so Figure 9.7 displays medians for the 15 most cited activities

performed by all respondents prior the 2010-13 drought. The solid ellipses indicate the variability recorded for production-related activities and for consumption-related activities.

The diagram reveals that most movements, both for production and consumption purposes, were of short duration, with some degree of variation in the number of completed trips per month. This mobility is driven by basic household necessities such as the need to secure access to water, visit livestock markets to sell produce, and maintain long-established social networks. A notable exception is income generating activities related to non-farm work, which are longer in both time away from home and more frequent in number of trips per month. Renewal of welfare benefits triggers a small number of trips per month, but they are of longer duration because of the need to travel to larger towns or cities. On the consumption side, visits to relatives also display a broader temporal pattern, with few absences but longer stays away from home.

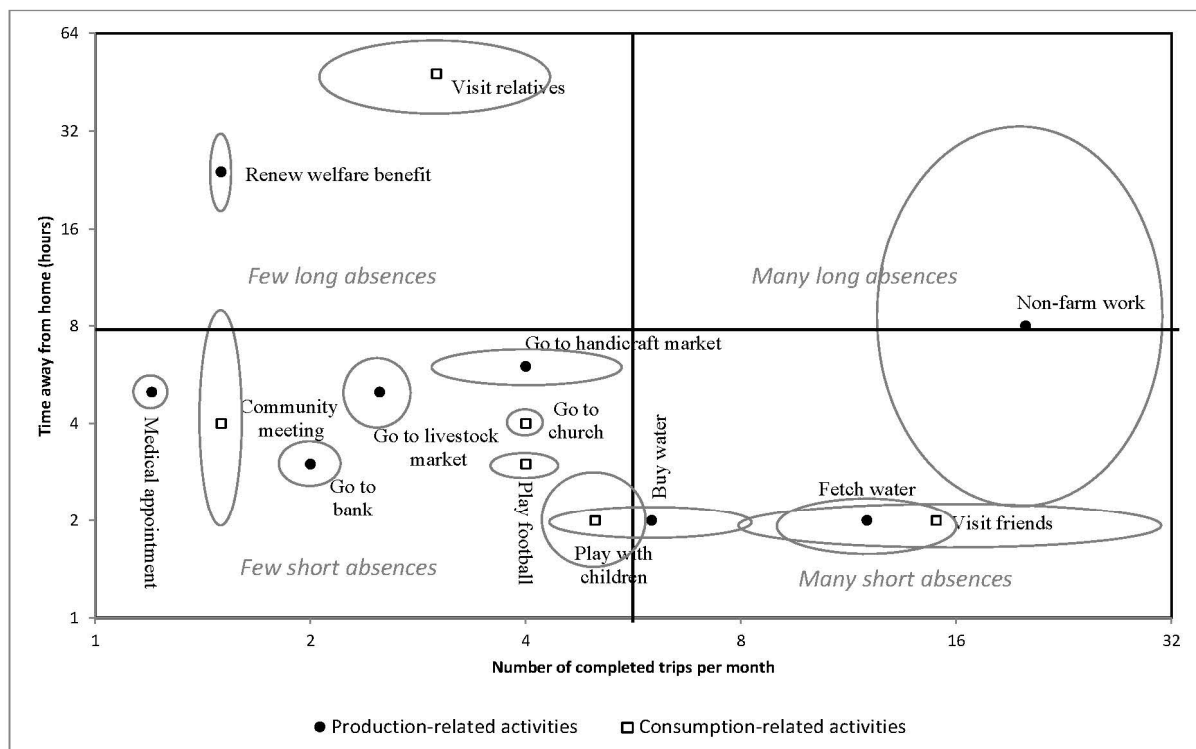


Figure 9.7 Frequency, duration and variability of the most frequently cited customary circulatory movements prior to the 2010-2013 drought (n=138 individuals)

The 2010-13 drought resulted in a number of alterations to the spatiotemporal signature of temporary mobility and introduced a range of new moves among many households. Figure 9.8 shows the changes in median duration and frequency of production-related movement resulting from the drought. Customary activities are identified by circular symbols with

arrows indicating the change from pre-drought timing (solid symbols) to timing during the drought (open symbols). Key changes include a marginal increase in the frequency of trips associated with non-farm work, and a substantial rise in their average duration, as households sought work more distant from home, often travelling as far as the state capital, 150km away, to supplement their budget. In contrast, trips to local livestock markets reduced in frequency as households struggled to support their animals during the drought, though such trips also increased in duration, perhaps because farmers stayed longer at market hoping to reach more consumers. In a semi-arid environment undergoing drought, access to water inevitably figures as a major focus. Paradoxically, trips to fetch water actually declined in frequency because local publicly accessible dams dried out. Conversely, trips to buy water registered a sharp rise in frequency. Interviews recorded during fieldwork reveal the shift in behaviour: *“The local dam has been dry since the first half of 2013. There is no provision to keep livestock unless we keep moving the animals in search of pasture, or sell the little we have to buy fodder.”* Figure 9.8 also reveals that some new activities, such as hunting and the acquisition of loans (signified by hollow triangular markers), entered household livelihood portfolios as they fought to mediate the hardships brought about by the drought.

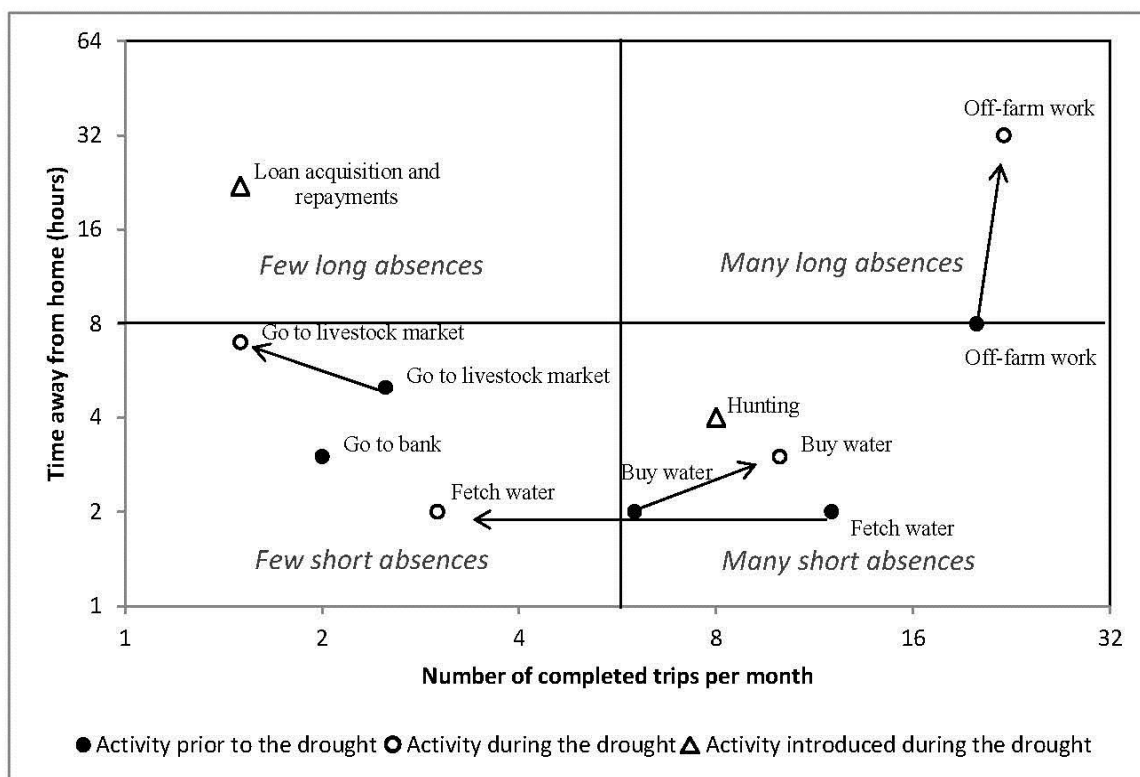


Figure 9.8 Frequency and duration of the most frequently cited production-related movements prior to and during the 2010-13 drought (n=138 individuals)

Figure 9.9 shows that some consumption-related activities reduced in both frequency and duration. Visits to relatives occurred at longer intervals and reduced in length because of the financial burden of such trips. Visit to friends displayed a similar pattern, though with a less sharp reduction in frequency. On the other hand, religious observance, as indicated by church attendance, increased in frequency during the hardship, while new undertakings such as prayer group meetings also emerged among some respondents. Such meetings often include the participation of ‘*profetas da chuva*’ (rain prophets) who provide climate forecasts based on local traditions. Such meetings commonly occur within the confines of the municipality, invoking a sense of belonging linked to traditional activities in the semi-arid Northeast of Brazil (Greenfield 1993).

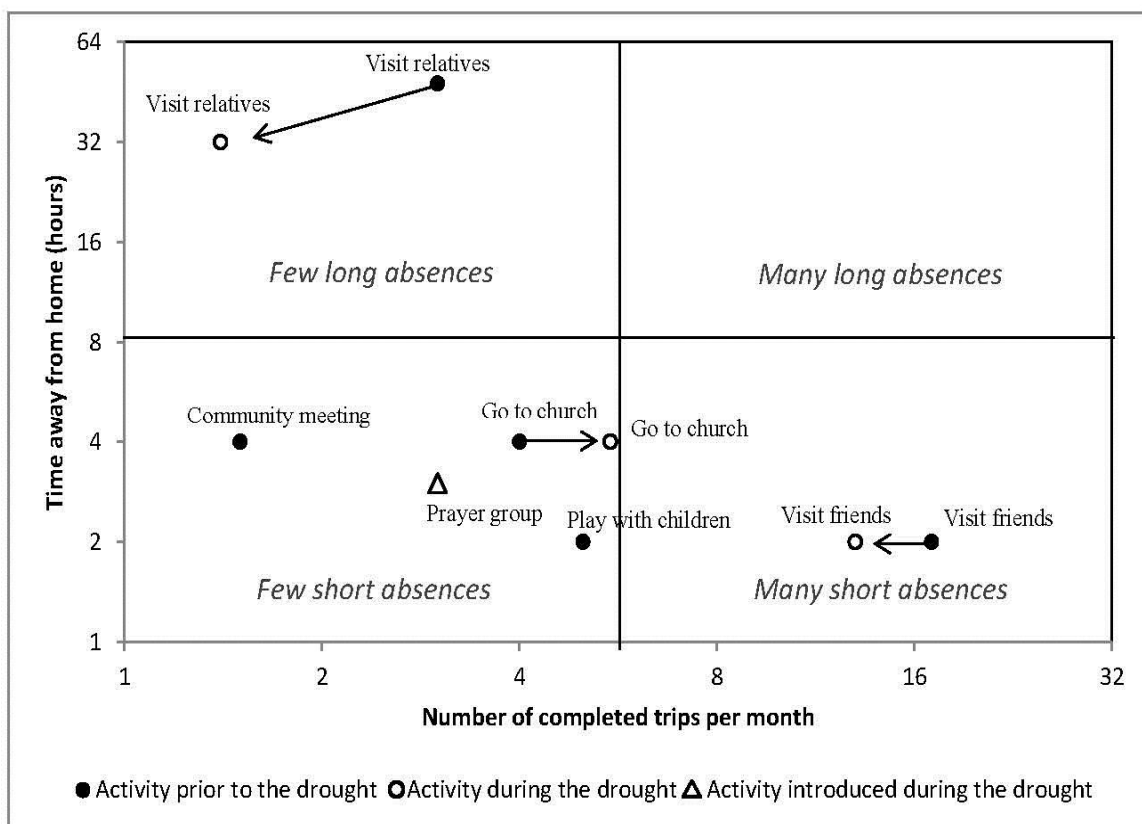


Figure 9.9 Frequency and duration of the most frequently cited consumption-related movements prior and during the 2010-13 drought (n=138 individuals)

Breakdown of the occupation data by household type underlines the relationship between main source of income and variations in the local circulation in the study area. Among all respondents, commercial livestock-oriented household members move about most frequently and with wider variation in time spent away from home, in number of completed trips per month and in purpose. As a result, the 2010-2013 drought seemed to have impacted the local circulation of this group the most. Conversely, welfare dependent

households members travel the least and with a limited range of purposes. To cope with the effects of the drought, members of this group employed a wide range of mobility responses, reflected in the number of activities introduced during the drought. The discussion below reveals the five most cited production and consumption-related moves prior and during the 2010-2013 drought for each household type.

9.5.1 Local circulation of members of welfare dependent households

Prior to the 2010-2013 drought, members of this household type displayed limited variation in the purpose of production-related moves. The most frequently reported were associated with trips to collect water, to go to bank to collect the welfare benefit, occasional non-farm work, and periodic trips to large urban centres with the purpose of renewing the welfare benefit (Figure 9.10). The drought did not impact on the frequency of trips associated with welfare claims, however, its impacts were felt across other livelihood dimensions, resulting in a number of mobility responses. For example, productivity of subsistence agriculture was greatly reduced, resulting in household members supplementing their diet by hunting small rodents and birds. The drying out of local dams triggered a mobility response in the form of trips to the urban centre to purchase water. Household members also engaged in trips to large urban centres to acquire a loan which provided some financial relief to these households. Household members who engaged in occasional non-farm work prior to the drought, found off-farm work in the more productive lands in the neighbouring city of Uruburetama, resulting in an increase in both frequency and duration of trips.

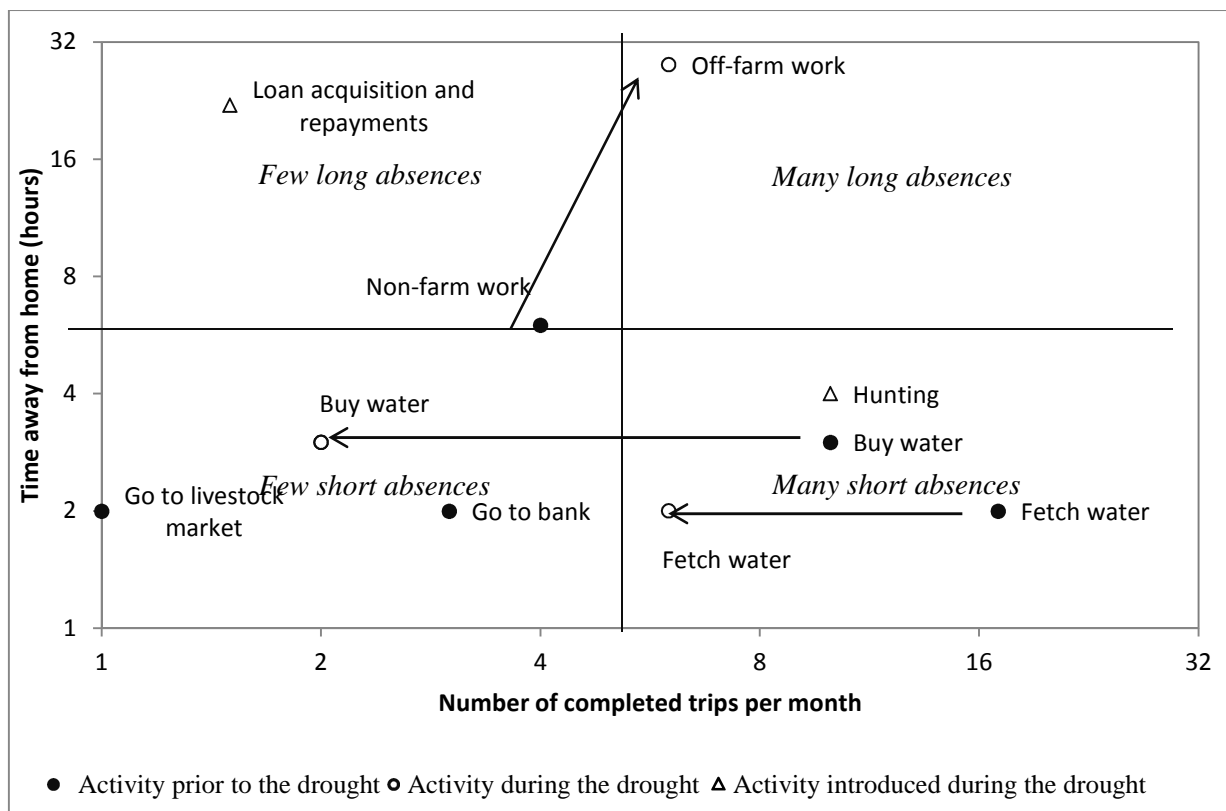


Figure 9.10 Frequency and duration of the most frequently cited production-related movements prior to and during the 2010-13 drought in welfare dependent households

Consumption-related moves in this household group generally do not involve frequent long-distance trips, with the notable exception being trips to visit relatives. Most social activities are performed locally and were subsequently not greatly altered by the 2010-2013 drought. As mentioned in the previous section, religion is a notable feature of semi-arid Northeast Brazil, and the importance of this activity increases in times of hardship, particularly among vulnerable groups. As a result, Figure 9.11 shows that religious activities increased in frequency, and a new activity such as the participation in praying groups was introduced to help cope with the impacts of the drought.

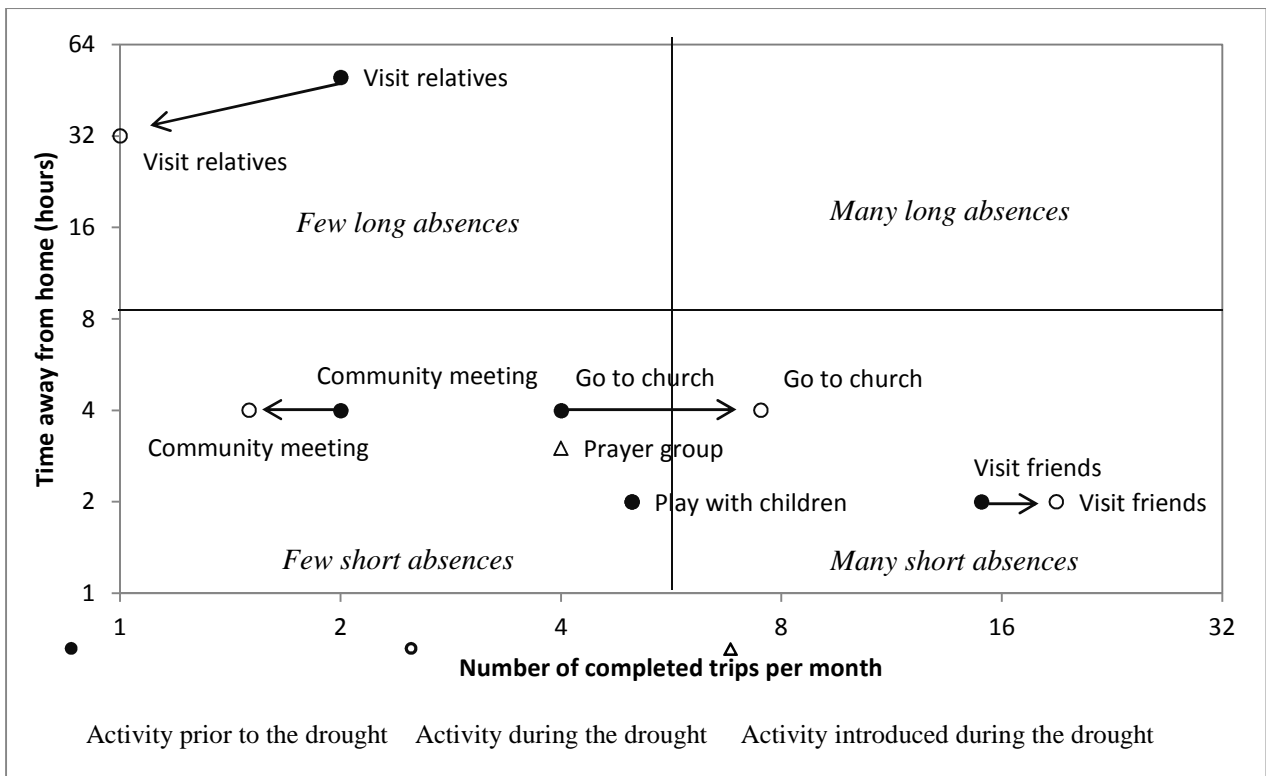


Figure 9.11 Frequency and duration of the most frequently cited consumption-related movements prior and during the 2010-13 drought in welfare dependent households

9.5.2 Local circulation of members of mixed livelihood households

Production-related moves in this group involve a combination of occasional trips to farmers' markets as well as journeys for non-farm work. Due to the financial costs, most households which had livestock sold their animals during the 2010-2013 drought. As a result, trips to markets were reduced. Several mixed livelihood households also benefit from welfare grants as a source of income, which, like their welfare dependent counterparts, entail periodic trips to large urban centres to renew the allowance. Figure 9.9 shows that customary trips to collect water from the local weirs were greatly diminished, resulting in an increased number of trips to purchase water.

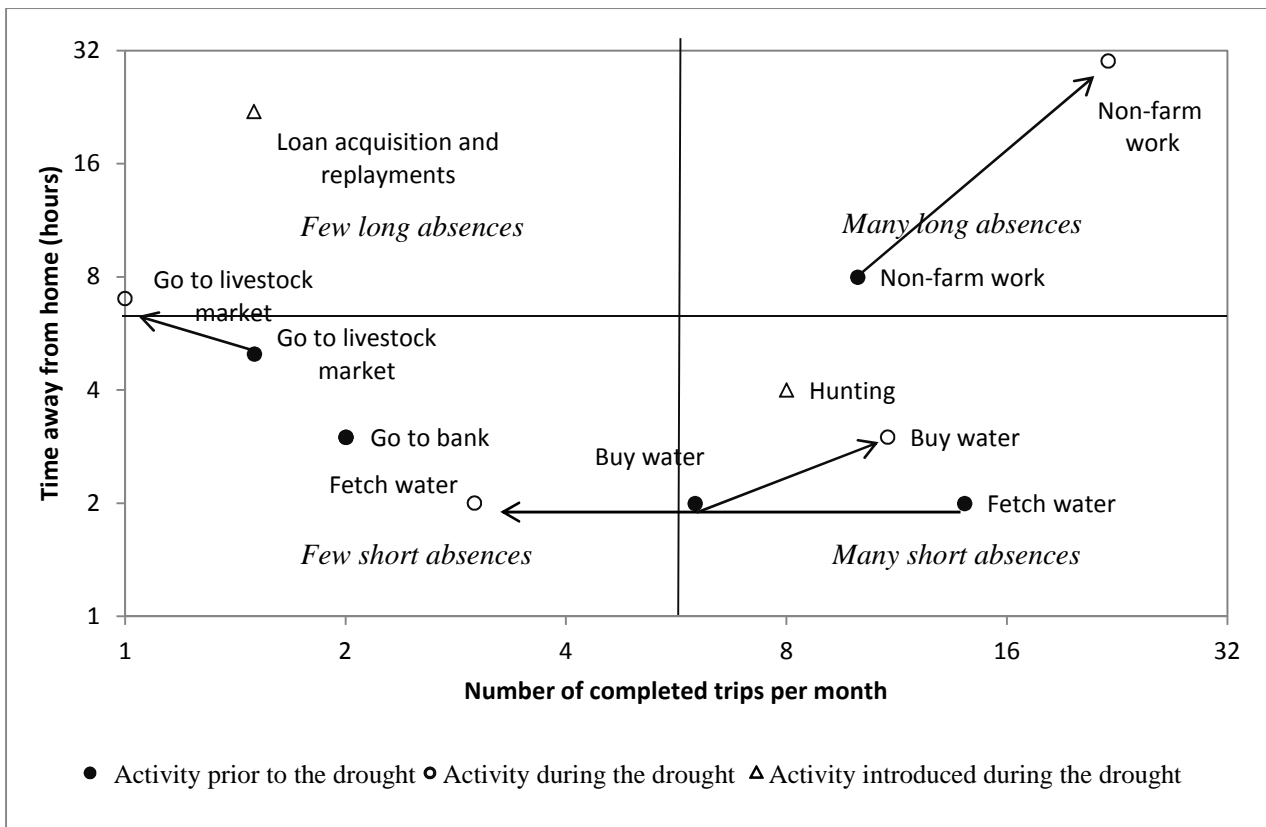


Figure 9.12 Frequency and duration of the most frequently cited production-related movements prior to and during the 2010-13 drought in mixed livelihood households

Like the other three household types, members of mixed livelihood households reduced both the frequency and duration of costly consumption-related moves, such as visits to relatives living in other cities (Figure 9.12). This group recorded an increase in the frequency of visits to friends living locally, which corroborates the findings of Chapter 6 where the importance of social capital in coping with climatic events in the region was reported. Consumption-related moves associated with religious activities also recorded an increase in frequency (Figure 9.13).

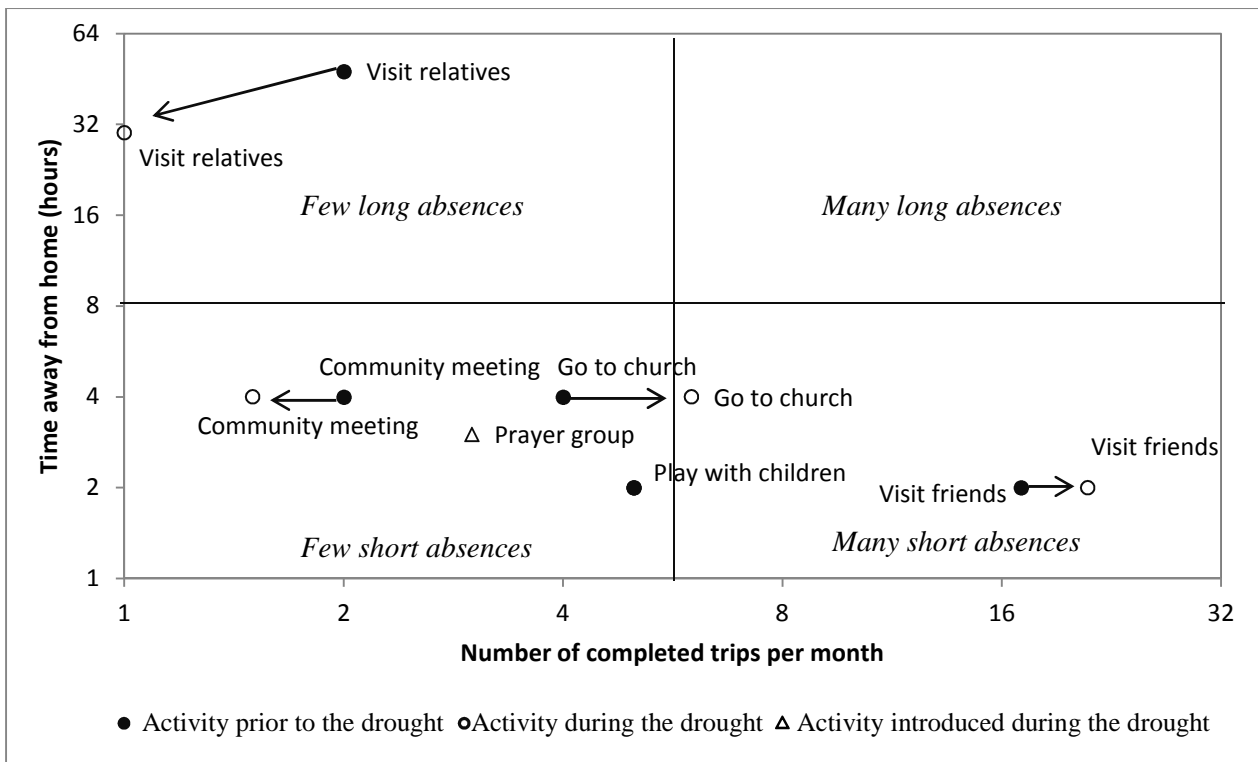


Figure 9.13 Frequency and duration of the most frequently cited consumption-related movements prior and during the 2010-13 drought in mixed livelihood households

9.5.3 Local circulation of members of non-farming households

Non-farm work was the most cited production-related move for members of this household type. Workers are employed in local businesses in the district where they live, or have a full-time employment in the urban centre of the municipality. These individuals travel for work on weekdays, and those who remained employed during the 2010-2013 drought did not experience any change in either the duration or frequency of trips. Respondents who lost their jobs in Irauçuba found full-time employment in neighbouring cities, resulting in extended lengths of time spent away from home. Other production-related moves associated with their main source of income, such as trips to the bank, remained unaltered during the drought. Figure 9.14 shows that basic household necessities such as water collection at local weirs were greatly impacted, causing significant changes in the pattern of circulation associated with this activity. Like the other three household types, trips to the urban centre of Irauçuba, and to local distribution centres, were a form of response to water shortages.

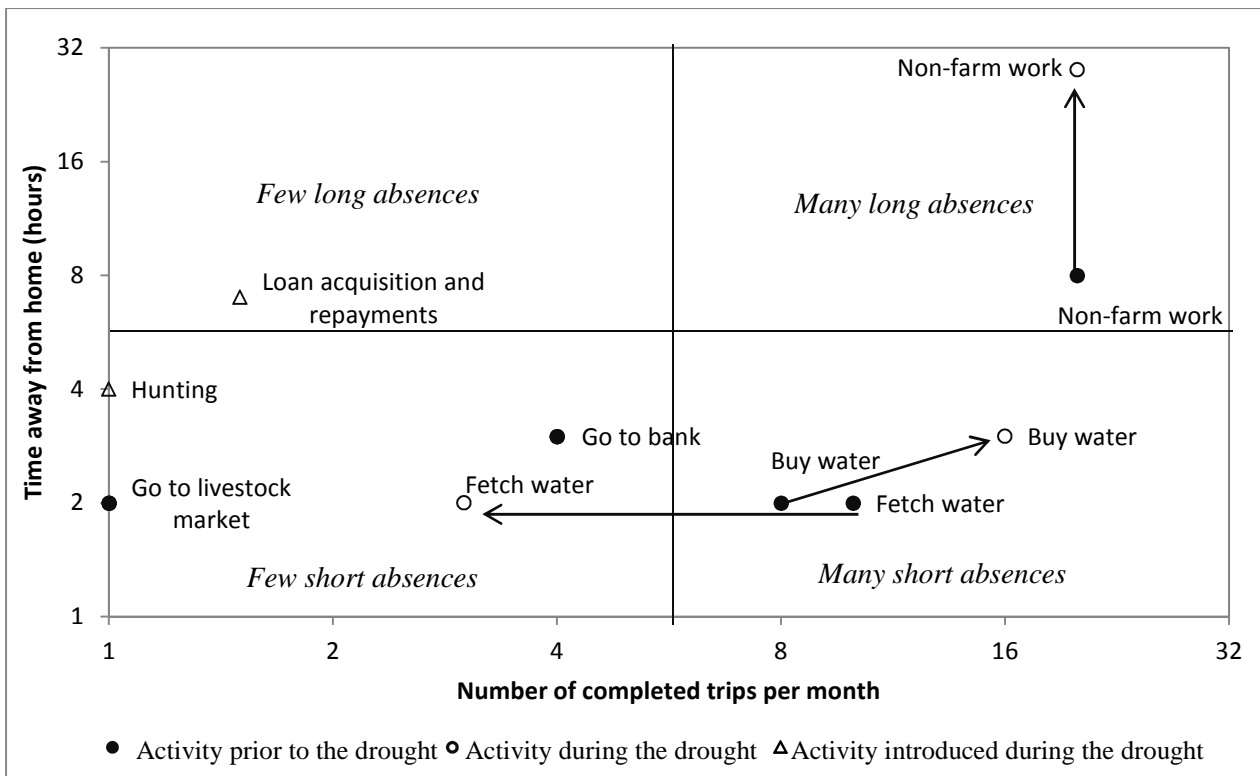


Figure 9.14 Frequency and duration of the most frequently cited production-related movements prior to and during the 2010-13 drought in non-farming households

Consumption-related moves were greatly altered during the 2010-2013 drought. Due to their financial capacity, members of non-farming households tend to frequently engage in leisure activities frequently. However, due to the perceived impacts of the drought such as the increased costs of food and water, as well as the instability of the non-farm labour market, the frequency and duration of costly consumption-related activities were reduced in favour of local activities (Figure 9.15)

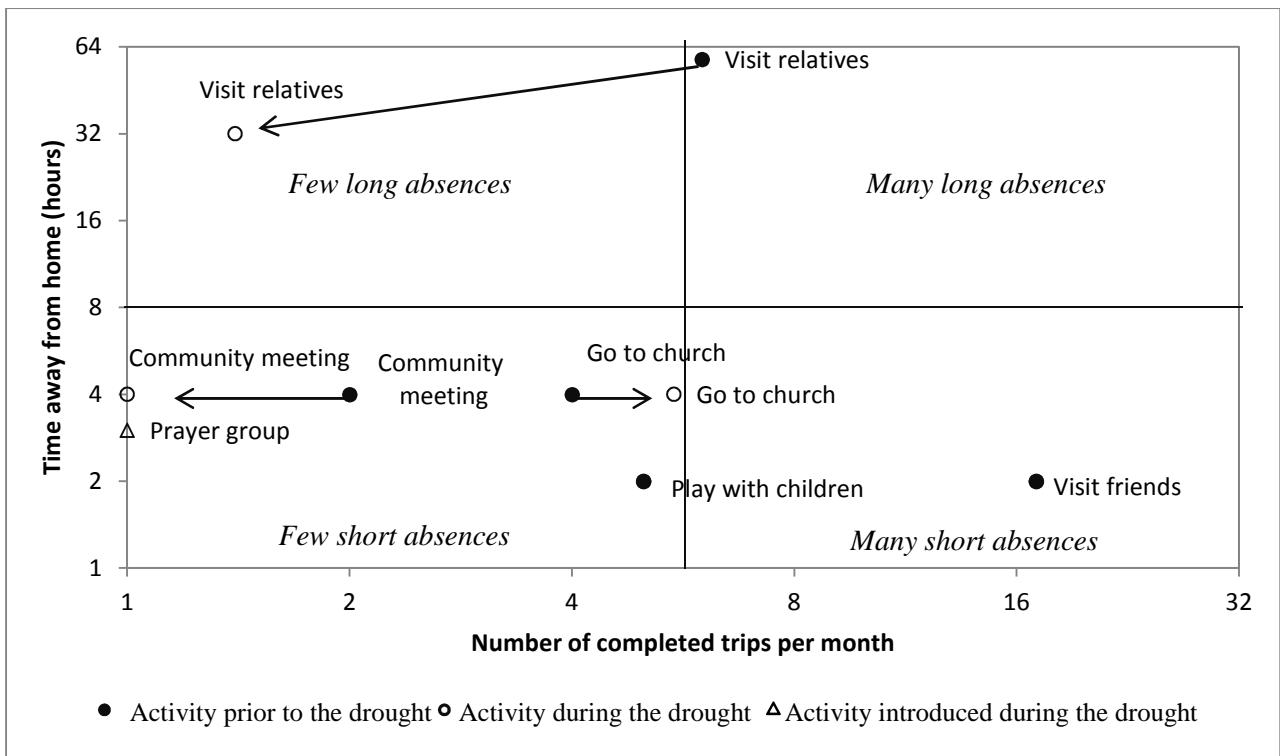


Figure 9.15 Frequency and duration of the most frequently cited consumption-related movements prior and during the 2010-13 drought in non-farming households

9.5.4 Local circulation of members of commercial livestock-oriented

The main economic activity of this household type is associated with the production and distribution of animal produce. These households also have members who are engaged in non-farm work in the municipality of Irauçuba. Trips to the local farmers' market and to markets in the surrounding municipalities usually occur between four to six times per month. Most individuals involved in these trips leave their residence early and return in the evening to increase the chances of profit. One of the main impacts of the 2010-2013 drought was felt in commercial livestock-oriented households who either lost or sold animals, which in turn reduced the potential financial gains from the activity. As a result, Figure 9.16 revealed that the frequency and duration of trips to farmers' markets was greatly reduced. Members who had casual non-farm work were forced to leave the activity to help on the farm, as livestock had to be moved long distances due to the drying out of local weirs.

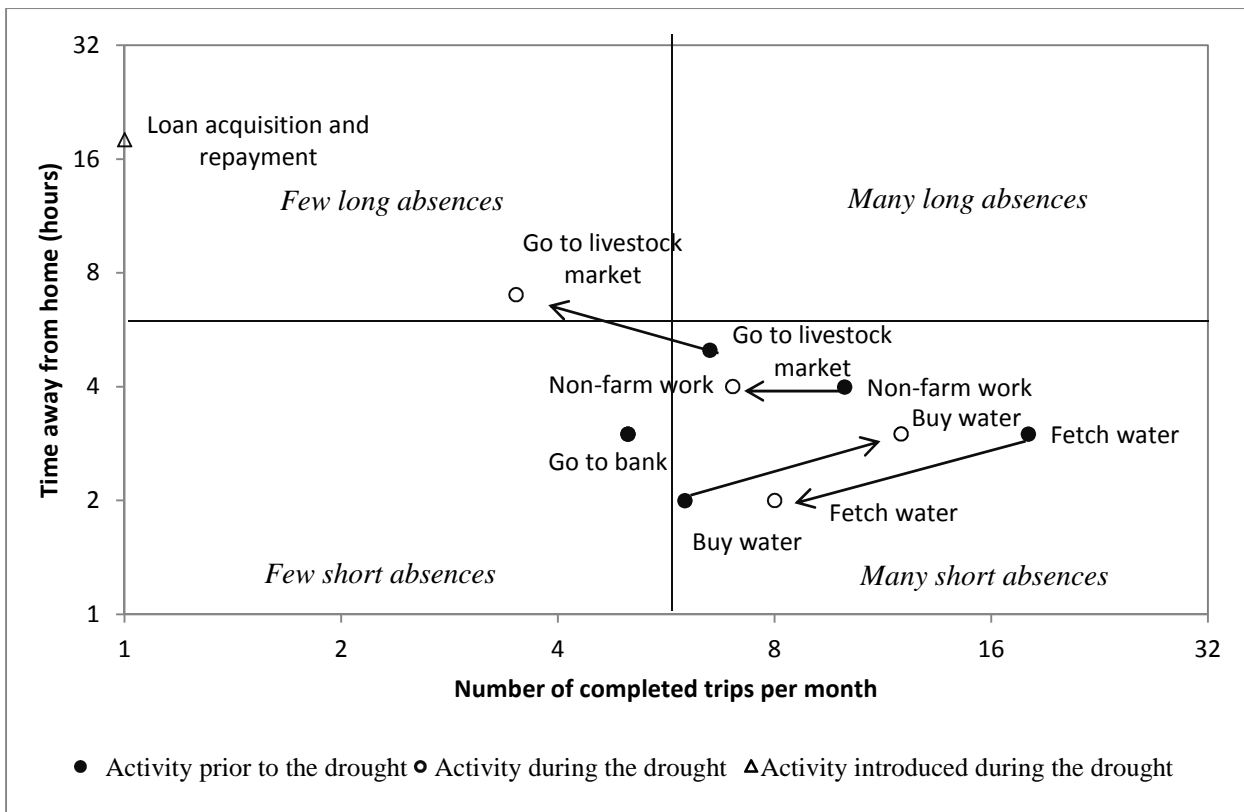


Figure 9.16 Frequency and duration of the most frequently cited production-related movements prior to and during the 2010-13 drought in commercial livestock-oriented households

Consumption-related activities were also impacted by the 2010-2013 drought. Both the frequency and length of stay of trips to visit distant relatives displayed changes as a form of expenditure reduction (Figure 9.17). Other activities which involve trips outside their district, such as intra-municipal festivities, halted or were greatly reduced. Of note is the increasing trips involving religious activities.

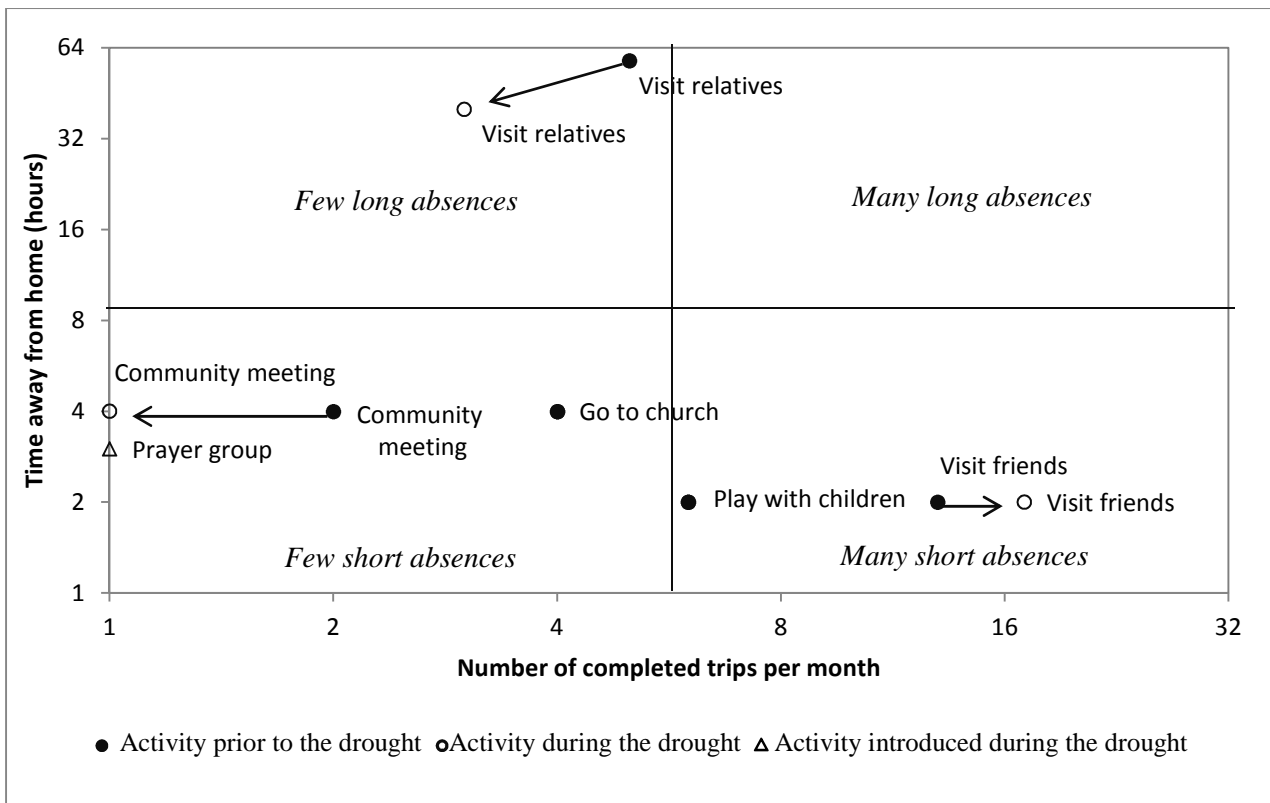


Figure 9.17 Frequency and duration of the most frequently cited consumption-related movements prior and during the 2010-13 drought in commercial livestock-oriented households

9.5.5 Summary of local circulation in the study area

This section focused specifically on identifying customary forms of everyday mobility and the changes which occurred in response to the 2010-2013 drought. Plotting frequency against duration on an x-y scatter graph reveals distinctive patterns of spatial behaviour and systematic shifts in response to drought, extending across both production and consumption-related movements. Overall, there was a sharp increase in non-farm work across three (welfare dependent, mixed livelihood and non-farming households) of the four household types identified in Chapter 6. In addition, there was a reduction in trips to market and a change in patterns of movement to secure water. New forms of mobility emerged, notably hunting to supplement subsistence, and seeking loans to supplement income. At the same time, visits to friends and relatives reduced in frequency while church attendance increased. Important social activities, such as trips to attend community meetings, continued, albeit with a slight reduction in frequency. Table 9.7 summarises these differences among the four household types with regard to local mobility in the study area.

Table 9.7: Summary of local mobility by household type

| Household type (total) | Production-related moves | | Consumption-related moves | |
|---------------------------|---|--|--|--|
| | Prior to the 2010-2013 drought | During the 2010-2013 drought | Prior to the 2010-2013 drought | During the 2010-2013 drought |
| Welfare dependent (44) | Predominantly short absences with trips mainly occurring locally or within the municipality. Occasional non-farm work resulted in few short absences. | Change in recurrent activities resulted in long absences related to off-farm work. Newly introduced activities and acquisition of loans. Trips to the urban centre became more frequent. | The range of moves included many short absences which revolved around religious and community-related activities and few long absences related to visits to relatives living outside the municipality. | Frequency of both social and religious activities increased resulting in repetitive trips to visit local friends and attend prayer group. The frequency of long absences to visit relatives was greatly reduced. |
| Mixed livelihood (21) | Moves display ample variability in frequency because of the different livelihood strategies. Non-farm work involves long absences while visits to livestock market result in infrequent short absences. | Increased engagement in non-farm work during the drought resulted in long absences from home. The introduction of new activities as well as the changes in customary activities increased the spatiotemporal variation of moves. | The range of moves included many short absences which revolved around religious and community-related activities and few long absences related to visits to relatives living outside the municipality. | Frequency of both social and religious activities increased resulting in repetitive trips to visit local friends and attend prayer group. The frequency of long absences to visit relatives was greatly reduced. |

Table 9.7: Summary of local mobility by household type (continuation)

| Household type (total) | Production-related moves | | Consumption-related moves | |
|--|---|---|--|--|
| | Prior to the 2010-2013 drought | During the 2010-2013 drought | Prior to the 2010-2013 drought | During the 2010-2013 drought |
| Non-farming (15) | Non-farm work is the main source of income for this household type, resulting in long absences from home. Other activities relate to basic household needs result in few or many short absences according to the purpose of the activity | Changes in the non-farm work routine resulted in increased time spent away from home. Basic production-related moves such as the purchasing of water greatly increased in frequency. New activities such as loan acquisition resulted absences of variable duration | Few long absences related to time spent with relatives who live outside of the municipality. Religious and social activities result in few and many short absences. | The frequency of visits to relatives decreased substantially but time spent away from home only changed marginally. Consistent with the other household types, trips associated with religious activities increased in number, whereas community meetings which may require commuting long distances declined in frequency |
| Commercial livestock- oriented (10) | The majority of production-related activities revolve around frequent short absences. Visits to sell livestock produce at local markets in neighbouring municipalities are the main source of income. Part-time non-farm work is frequent | Production-related activities associated with income decline in frequency. However, the length of the trips to livestock markets increased. Acquisition of water for human consumption greatly increased in frequency | Due to the nature of the main source of income of this household type, which demand the presence of members on the farm, the distribution of consumption-related moves revolves around short absences with the exception of visit to relatives | Like the other three household types, consumption-related moves declined in both time spent away from home and number of trips per month. A notable exception was the increase in the number of trips dedicated to visiting friends. |

One of the key features of the MISTIC toolkit is that it enables direct recording of information on the reasons people move. With that information, it is possible to assess the relative significance of production- and consumption-related moves for sample household members. Associated with these two types of movements is the notion that differences in capital assets and livelihood strategies determine the extent to which key dimensions such as duration and frequency shape spatial mobility. Table 9.7 shows that production-related moves across all four household types involve variable durations and numbers of trips completed in a month. Moreover, the analysis enables comparison of the differences among household types.

Prior to the 2010-2013 drought, production- and consumption-related moves recorded in welfare dependent households displayed limited temporal variation and did not involve a large number of trips. In fact, a first appraisal indicates that the circulation of members of this household type is judiciously planned and associated with occasional non-farm work and the fulfilment of basic needs. However, the 2010-2013 drought triggered changes at both ends of the spectrum of activities. Engagement in off-farm work outside the municipality resulted in longer periods of absence from home. The infrequent consumption-related trips to visit relatives were halted due to the financial costs of travel. On the other hand, the frequency of religious trips increased slightly, revealing the different strategies by which households in the study area cope with external stressors such as climatic events.

The impact of the 2010-2013 drought resulted in significant variation in the local circulation of members of mixed livelihood households. The customary production-related mobility recorded for this household type involves trips of variable duration and frequency due to its diversified livelihood strategies. During the drought, trips to livestock markets decreased in frequency because many farmers sold or lost their animals. On the other hand, like welfare dependent households, non- and off-farm work trips increased in duration. New production-related activities such as hunting were introduced to mediate the impact of the drought. With regard to consumption-related moves, visits to friends increased in frequency. This corroborates the findings in Chapter 6, which emphasized the importance of social capital during periods of hardship. Of note is the addition of new religious activities such as the attendance at prayer groups.

As shown in the diagrams, non-farming households have a clear local circulation pattern associated with their full-time employment in non-farm work and in the basic activities of everyday life. One important feature of consumption-related moves is the high frequency and duration of trips to visit relatives outside the municipality, compared with the other three

household types. These trips were greatly impacted during the 2010-2013 drought, resulting in a substantial decrease in the number of completed trips per month. Of note is the increased frequency of religious activities during the drought. On the other hand, community meetings, such as the one depicted in Figure 9.18, halved in frequency.



Figure 9.18 Local residents gathering outside a community centre in Caxitore

The local circulation of members of commercial livestock-oriented households displays a singular feature. The majority of production-related moves resulted in frequent short absences. This is explained by the type of economic activities performed by this household group. Frequent trips to several livestock markets, which take place in the municipality of Irauçuba and in neighbouring towns, are a key aspect of the everyday life of members of commercial livestock-oriented households. Many short trips to fetch water from the local dams or buy water in the urban centre were also captured. The 2010-2013 drought resulted in the reduction of both duration and frequency across many production-related moves, including the number of trips associated with non-farm work, as members engaged in this activity were called back to assist on the farm. Like the other three household types, consumption-related moves experienced a decline in time spent away from home and

number of trips completed, with the notable exception of visits to friends, which increased in frequency.

From the empirical analysis of the rural Irauçuba data summarised in this chapter, there is evidence that local circulation is an important feature within the broad continuum of mobility behaviour. Moreover, production- and consumption-related moves are key features of the everyday life of people in rural areas. The findings reported here suggest that households in the study site did not respond to the 2010-2013 drought in the same way. Accordingly, members of the sample households changed their circulatory pattern to optimize access to activities in various domains in order to mediate the impact of the drought in accordance with each household type's requirements.

9.6 Local mobility, capital assets and livelihoods

Chapter 6 established that households in the study area have different levels of access to capital assets which mediate their livelihood strategies. Because households are risk averse, they seek to minimise losses by allocating resources across a range of a livelihood strategies (Ellis 1998). One of these strategies is associated with asset sales which are transformed into financial capital used to secure basic household needs during hardship (Chambers and Conway 1992). Another strategy commonly pursued is the use of funds kept in a savings account, which also form part of the portfolio of assets available to households (Moser 2007). This section investigates how these assets affect changes in local mobility among the four household types in the study area. Table 9.8 shows the proportion of households with a savings account, and the proportion of households which sold assets during the 2010-2013 drought.

Table 9.8: Access to savings account and asset sales during the 2010-2013 drought

| Asset | Household type (Total) | | | |
|------------------------------------|-------------------------------|------------------------------|-------------------------|---|
| | Welfare- dependent (44) | Mixed- Livelihood (21) | Non- Farming (15) | Commercial livestock- oriented (10) |
| Savings account (%) | 12 | 24 | 80 | 90 |
| Sold assets during the drought (%) | 11 | 23 | 33 | 70 |

Source: Field survey (2014)

There is wealth of literature on the importance of savings as a household insurance against the impact of droughts and other climatic events (Banerjee and Duflo 2007; Benson and Clay 1994). Households often tap into this resource when agriculture and livestock output is severely affected. Table 9.8 shows that the majority of non-farming and commercial-livestock oriented households have access to a savings account, in comparison with the other two groups. The empirical evidence suggests that access to savings affects the nature and the extent of changes in local mobility. All four household types reported changes in mobility patterns for both production- and consumption-related activities during the 2010-2013 drought, but these were less pronounced in non-farming and commercial-livestock oriented households. This suggests that households with access to savings use these funds to cope with income losses due to agriculture failing or loss of non-farm work, without needing to make drastic changes in local circulation in response to hardship. With limited access to the financial safety net provided by accrued savings, welfare-dependent and mixed livelihood households sought alternative coping strategies, which resulted in longer periods of absence from home.

Table 9.8 also revealed that all four household types sold assets during the drought. In the majority of cases, these assets were farm tools, livestock, and material goods such as motorbikes, bicycles and mobile phones. Asset sales are a common survival strategy employed by subsistence farmers in many drought-prone areas of the world (Swinton 1988). The funds obtained help households to cope with hardship. In the study area, asset sales affected local mobility associated with production-related activities in two ways. Less asset-endowed households, which were not able to liquidate assets, displayed more pronounced changes in local mobility. Members of welfare-dependent and mixed-livelihood households were more likely to engage in off-farm and non-farm work outside the study area, which caused longer absences from home. Conversely, non-farming and commercial livestock oriented households were able to liquidate assets in order to reduce the impact of the recent drought. Asset management was an important strategy in commercial livestock-oriented households. The strategy involved cutting herd size in order to reduce their resource and avoid financial loss due to animal death. As a result, members of this group reported that the frequency of trips to farmers markets was reduced during the 2010-2013 drought. Earnings from livestock sales generated sufficient income to purchase water and other basic household needs without interfering substantially in circulation patterns. Commercial livestock-oriented households' spatial mobility during the drought continued to involve

predominantly short absences of their members (the bottom right quadrant in the xy scatterplot).

The analysis indicates that commodities such as savings or physical goods and livestock, which are part of household's portfolios of assets, not only mediate livelihood strategies but also shape changes in local mobility as a response to the impacts of the 2010-2013 drought. The empirical evidence revealed that the frequency and length of time spent away from home varied among all household types. These differences reflect the level of access to capital assets available to residents of the study area.

9.7 The role of local mobility in the study area within the context of the environment-migration relationship

The findings presented in Chapter 8 refute previous notions that, when confronted with severe climatic, rural residents of semi-arid Northeast Brazil become an army of destitute drought-fleers roaming around the country. On the one hand, permanent migration is closely associated with the migrant life-cycle stage. According to household heads, climatic hardship had limited direct impact on the decision to relocate. On the other hand, seasonal migration is a recurring livelihood strategy employed by many households, irrespective of the occurrence of droughts in the region (although, it should be noted that the findings in Chapter 8 suggest that seasonal moves become an effective household response to these events). But what is the role of local mobility in the context of severe climatic events such a drought? The answer to this question is what has been missed in the majority of studies examining the relationship between the environment and migration.

Spatial mobility occurs along a spatiotemporal continuum which ranges from temporary moves to permanent relocation (Figure 9.16). Local circulation is situated within the latter, as it does not entail a permanent change of usual address. In fact, the vast majority of population movements do not result in the crossing of an administrative boundary. In his seminal work, Zelinsky (1971) emphasized the importance of circulatory movements in everyday activities such as social visits, religious activities and farming in pre-modern and transitional societies.

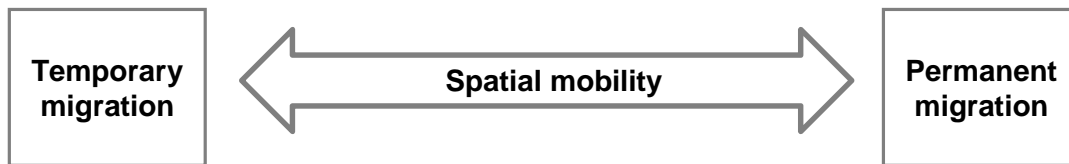


Figure 9.19 Spatial mobility continuum

The findings presented in this chapter corroborate Zelinsky's view. The majority of daily activities related to both production and consumption, which form part of the livelihood of the residents of rural Irauçuba, result in a territorial movement of some form. For example, respondents regularly perform many trips to collect water from the local dams over a month. At the other end of the spectrum, some residents of sample households reported sporadic trips to community meetings. In essence, local circulation is repetitive in nature and can have variable duration and multiple frequencies. The analysis of these movements by migration scholars has been constrained by the challenges in measuring these variables.

What is important to note is that local circulatory movements take place concomitantly with other mobility responses to climatic events. In fact, an argument can be made that more immediate adjustments in the livelihood strategies result in changes in the pattern of local circulation, before a potential migration response is envisaged by individuals or households. Previous studies investigating coping mechanisms in the Sahel suggests that farmers employ a range of strategies such as changing crops, selling livestock and engaging in handcraft activities occur locally (Mertz, Mbow, Reenberg and Diouf 2009; Mortimore and Adams 2001). Despite the different socioeconomic and cultural background, the analysis in chapters 6 and 7 indicated that similar *in situ* practical measures were employed by households in rural Irauçuba to respond to the 2010-2013 drought. Furthermore, Chapter 8 showed that seasonal migration depended to a large extent on people's access to networks and the availability of off-farm and non-farm work elsewhere. Indeed, seasonal work outside the municipality seemed not to be available, or was not pursued at all by sample households. Perceived livelihood stressors thus do not necessarily translate into migration. Rather, diurnal, daily and weekly trips, which are complementary to the broad spectrum of mobility behaviour, are the first to be impacted and undergo changes to adapt to the new circumstances imposed by a climatic event.

Despite the evidence discussed above, the majority of previous studies have bypassed, or dedicated limited attention to, temporary forms of local circulation in the context of climatic and other environmental hazards, yet this form of population movement is an integral part

of the spatial mobility continuum. A broad understanding of local circulatory moves provides essential empirical insights into the way spatial mobility changes in response to droughts. In particular, it expands the basis within which to address the direct forms of the impact of climatic events on population movement, which have long eluded researchers in this field. This discussion will be further elaborated in the concluding chapter.

9.8 Conclusion

With the notable exception of contemporary research in the Pacific (Campbell 2014), most empirical work linking climate change to mobility has been framed around migration as a response of last-resort. Less attention has been given to the way individuals, households and communities adjust existing forms of circular and temporary mobility in the face of environmental stress. These varied types of movement are integral to the lives and livelihoods of people dependent on subsistence farming in marginal areas of developing countries, but they are almost invisible in conventional statistics. Fine spatial and temporal detail is needed to reveal the nuances of adaptation to change. This in turn calls for recognition that mobility is a multi-faceted process, and for the use of a wider repertoire of research strategies linked to measures that capture its essential dimensions (Boyle et al. 1998; Skeldon 1994).

Local circulation, which represents a temporary form of population movement, occurs within a continuum that includes other forms of spatial mobility. Changes triggered by exogenous contextual forces such as climatic and other environmental stressors, may cause a shift in spatial mobility behaviour. The drought in rural Irauçuba provided the background against which to test the conceptual model presented in Chapter 4. The empirical evidence presented here showed that mobility responses assumed different forms across the full spectrum of the spatial mobility. Concurrently, the results also show that these moves were mediated by exogenous (macro socioeconomic structure and institutional responses) and by endogenous (access to capital assets and livelihood strategies) factors within which households in the study area were embedded. Differences in the patterns and forms of local circulation prior to and during the 2010-2013 drought were recorded across the four household types, with variation among households reflecting different levels of access to capital assets and livelihood strategies.

The empirical evidence indicated that local mobility has a tendency to lie in the lower quadrants of the xy scatterplot, revealing a strong attachment to home, even if the frequency

of some production- and consumption-related trips is high. The unique data captured in the field revealed that the length of time spent away from home and the number of completed trips per month recorded for the majority of these activities showed systematic changes in response to the 2010-2013 drought. First, the change in the frequency of trips associated with off-farm and non-farm work resulted in long absences from home. This occurred in response to the declining agricultural productivity and work opportunity in the study area. The number of trips completed to fulfil basic household needs, such as water collection, was greatly reduced in favour of increased movement to purchase water in the urban centre of Irauçuba. Consumption-related activities such as inter-municipal trips to connect with relatives, which normally incur long periods of absence, were greatly reduced due to the financial costs involved in the activity. Of note was an increase of movement associated with religious activities during the drought.

The changes in the local mobility affected the four household types in different ways. The findings suggest that the level of access to capital assets and main source of income played an important role in determining the form of these changes. The two less asset-endowed household types, Welfare-dependent and Mixed-livelihood, recorded the most significant changes in local circulation associated with both production- and consumption-related activities. This is explained by the limited access to financial and physical assets which could be used to reduce the impact of the drought on their livelihoods. With the absence of savings or few animals to sell, the members of these two groups sought work outside the municipality in order to generate income for the household. Several activities, such as hunting for small rodents and birds, were introduced during the drought to respond to the decline in subsistence agriculture output. On the other hand, social capital, in the form of support from friends and the community, became an important asset during the hardship, thus resulting in an increased number of trips associated with this form of consumption-related activity. The changes recorded for Non-farming and Commercial livestock-oriented households were associated with the main source of income, but with different results. Members of Commercial livestock-oriented households reported a decline in the number of trips to local farmers' markets as a result of the loss or selling of animals. However, the duration of these trips was increased because farmers wished to improve their potential of doing business with fewer resources. Non-farming households recorded few changes in their local circulation, except for basic household consumption such as water collection, as the majority of local dams dried out. The reduction in consumption-related activities among households

in this group was also less pronounced, indicating a more conservative use of the financial capital during the hardship.

It is clear that the residents of the study area adjusted their livelihood strategies through changes in local mobility over the course of the 2010-2013 drought. The conceptual model guiding this study indicated that spatial mobility is mediated by both external and internal factors to households, and reflect livelihood strategies and access to capital assets. The impact of a climatic event affects these factors, resulting in changes in the dimensions of mobility. This was represented by variation in the timing and sequencing of trips associated with customary production- and consumption-related activities captured in the xy scatterplots. The inclusion of new activities to respond to the drought also represented evidence that changes in local mobility behaviour formed part of the coping strategies in the study area.

Conventional practice in many studies investigating the links between severe climatic events and spatial mobility is to separate migrants into two groups; 'movers' and 'stayers'. This coarse distinction overlooks a range of circulatory practices which are a fundamental part of the lives of residents of marginal rural areas. Non-permanent movements have a range of dimensions which have been largely overlooked by previous studies. If progress is to be made in understanding more nuanced forms of mobility response to climate change and other environmental hazards, continuing attention is needed to develop strategies to overcome the challenges of data collection, as well as to develop suitable methods of analysis based on the established theories of temporary forms of population movement. A potential way forward in this unexplored territory is discussed in the concluding chapter.

Chapter 10. Conclusion

10.1 Introduction

Piguet (2012) argued that contemporary migration studies neglected earlier efforts within their discipline to contend with the role of the environment. Over the last decade, significant progress has been made in understanding this relationship. This renewed interest has raised new theoretical and methodological challenges. The significance of permanent migration and seasonal moves in response to climatic events and other environmental hazards is well documented. However, little attention had been dedicated to capturing and measuring variations in local mobility. This limitation is unfortunate because local mobility is a key part of the everyday life of inhabitants of marginal rural areas which are cyclically impacted by climatic events, and is associated with production- and consumption-related activities which form the livelihood of households in these regions. Moreover, despite the longstanding recognition that spatial mobility is a key strategy to maintain livelihoods and adapt to the effects of climate variability, previous work has largely omitted local mobility from consideration in theoretical models examining the relationship between the environment and migration. As a result, empirical analyses have tended to neglect these forms of population movement which are part of the full spectrum of spatial mobility, with little evidence taken from rural areas of the developing world. To overcome these problems, this thesis argued that a comprehensive research approach is needed, which focuses on mobility in a broad context that considers its multiple forms and connections with household livelihood strategies and access to capital assets.

This thesis sought to contribute to filling these gaps by arguing for a shift away from attempts to examine the environment-migration nexus using static push-pull frameworks, which treat migration as a unidirectional response of last-resort, in favour of a broader and more robust framework of analysis. In practice, this thesis argued that migration is a complex, multi-faceted phenomenon and people respond differently to its various drivers depending on individual characteristics, household composition, livelihood, access to capital assets, and their contextual setting. Moreover, migration itself forms just one component in a broad spectrum of mobility behaviour.

Despite a growing body of literature, studies about environmentally-driven migration have been hindered by numerous reports focused on estimating the volume of environmentally-driven migration. In addition, excessive concern with categorising people whose mobility

decisions are impacted by climatic events and other environmental factors has been unproductive with regard to advancing the scientific understanding of this nexus. As a result, comparatively little progress has been made in understanding spatiotemporal patterns of mobility, particularly subtle forms of temporary movement in response to climatic events.

This thesis sought to address these shortcomings by undertaking a comprehensive, wide-ranging study of the relationship between climatic events, livelihoods and mobility in an overarching framework. This approach considers the linkages between socioeconomic and climatological contextual factors, household livelihood strategies and access to capital assets and multiple forms of mobility in the context of the 2010-2013 drought in semi-arid Northeast Brazil. To this end, a multifaceted research strategy drew on population and climatological secondary data, a household survey, and a new toolkit designed to capture the spatiotemporal patterns of household members' everyday mobility using a flexible, participant centred approach that facilitates data recording and subsequent analysis. A suite of statistical analyses and a range of metrics derived from population geography studies were used to analyse the connections between climatic events, livelihoods, capital assets and distinct forms of spatial mobility.

In order to summarise the main findings of this study, it is important to stress the socioeconomic context of Brazil. Contrary to Sahelian and Southeast Asian countries, the inhabitants of Northeast Brazil benefit from a robust welfare system. The *Bolsa Família* (Family Allowance), the world's largest conditional cash-transfer programme, has played an important role in providing financial support to impoverished households. The structure and dynamics of economic activity in this region, which have historically taken place on the Atlantic coast, constitute additional factors promoting population movement from the semi-arid hinterland. Operating together, these factors represent a distinct socioeconomic context that frames migration, and shapes the influence of other drivers of spatial mobility.

This final chapter is organised as follows. Section 10.2 summarise the key findings from this study. Section 10.3 then discusses its contributions and implications framed in four domains: theory, methodology, substantive knowledge and policy. Section 10.4 discusses the key limitations which constrained the study, before Section 10.5 provides directions for future research.

10.2 Summary of the main findings

To understand spatial mobility in the context of severe climatic events, this research sought to meet four core objectives:

1. *Develop a conceptual model linking spatial mobility to rural livelihood strategies in the context of severe climatic events*
2. *Establish the socioeconomic and climatic context of contemporary mobility in semi-arid Northeast Brazil*
3. *To identify the characteristics of households that shape livelihoods in rural semi-arid Northeast Brazil*
4. *Determine the variation in mobility behaviour before and after the occurrence of a severe climatic event*

To address these objectives in a coherent manner, the research strategy focused on two key aspects. First, a conceptual framework was constructed to guide the subsequent phases of this study. Building on previous frameworks conceptualising the relationship between environmental factors and migration, Chapter 4 first reviewed and discussed how this relationship had been framed in five models. A new conceptual model was then elaborated establishing linkages between mobility processes, livelihoods and external and internal dynamics embedded in household responses to climatic events. This model underlines the variety of mobility processes through the analysis of key spatiotemporal dimensions of spatial mobility, including duration, frequency, periodicity, seasonality, and distance, identified by Bell (2004).

The second aspect focused on the development of a robust methodology based on a multifaceted approach, which was discussed in detail in Chapter 3. To this end, aggregate climatological and migration data were combined with a comprehensive household survey. In addition, a unique toolkit was designed and constructed to capture customary local mobility and the changes brought about by the 2010-2013 drought in a quantifiable format. A suite of metrics derived from population geography was employed to provide robust statistical evidence on the patterns and forces driving different forms of spatial mobility in semi-arid Northeast Brazil.

These two domains of attention form the backbone of this research. The focus now turns to a summary of the main findings relating to each of the four objectives.

10.2.1 A conceptual model linking spatial mobility to rural livelihoods strategies in the context of severe climatic events

Chapter 4 developed a new model conceptualising the relationship between climatic events and spatial mobility. Building on previous conceptual diagrams, the model developed for this study argues that climatic events should not be disconnected from other factors that underpin mobility decisions. This approach focuses on the complexity of these linkages, while further arguing that spatial mobility in response to climatic and other environmental stressors should not be limited to an analytical perspective which identifies population movement as a unidirectional response of last resort.

Previous conceptual models, such as Black et al. (2011), have employed an approach that examines how global environmental change may impact existing drivers of migration. However, the limited characterisation of population movements, which form the full spectrum of spatial mobility remains unresolved, as the model identifies two outcomes: migrate or stay. Of the five conceptual models analysed in this study, only Martin et al. (2014) explicitly acknowledges a range of mobility responses. However, their model is limited by the exclusion of key spatiotemporal dimensions of mobility, which shape the circulatory movements of household members in response to climatic events.

The conceptual model advanced in this thesis goes one step further by including key spatiotemporal dimensions of mobility. This approach considers the length of time spent away from home, the number of trips, purpose and seasonality of the moves, and the composition of movers in order to capture the variation in mobility patterns across a range of production- and consumption-related moves, which a part of the daily lives of the inhabitants of semi-arid Northeast Brazil. It also draws attention to the changes brought about by the 2010-2013 drought. The model also integrates contextual factors, drawing on the sustainable livelihoods approach (DIFD 2000), such as institutional responses and household access to capital assets, which influence livelihood outcomes such as mobility. As a result, this model advances research knowledge beyond the dichotomy of trapped populations or out-migrants, underlining the characteristics of key spatial and temporal dimensions which form the full spectrum of mobility.

10.2.2 Socioeconomic and climatic context of contemporary mobility

The second objective sought to examine the socioeconomic and climatological characteristics of semi-arid Northeast Brazil in order to establish the context within which livelihood strategies and spatial mobility occurs in the region. From the findings in Chapter 5, it is clear that cyclical droughts are an intrinsic feature in the landscape of the area. The analysis revealed that this type of slow-onset climatic event is the main environmental hazard in the region, with catastrophic consequences to rain-fed subsistence agriculture and livestock keeping. Together with the effects of limited economic development, the influence of geographical factors on the lives of the inhabitants of semi-arid Northeast Brazil is a common characteristic of the region.

Supplementing analysis of the socioeconomic and climatic contexts, the findings in Chapter 5 indicate that population mobility in Northeast Brazil is a well-established process. Two reasons explain this phenomenon: first, the harsh and volatile nature of the local climate, in a predominantly agricultural setting. Since the 16st century, cyclical droughts have affected the economy of the region, discouraging development and forcing relocation of the more vulnerable families and individuals. Second, is the existing pattern of population settlement in Northeast Brazil. The primacy of metropolitan urban areas located on the Atlantic coast results in a greater level of economic development and industrial capacity compared to that of the municipalities in the semi-arid area. Concurrently, this exerts a great power of attraction over young adults who live in the hinterland, and contributes to shape the well-established rural-to-urban patterns of population movement in the region. However, traditional analysis of the 2000 and 2010 censuses revealed changes in the spatial pattern of migration. The combination of greater public investment in infrastructure in rural areas and the implementation of a robust welfare system facilitated diversification of livelihood strategies in sending areas and increased the volume of return migration. The improving socioeconomic conditions in the hinterland are reflected in the 2010 census data. Several municipalities recorded reduced out-migration while others recorded positive net-migration rates, in spite of the occurrence of two droughts in the period.

From the perspective of the study area, the municipality of Irauçuba reflects the macro socioeconomic and climatological characteristics of semi-arid Northeast Brazil. Despite the fact that population and labour force participation increased between 2000 and 2010, unemployment in the non-agricultural sector constitute the main labour market response. The analysis revealed that limited development, and with an economic sector primarily

based on agricultural activities, the net out-migration characteristics in the city fall into the expected norm for the region. Consistent with the literature, young adults predominantly aged 16-29 constitute the largest group of out-migrants from the rural districts.

10.2.3 To identify the characteristics of households that shape livelihoods in rural semi-arid Northeast Brazil

The third objective of this study sought to investigate household characteristics, such as livelihood portfolios, access to capital assets and perceptions, which mediate responses to climatic events in the study area. The analysis was conducted using data from a survey of 90 households across three rural settlements. The livelihoods of the households in the study area were dominated by subsistence and commercial agricultural activities combined with non-farm wage work. The findings revealed that the distribution of assets is the main determinant of livelihood outcomes. Overall, reduced access to assets (natural, social, human, physical and financial capital) limits livelihood strategies and mobility choices, resulting in low annual income. For example, household composition (human capital) is directly related to their ability to diversify livelihoods and increase household wealth. It also shapes the pattern of permanent out-migration and seasonal moves. Large households have more human capital available to engage in income generating activities within and outside their place of origin, in order to supplement subsistence agriculture.

To supplement the analysis of livelihoods and assets carried out in Chapter 6, cluster analysis was used to segmented households into four distinct types. These were: Welfare dependent; Mixed livelihood; Non-farming; and Commercial livestock-oriented. The first two groups were characterised by low annual income and few capital assets. According to Moser (1998, 2008), reduced access to capital assets equates to greater vulnerability to external stressors such as climatic events because of the limited capacity of substitution between assets and livelihood strategies. Within these two groups, which account for 72% of sample households, conditional cash-transfer policies proved to be an essential component of their livelihoods, especially for welfare dependent households. Non-farming and Commercial-livestock oriented households had a comparatively larger asset base to mediate the impacts of the 2010-2013 drought. Survey data and field observations revealed that engagement in subsistence and other agricultural activities became increasingly unproductive, and welfare itself is not sufficient to secure income to meet basic household consumption. As a result, households seek to diversify their livelihood strategies in order to maximise income

generation. Over one third of sample households reported at least one member temporarily absent, engaged in off-farm and non-farm work outside their original locality.

Another important element of research objective 3 was the investigation of people's perceptions of a range of socioeconomic features and changes in the local climate. Comparison of precipitation data with the information recorded in the survey indicates that people's perceptions do not always correspond with the statistical evidence. This may well be a result of households being overly influenced by losses in capital assets and an overall sense of increased vulnerability during the 2010-2013 drought. This sense of insecurity impacted a range of other socioeconomic factors which are part of the everyday life of the inhabitants of the study area. The drought appeared to have exacerbated problems such as crime, unemployment, poverty and access to water. This suggests that climatic events impacted indirectly as well as directly on everyday aspects of residents' lives and livelihoods. Analysis of the survey data also provided relevant insights into the ways the inhabitants of the study area perceive, and react to climatic variations. While the perceptions reported by residents for the 2010-2013 period are in line with the rainfall data, they tended to overstate the occurrence of cyclical droughts in the region. This perception may well be a product of respondents being overly influenced by household losses in capital assets, which impacted livelihoods and overall sense of security over the course of the recent drought. Integrating this analysis into this thesis provided empirical evidence that these perceptions are linked with household livelihood strategies, ownership of capital assets, and perceived impact of a climatic event.

10.2.4 Variation of mobility behaviour before and during the occurrence of a severe climatic event

Examining the distinct forms of population movements in the context of the 2010-2013 drought was the final objective of this thesis. To this end, a broad framework that considers multiple forms of mobility responses was adopted. The analysis broke down spatial mobility into permanent out-migration, seasonal moves and customary local mobility associated with production- and consumption-related activities.

The findings revealed the nature of permanent and seasonal migration, and the thesis investigated their linkages with the 2010-2013 drought in the study area. The empirical evidence suggests that out-migration is associated with economic reasons, and stage in the life-cycle. Although the effects of the recent drought permeated through various

socioeconomic domains, climatic events were seldom reported as the main driver behind the relocation of household members in the study area. Seasonal migration flows displayed different motivations, composition and destinations. The majority of seasonal migrants were male adults aged between 30-44 years who engaged in off-farm and non-farm work in urban centres or rural areas where agricultural work was available. The findings indicate a significant relationship between the recent drought, and households with seasonal migrants, expressed in proportion of households which perceived worsened climatic conditions, and also reported seasonal migration. The findings also suggest a connection between permanent out-migration and seasonal moves. One-third of sample households with permanent-out migrants also reported at least one seasonal migrant. This relationship was further expressed, in the survey data, through the networks which migrants tap into to obtain support to find employment and accommodation at the destination.

The relationship between out-migration and remittances was also examined. Chapter 8 discussed the role of remittances within livelihood strategies and household expenditure, and the findings indicate a more nuanced story than that of a predominantly positive impact on development, as suggested by De Haas (2010). Households in semi-arid Northeast Brazil use remittances as an ancillary source of income, mainly employed in the acquisition of foodstuff to support internal consumption. Contrary to other marginal parts of world, remittances in the study area were seldom converted into productive capital.

The evidence presented here extended the analysis which is commonly found in the literature on the environment and migration into new territory by focusing on the more nuanced aspect of mobility based on local customary moves. Several studies postulate that negative environmental conditions associated with climatic events influence out-migration directly (for example, Myers 2002). However the occurrence of a severe drought in semi-arid Northeast Brazil was not reported as the main reason for permanent relocation. Instead, the primary effects of the 2010-2013 drought were adjustments to temporary forms of mobility, including seasonal and circulatory patterns of mobility.

The empirical evidence revealed that residents of the study area adjusted their livelihood strategies through changes in customary local diurnal and circular mobility associated with production- and consumption-related activities over the course of the 2010-2013 drought, with the extent of the change reflecting household livelihood strategies and access to capital assets. In response to the declining agricultural productivity and work opportunity in the study area, changes in production-related moves resulted in long absences from home

between work cycles. The number of trips completed to fulfil basic household needs such as water collection performed locally was reduced in favour of increased movement to purchase water in the urban centre of the municipality. Consumption-related activities involving long absences from home were greatly reduced due to demanding financial costs. On the other hand, religious activities increased in frequency during the recent drought. This is consistent with the conceptual model guiding this study, which indicates that spatial mobility is mediated by both external circumstances and factors internal to households, and is determined by livelihood strategies and access to assets. Climatic events, therefore, resulted in changes in the spatiotemporal dimensions of mobility associated with the household type, as described in Chapter 6. This was represented by variation in the timing and sequencing of trips associated with customary production- and consumption-related activities. The inclusion of new activities to respond to the recent drought also represented evidence that changes in local mobility behaviour formed a key part of the coping strategies of households in the study area. This evidence lend support to the notion that environmentally-driven mobility is likely to be over short distances (Findlay 2011), with changes in customary trajectories being influences by a combination of social networks and the internal dynamics of households.

10.3 Contributions

In addressing the four research objectives discussed in the previous section, this thesis has made contributions in four distinct domains: theory, methodology, substantive knowledge and policy. Each is discussed below.

10.3.1 Contributions to theory

This thesis contributed to theory by developing a conceptual framework that can be employed to analyse the environment-migration nexus in a non-linear manner. This approach includes macro socioeconomic external factors and elements endogenous to households such as livelihood strategies, capital assets and perceptions. The model further argues that climatic events should not be investigated in isolation from these factors when assessing mobility decisions. The suggestion that shifts in migration patterns occur due to climatic events and other environmental factors has been recognised in previous conceptual frameworks (see Chapter 4). However, the empirical evidence discussed in chapters 6-9 revealed that isolating environmental factors from the range of other factors that drive

mobility is not advisable because events like the 2010-2013 drought permeate the entire spectrum of socioeconomic macro structures and household internal dynamics.

Isolating climatic events as drivers of migration creates a theoretical gap, as demonstrated by the various efforts to categorize and estimate the volume of current and future mobility associated with environmental factors. The existing partition present in academic and policy circles relates to definitions of categories such as 'environmental refugees' and 'environmental migrants'. The main concern with regard to existing definitions is the limited representation of the various spatial and temporal dimensions of mobility responses. Migration is just one form of population movement within the mobility continuum. Many livelihood strategies involve repetitive trips of varied spatial and temporal signatures associated with production- and consumption-related activities. Moreover, existing definitions implicitly assume a linear relationship between environmental factors and migration. The findings presented in chapters 8 and 9 revealed that out-migration in the study area occur in response to multiple drivers, and to migrants at different stages in the life-cycle. Seasonal migration continues to occur in response to the cyclical droughts that affect semi-arid Northeast Brazil. This evidence raise doubts about the necessity to define and categorize environmentally-related migration, particularly in the case of slow-onset events. It is preferable to focus efforts on unpacking the spatial and temporal complexity of population movements and the dimensions of mobility, and how these intersect with climatic events and other environmental hazards.

Conventional practice in many studies investigating the environment-migration nexus is to separate migrants into two groups: 'movers' and 'stayers'. This coarse distinction overlooks a range of circulatory practices which are a fundamental part of the lives of residents of marginal rural areas. Non-permanent movements have a wide range of spatiotemporal dimensions, which have been largely overlooked in previous research. If progress is to be made in understanding mobility responses to climate change and other environmental hazards, continuing attention is needed to expand the theoretical approach within which multiple forms of mobility, represented by discrete spatial and temporal dimensions, are investigated

10.3.2 Contributions to methodology

This study points to new directions in data collection and analysis related to mobility of individuals and communities, as well as to opportunities for integration of other research

methods. Drawing on approaches from population geography and participatory techniques, this work developed a multifaceted methodology to study the relationship between climatic events and spatial mobility. Specifically, it contributed a new method for data collection on the micro level patterns of everyday mobility. It did so by coupling a participant-centered data collection strategy to a suite of indicators which capture the spatial and temporal dimensions of population mobility, retaining the considerable richness of detail conveyed from semi-structured, individual accounts. This technique provides a vehicle for collecting the information essential to measure mobility in a robust manner. The significance of this blended approach is that it overcomes major deficiencies in measuring more nuanced variations in temporary mobility and local circulation in areas impacted by severe climatic events. These are represented by a lack of statistical data, difficulties of collecting information on local space-time trajectories, and the absence of sound statistical measures by which to express them.

By placing emphasis on capturing customary itineraries and multiple household connections to each destination, this approach foregrounds individual and collective household agency and goes beyond coarse spatial and temporal scales with respect to mobility behaviour. The identification and analysis of customary forms of everyday mobility, and the changes which occurred in response to the 2010-2013 drought were central to the aims of this study. Analysis of spatiotemporal dimensions of mobility revealed distinctive patterns of spatial behaviour and systematic shifts in response to drought, extending across both production- and consumption-related movements. The findings identified a sharp increase in non-farm work, a reduction in trips to farmers' markets, and a change in patterns of movement to secure water. New forms of mobility emerged, notably hunting to supplement subsistence and for loans to supplement income. At the same time, visits to relatives reduced in frequency, while church attendance and visits to friends increased, revealing the importance of localised social networks during hardship.

10.3.4 Contributions to substantive knowledge

This study elaborates the nuanced forms of temporary mobility in response to drought, and shows how they are related to household livelihood strategies and access to capital assets. This concept was then applied to an examination of a wide spatiotemporal spectrum of mobility. To appreciate the main contribution, it is useful to frame the discussion against the

seminal work of authors such as Findley (1994), Hugo (1996), Henry, Schoumaker and Beauchemin (2004) and Warner and Afifi (2014) who have contributed to the field by examining the linkages between environmental factors and migration. These studies largely overlooked the role of local mobility. This thesis extended the analysis into new territory by shifting the focus from migration to everyday movements, which are not captured by population censuses or registers, but which form an integral part of the livelihood of rural communities in semi-arid Northeast Brazil and other parts of the world.

A first substantive contribution is, therefore, articulation of the linkages between climatic events and local mobility, providing robust empirical evidence as to the impact of the 2010-2013 drought in altering diurnal and circular mobility associated with customary production- and consumption-related activities in the study site. Specifically, it revealed that the spatial and temporal characteristics of these changes were predominantly shaped by household livelihood strategies and access to capital assets. Consistent with this evidence, this study revealed that a major driver of changes in the circulatory patterns was the decline in the capacity to sustain livelihood activities related to agriculture and livestock. Since the majority of the inhabitants of rural semi-arid Northeast Brazil engage in these activities, which are heavily dependent on the availability of water, the impact of the recent drought reduced the productive capacity of smallholders, and triggered the adoption of alternative strategies to generate income. As a result, the customary mobility of the inhabitants of the study area changed in response to the altered production-related activities. The impact on the overall income of households also triggered changes in customary consumption-related moves. The survey data revealed the increasing cost of foodstuffs during the 2010-2013 drought. As a response, households invested financial capital in the acquisition of basic necessities. This coping strategy resulted in a decrease in the frequency and duration of leisure activities.

A second substantive contribution of this thesis is to further cement the multi-causal nature of migration. The recent drought was a catalyst, not a cause, of change in out-migration patterns in semi-arid Northeast Brazil, where the majority of residents depend on a subsistence agricultural economy. The ripple effects of poor harvests affect the welfare of households in marginal areas of Northeast Brazil. The empirical evidence revealed that the majority of people in the study area continued to permanently move out of the area were motivated by economic reasons. Only 3 of the 37 households with permanent migrants reported that the recent drought was the main reason for the move. However, it is important to note that, as discussed in Chapters 5 and 6, subsistence agriculture and other forms of rural livelihoods are contingent on the optimal occurrence of the wet season. This means

that migration decisions are not linear, unidirectional responses. This is more evident in seasonal moves, with a positive relationship between perceived deterioration of climatic conditions and households with a seasonal migrant. Of the 90 households, 33 reported at least one member engaged in seasonal migration to diversify livelihoods during the drought.

The findings revealed that temporary forms of internal migration are an important part of the livelihood strategies employed by households as they do not require large financial resources, relying instead on established networks. The contrast between previous studies and the findings presented here reinforces the arguments discussed by Laczko and Aghazarm (2009) regarding the need to move away from international out-migration based on deterministic models, towards a stronger focus on internal mobility. Previous studies have emphasized static push-pull frameworks based on simple assumptions as to the size of the population in at-risk regions and treat migration as a unidirectional response of last-resort, with all individuals responding to the stimuli in the same way. Shifting the research focus provides fertile ground in which to develop more comprehensive approaches to spatial mobility linked to environmental factors, as accomplished in this thesis (Chapters 8 and 9).

10.3.4 Implications for policy

While the aim of this study was not focused on developing policy responses to migration associated with climatic events and other environmental hazards in semi-arid Northeast Brazil, the findings provide a better understanding of this interaction. The empirical evidence revealed a compelling case for the adoption of a needs-based approach, focused on the sustainability of communities which are impacted by droughts cyclically, as opposed to legal protective mechanisms specifically designed to attend environmental migrants. Mobility processes are embedded in a wide context, which includes external political and economic factors, and the internal dynamics of households. Therefore, public policies should be concentrated in two basic aspects: expansion of economic opportunities; and improvement of access to infrastructure and other basic frontline services.

A challenge for policy-makers in marginal areas of developing countries lies in stimulating rural financial systems and securing young people's access to education and professional training. The microfinance revolution that started in the 1990s (Barret, Reardon and Webb 2001) has shown some promise in extending financial services, such as credit, insurance and savings, to allow populations previously unable to engage in non-farm activities access to sufficient financial capital to permit productive non-farm investment. However, without

more widespread access to education and other forms of professional skill-training facilities, the inhabitants of marginal rural communities will continue to remain trapped in low-return, high-risk livelihood strategies, which are highly dependent on optimal environmental circumstances. The findings of this study revealed that households which have a diversified livelihood portfolio, such as the non-farming households in the study area, are better equipped to endure hardship. Therefore, improvement of employment conditions in the non-agricultural sector could have a significant influence on the lives of rural inhabitants of semi-arid Northeast Brazil. While the exact implications of these policies are difficult to predict, the contribution of rising incomes is likely to improve educational attainment, enhance existing agricultural practices and reduce vulnerability to droughts.

The findings of this study demonstrated that out-migration to urban areas was not a direct consequence of climatic events, but rather was product of migrant aspirations and life-cycle stage. Seasonal moves in the study area were partly shaped by the 2010-2013 drought. However, it was local mobility associated with customary productive- and consumption-related activities that underwent the greatest variation during the recent drought, revealing that the inhabitants invested in localised forms of responses. Therefore, rather than focusing exclusively on policies which privilege infrastructure in urban areas, public authorities should ensure effective distribution of and access to frontline services in rural communities, as well as ensure that adequate adaptive strategies are in place. Without these supporting policies, mobility by itself cannot provide long-term upward social mobility, nor can it eliminate the threat brought about by climatic events and other environmental hazards.

10.4 Limitations of the study

The comprehensive field data collected in this study represents a significant undertaking with regard to time and financial resources. Yet, the 90 household interviews represent only a snapshot in the lives of rural residents in the study area, therefore the results are necessarily limited in terms of understanding the complex dynamics of livelihoods and spatial mobility. For example, data concerning annual income, access to capital assets or perception of changes in the local climate or other community issues are vulnerable to macro-economic and environmental fluctuations. To overcome these limitations, monitoring of a sample of households over a long period of time would be required.

Some data limitations somewhat restricted the scope of this research. Like the majority of population censuses across the world, the Brazilian census collects migration data on a fixed interval transition, in this case comparing the place of residence at the time of enumeration with their place of residence five years earlier. Transition data in Brazil can also be found in the form of latest move, combining place of last residence and length of time in the respective dwelling. While these traditional methods provide a useful representation of the balance of internal migration in the country, they do not accurately capture the temporary moves which vary in duration and frequency. Since the 2000 Census, questions about commuting were included in the questionnaire. These data indicate journeys associated with work or study, but the decennial periodicity of the census greatly limits any attempt at systematic analysis of circulatory patterns. In the specific case of nuanced local circulation, the dynamic nature of spatial mobility suggests that changes with regard to destination, duration and frequency of journeys, which display significant variation over time, are simply not captured by any statistical method. This limitation constrained the analysis of local mobility, leaving several questions unanswered. For example, it is unclear if overall levels of circulation and commuting varied over previous climatic events. The findings of this study revealed a strong relationship between the 2010-2013 drought, and changes in the local mobility pattern of the inhabitants of rural Irauçuba, suggesting that changes in response to this type of climatic event occurred in previous dry years.

A third limitation of this study is related to the potential generalisation of the study across other climatological regions of Brazil and other countries. This research was limited to a semi-arid region under specific climatic conditions. Whilst some of the empirical findings are restricted to this climatic niche, the conceptual model and methodology is generalizable to other rural areas in world. Moreover, the distinctive aim of this study, which investigated population movements within a wide spatiotemporal spectrum of mobility responses in a different cultural and socioeconomic setting, contributes to improve understanding of the impact of climatic events and other environmental factors on mobility in other parts of the world.

10.5 Paths for future research

Three lines of inquiry are envisaged as natural extensions of this research. The first involves analysis of mobility in a different spatial setting, as urban households in the Atlantic coast of the country face the threat of other climatic and environmental hazards such as flooding and landslides as the impacts of climate change increase in frequency and strength. In the first

instance, urban dwellers have access to a wider range of frontline services, and rely on different livelihood portfolios. As a result, mobility responses to these events would take different spatiotemporal forms compared to a rural setting.

A second line of inquiry that merits further research is the nexus between spatial mobility and institutional responses. While, as discussed in this study, the importance of conditional cash-transfer policies and other emergency-relief programmes in Brazil is well documented, there is little robust empirical research on the implications of these policies on population movement in the country. The economic benefit provided by welfare programmes alters the income composition of households with regard to earned and unearned income. As argued throughout this thesis, climatic events act as an underlying cause which impact across a range of socioeconomic factors associated with rural livelihoods and spatial mobility. In the field interviews, several respondents indicated that the income derived from the *Bolsa Família* (Family Allowance) was responsible for reducing vulnerability and alleviating poverty during the 2010-2013 drought. In addition, the conditionality related with school attendance constrains the movement of individuals who could have engaged in seasonal or permanent migration. The empirical findings of this study revealed that the welfare system currently in place in Brazil has direct implications for rural household livelihoods, and their capacity to cope with external stressors. Research is needed to assess the effect of these policies on the distance, direction and purpose of mobility, as well as their impact on the increasing flows of return migrants to Northeast Brazil.

A third potential line of inquiry is the incorporation of other techniques to enhance the MISTIC toolkit capability. Approaches including social media and mobile phones can improve the accuracy of the toolkit, providing ways to capture the movement and location of people in real time. The improvement of the MISTIC toolkit can assist in the production of more accurate profiles of customary local mobility and circulation in the context of climatic events and other environmental hazards which occur cyclically, and which have the potential to increase in strength and frequency due to climate change.

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Appendix: Household questionnaire

Living with drought: a study of spatial mobility in semi-arid Northeast Brazil. Questionnaire for the household head (HH)

| | |
|--------------------|-------|
| Questionnaire No.: | Date: |
| Location: | |

A) Human Capital

Thank you for taking the time to answer these questions. First, I would like to get to know more about you and the other people that live with you by asking about the characteristics of the household:

- 1) How many people live in this household? _____
- 2) How many of them are economically active? _____
- 3) Are there any people you regard as usual members of the household who are currently absent? Yes No
- 4) If yes, how many? _____

Could you please give me the following specific information about both present and absent members of the household?

| 1 | 2 | 3 | 4 | 5 | 6 | 6 | 8 | 9 |
|----|---|-----|-----|--|-----------------|--|--------------------------|--------------------------------------|
| ID | Relationship to the head of the household | Sex | Age | Level of education completed | Main occupation | Marital status | Current residence status | How long has this person lived here? |
| 1 | Head of Household | | | | | | | |
| 2 | | | | | | | | |
| 3 | | | | | | | | |
| 4 | | | | | | | | |
| 5 | | | | | | | | |
| 6 | | | | | | | | |
| 7 | | | | | | | | |
| | | | | 1= Incomplete primary 2= primary 3= Incomplete secondary 4= Secondary 5= Tertiary/techn. 6= No formal schooling | | 1= Single 2= Married 3= Divorced 4= Separated 5= Widowed | 1= Present 2= Absent | In number of years |

B) Physical Capital

I would like to ask some information about the characteristics of the farm and the land you currently live on:

- 1) **How much land do you have here?** _____
- 2) **Under what arrangements do you occupy this land?**
 Own Rents Share Work at Look after it Other (_____)
- 3) **Do you farm the land?** Yes No
- 4) **If yes, please indicate which of the following:**
 Food crop Cash crop Grazing Forestry Fallow Not used Other (_____)
- 5) **What is the farm's primary activity?**
 Food crop Cash crop Grazing Forestry Fallow Not used Other (_____)
- 6) **Do you own livestock?** Yes No
- 7) **If yes, what is the use of livestock on your farm?**
 Own consumption Selling Manure Traction Transport Other (_____)
- 8) **Where do you get water for your farm?**
 Irrigation system Communal dam Underground pump Cistern Other (_____)
- 9) **How far must you travel to access your water supply?** _____
- 10) **Are there any other improvements on your farm?** Yes No
 Fences Sheds Irrigation system Cistern Other (_____)

Now, I would like to ask some questions about your house

- 1) **Do you own the house you live in?** Yes No
- 2) **What is the main construction material of your house?** _____
- 3) **How many rooms does your house have?** _____
- 4) **Do you have a cistern?** Yes No
- 5) **Does the household have electricity?** Yes No
- 6) **Does the household have an inside toilet?** Yes No
- 7) **Do you own any means of transport?** Car Motorcycle Bicycle Tractor None
- 8) **Do you own any domestic assets?** TV Radio Fridge Stove Cooking utensils
- 9) **Do you own a mobile phone?** Yes No
- 10) **Do you have access to the internet at home?** Yes No

Now, I would like to ask some questions about access to services

- 1) **Where is the nearest primary school?** _____

- 2) **How long does it take to get there?** _____

3) Where is the nearest secondary school? _____

4) How long does it take to get there? _____

5) Where is the nearest healthcare facility? _____

6) How long does it take to get there? _____

7) Is this area serviced by public transport? Yes No

8) How long does it take to go to the closest public transport station? _____

C) Financial Capital

I would like to ask you some questions about the economic activity of the household:

1) **Which of the following sources contribute to household income?**

- Crop sales Livestock sales Off-farm labour Remittances Government assistance (name of benefit _____) Other (_____)

2) **What is the main source of household income?** _____

3) **If the household receives income from off-farm labour then:**

| 1 | 2 | 3 | 4 | 5 |
|--|--|---------------------|----------------------|--------------------------|
| Which household member works off-farm? | What is the nature of work they perform? | When does it occur? | Where does it occur? | How often does it occur? |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |

4) **If the household receives any government assistance what form of benefit is received?**

- Retirement pension Widow allowance Early retirement pension Unemployment allowance "Family" allowance programme Other (_____)

6) **If the household receives remittances what is their importance in the household budget?**

- Unimportant Not very important Somewhat important Important Very important

7) **If your household received remittances has their importance increased, declined or remained the same over the past dry period?**

- Increased Declined Remained the same

7) **Who is the source of the remittances?** _____

8) **What are the remittances used for?** _____

9) **Could you please estimate the total income of the household in the last year?** _____

10) **Does the household have savings?**

Yes **No**

11) **Does the household have loans?**

Yes **No**

D) Social Capital

I would like to ask the head of household some information about support from relatives and friends:

- 1) Are you a member of the local agriculture cooperative? Yes No
- 2) Do you attend church on a regular basis? Yes No
- 3) Are you a member of any other local community group? Yes No
 - a. If yes, what group? _____

- 4) Do you have relatives who live locally? Yes No
- 5) Do you have relatives living in Iraucuba? Yes No
- 6) Do you have relatives living in Fortaleza? Yes No
- 7) Do you have relative who works in governmental department? Yes No
- 8) Do you have any relative who owns a business? Yes No
- 9) Does the household receive any form of outside assistance? Yes No
 - a. If yes, what form does this take? _____

 - b. If yes, who provides this assistance? _____

E) Natural Capital

Based on field observations, respondents (heads of households) and key informant interviews on:

1. What is the soil type where the land is located: _____

2. Determine the soil quality for crop production and farming:

Very low Low Average High Very high

3. Determine vegetation density:

Very low Low Average High Very high

4. Indication of deforestation:

Very low Low Average High Very high

5. Indication of desertification processes:

Very low Low Average High Very high

F) Livelihood Assessment

Now, I would like to ask you some questions about your livelihoods specifically over the recent dry period:

- 8) Over the recent dry period have you changed the main livelihood activity? Yes No
- 9) If yes, what activity have you taken up? _____

- 10) What activity have you dropped? _____

- 11) Over the recent dry period has the agricultural capacity of the land you farm improved, declined or remained the same? _____

- 12) Over the recent dry period has the livestock production capacity improved, declined or remained the same? _____

I would like to ask you a few questions about agriculture and livestock activities over the recent dry period:

| 1 | 2 | 3 | 4 |
|--|--|--|---|
| Over the recent dry period have you changed the agricultural activity on the land? | If you own livestock has the use changed over the recent dry period? | If you have changed what other activity have you taken up? | If you have changed what other activity have you dropped? |
| | | | |

0 – No 1 - Yes

0 – No 1 - Yes

- 13) Over the past dry period did you buy or sell any assets? Yes No
- a. What assets did you buy? _____

- b. What assets did you sell? _____

- 14) Has your household borrowed any money over the past dry period? Yes No

15) If yes, could you tell me what the money was used for?

- Purchase agriculture inputs or invest in a non-agricultural enterprise Purchase tools, equipment or livestock Purchase food Pay health care or medical treatment Pay for a social event Start Other (_____)

16) Could you tell me the source of the money?

- Family Friends Private institution Public institution Other (_____)

G) Migration History and Mobility of the Household

I would like to ask some questions about the places you and other members of the household have lived:

1) **Where were you born? (locality, municipality and state)** _____

2) **How long have you lived in this locality? (months and years)** _____

3) **What locality were you living in previously? (locality, municipality and state)** _____

4) **What was your main economic activity before moving here?**

Crop sales Livestock sales Off-farm labour Remittances Government assistance (name of the benefit _____) Other (_____)

5) **Which of the following factors, if any, were important in your decision to move here?**

| No | Factors | Very important | Important | Not important |
|----|---|----------------|-----------|---------------|
| | Social factors | | | |
| 1 | Access to schools | | | |
| 2 | Access to health services | | | |
| 4 | Proximity to relatives and friends | | | |
| 5 | Accompany a family member | | | |
| 6 | Form a new household | | | |
| | Economic factors | | | |
| 7 | Better job opportunities | | | |
| 8 | Better quality of life | | | |
| 9 | Better markets for selling crop production | | | |
| 10 | Better markets for selling livestock production | | | |
| | Environmental factors | | | |
| 11 | Improved access to water | | | |
| 12 | Improved soil conditions | | | |
| 13 | No conflict over land and resources | | | |
| 14 | Other (_____) | | | |

The following questions are about permanent out-migration of members of the household:

- 1) Over the past five years, has any member of your household moved away to live elsewhere? Yes No
- 2) If yes, how many? _____
- 3) Can you give me more details about them?

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|--|-------------------------------|---------------------------------|---------------------------|--------------------------------------|---|--|---|--|---|
| Person's relationship to the head of the household | What is the person's age now? | When did this person move away? | Where did this person go? | What was the main reason for moving? | What activity is undertaken in the new place? | Did this person know anyone in the destination area prior to moving? | Do you think the recent drought had any impact on the decision to move? | Has this person sent remittances to the household? | Does the migrated member intend to return to the household to live? |
| | | | | | | | | | |
| | | | | | | | | | |
| | | | | | | | | | |
| | | | | | | | | | |

0-No 1-Yes

0-No 1-Yes

0-No 1-Yes

0-No 1-Yes

The following questions are about seasonal migration of members of the household:

- 1) Has any member of your household engaged in seasonal migration to work elsewhere? Yes No
- 2) If yes, how many? _____
- 3) Can you give me more details about them?

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|--|---------------------------|--------------------------------|---------------------------|--------------------------------------|---|--|---|--|--|
| Person's relationship to the head of the household | What is the person's age? | When did this person departed? | Where did this person go? | What was the main reason for moving? | What activity is undertaken in the new place? | Did this person know anyone in the destination area prior to moving? | Do you think the recent drought had any impact on the decision to move? | Has this person sent remittances to the household? | How long has the migrant been absent from the household? |
| | | | | | | | | | |
| | | | | | | | | | |
| | | | | | | | | | |
| | | | | | | | | | |

0-No 1-Yes

0-No 1-Yes

0-No 1-Yes

1) Questions to initiate the application of the MISTIC toolkit:

- a) *I would like to know the places you have visited the township of Irauçuba in the last year?*
 - b) *Does any member of the household accompany you in the trip?*
 - c) *Could you tell me what activity did you perform there?*
 - d) *How often do you go to there?*
 - e) *How long do you usually stay there?*

- a) *I would like to know the places you have visited Fortaleza in the last year?*
 - b) *Does any member of the household accompany you in the trip?*
 - c) *Could you tell me what activity did you perform there?*
 - d) *How often do you go to there?*
 - e) *How long do you usually stay there?*

- a) *I would like to know about the other places you have visited in the last year?*
 - b) *Does any member of the household accompany you in the trip?*
 - c) *Could you tell me what activity did you perform there?*
 - d) *How often do you go to there?*
 - e) *How long do you usually stay there?*

2) Probing questions about the impact of the most recent dry period for mobility map discussion:

- a) *I would like to know if the destinations of trips both within Irauçuba and outside the municipality have changed during the most recent dry period?*
- b) *I would like to know if the frequency of trips has changed during the most recent dry period?*
- c) *I would like to know if the duration of trips has changed during the most recent dry period?*
- d) *I would like to know if the activity performed at the destination has changed during the most recent dry period?*

H) Perceptions of issues, household responses to climate shocks and adaptation strategies

I would like to ask a few questions about external factors, institutional responses and household responses to shocks impacting livelihoods:

1) Please indicate your level of concern regarding each of the following issues impacting the community:

| Issues impacting your household | No concern | Slight concern | Some concern | High concern | Extreme concern |
|---|------------|----------------|--------------|--------------|-----------------|
| Unemployment | | | | | |
| Poverty | | | | | |
| Levels of household income | | | | | |
| Ability to maintain or improve livelihood | | | | | |
| Crime levels | | | | | |
| Availability of water | | | | | |
| Availability of agricultural land | | | | | |
| Availability of health care facilities | | | | | |
| Availability of education facilities | | | | | |
| Availability of electricity for cooking, lighting and entertainment | | | | | |
| Availability of transport and infrastructure | | | | | |
| Availability of basic sanitation | | | | | |
| Environmental degradation | | | | | |
| Climate uncertainty and shocks | | | | | |
| Local adaptation and coping strategies | | | | | |

2) Looking back at the past two years, could you rank the aspects of your life and livelihood that have generally improved? (open responses)

1. _____
2. _____
3. _____
4. _____
5. _____
6. _____

3) Now, could you rank the aspects of your life and livelihood that have generally worsen

1. _____
2. _____
3. _____
4. _____
5. _____
6. _____

Now, I would like to ask you a few specific questions about the local climate:

1) **Have you noticed any changes in the local climate since you have been living here?** Yes No

2) **If yes, what are they?**

- Droughts more frequent Extended dry seasons Shorter dry seasons Irregular spatial and temporal distribution of rainfall Extended rainy seasons Shorter rainy season Other
(_____)

3) **Looking back specifically at the past two years have you perceived any changes in the local climate?**

- Droughts more frequent Extended dry seasons Shorter dry season Irregular spatial and temporal distribution of rainfall Extended rainy seasons Shorter rainy season Other
(_____)

4) **To what level does local climate influence your household's day-to-day activities?**

- No influence Slight influence Medium influence Strong influence

5) **Does rainfall uncertainty affect the economic situation of the household?**

- No influence Slight influence Medium influence Strong influence

6) **If it does affect, in what form?**

- Decreasing income Increasing food prices Crop loss Livestock loss Decreasing access to water
Other (_____)

7) **How does the household adapt to climate shocks such as droughts?**

- Sell assets Change Crops Sell livestock Borrow money from bank Governmental assistance
 Borrow money from family or friends Reduce household consumption Move places Remittances
 Rely on external help Other (_____)

8) **If the livelihoods situation deteriorates due to climate shocks would you consider leaving the area?**

- Yes No

9) **If yes, where would you go?** _____
