Pro-poor adaptation to climate change: Sanitation in Managua

Pro-Poor Adaptation to Climate Change: Sanitation in Managua

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Abstract

The world's climate is changing; results include the rise of temperatures and sea levels and decreased snow cover in the Northern hemisphere. With this change comes an increased vulnerability of low-income communities, which are more likely to feel the impact of climate change's possible effects. The impact on sanitation in these communities can be devastating, and can reverse the development process. This paper seeks to investigate how low-income urban communities which are at a greater risk to the impacts of climate change's effects, access sanitation; and whether these systems are able to mitigate these effects. A case study design has been adopted; low-income communities situated in Managua, Nicaragua will be examined; the flooding of Lake Managua is a frequent occurrence affecting these informal settlements.

This paper identifies sanitation as the hygienic disposal of human faecal waste. To improve understanding, the paper outlines the model and policies of sanitation provision, as well as the roles and relationships which are expected of relevant actors if pro-poor adapted sanitation is to be established. With this 'framework' one then makes a holistic analysis examining whether pro-poor adaptation of sanitation to climate change has in fact been instituted. Through examination of low-income communities one is able to establish whether pro-poor adapted sanitation has manifested itself at the household and community level through disaster risk management. It is important to uncover how low-income communities are accessing sanitation within the context of institutional arrangements as this is interrelated with pro-poor adaptation of sanitation to climate change. Fieldwork was carried out during a trip to Managua in July 2009.

This research will create a thorough understanding of how the urban poor access sanitation and whether these systems reduce the impact of flooding. Furthermore, the knowledge which this study will bring are invaluable in the context of Managua and many other urban settings across the world, because of the threat which climate change brings; planned improvements of the sanitation systems cannot continue to ignore climate change. The clarification and investigation of the roles, practices and relationships between the actors involved in the provision of sanitation and climate change adaptation will make it possible to identify opportunities and threats from the institutional to the household level for the implementation of a sanitation service adapted to climate change.

This study is also able to demonstrate that disaster risk management is not simply a reactionary process, but can also be preventative. The knowledge that will be gathered is applicable beyond the context of Managua as this study ultimately provides a deep understanding of the provision of sanitation and climate change adaptation in the context of low-income urban communities.

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Declaration

No portion of the work referred to in this dissertation has been submitted in support of an application for another degree or qualification of this or any other university or other institute of learning.

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Abbreviations and Acronyms

CONAPAS	National Commission of Potable Water and Sanitary Sewage System
ENACAL	Nicaraguan Company of Aqueducts and Sewage Systems
FISE	The Emergency Social Investment Fund
GRO	Grassroots Organisation
INAA	Nicaraguan Institute of Aqueducts and Sewage Systems
INETER	Nicaraguan Institute of Territorial Studies
INIFOM	Nicaraguan Municipal Institute for Municipal Strengthening
IPCC	Intergovernmental Panel on Climate Change
MARENA	Ministry of the Environment and Natural Resources
MINSA	Ministry of Health
NGO	Non-Governmental Organisation
OFDA	The Office of U.S. Foreign Disaster Assistance
PAHO	Pan-American Health Organisation
PRODEL	Local Development Programme
SIF	Social Investment Fund
SINAPRED	National System for the Prevention, Mitigation and Attention of Disasters

Interviewee Key[1]

Benita Ramirez	(Ramirez)	Project Secretary for Sanitation of INAA
Dennis Quesada	(Quesada)	Head Engineer of INAA
Edward Centeno	(Centeno)	Executive President of INIFOM
Hector Delgado	(Hector)	Project coordinator of the NGO Habitar
Hilda Delgado	(Hilda)	Technical supervisor of Prodel
Informant 1	(I-1)	Inhabitant of Santa Clara Barrio
Informant 2	(I-2)	Inhabitant of Santa Clara Barrio
Informant 3	(I-3)	Inhabitant of San Sebastion Barrio
Informant 4	(I-4)	Inhabitant of San Sebastion Barrio
	(I-5)	All four inhabitants of San Sebastion and Santa Clara
Jane Olley	(Olley)	Project supervisor of UN Habitat Managua
Omar Moncada	(Moncada)	Director of Municipal Decentralization of the Ministry of Property and Public Credit
Rito Siles	(Siles)	President of the Public Services Department of the Municipality of Managua

[1] All four informants from low-income communities wished to remain anonymous.

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Chapter One – Introduction

1.1 Sanitation and Climate Change Adaptation in Context

Sanitation is defined as the hygienic disposal of human faecal waste (Esrey and Habicht, 1986). The benefits and importance of sanitation cannot be denied, and the adoption of sanitation as one of the Millennium Development Goals is testimony to this. Access to a good sanitation system can help prevent disease, and research has shown that people of low-income settlements desire sanitation within their communities (Cairncross, 2003). Their reasoning for this is not solely due to health benefits, but for other motives too; these are: to reduce smells and flies, cleaner surroundings, privacy, less embarrassment when there are visitors, as well as less disease (Cairncross, 2003).

Despite the explicit benefits and demand of sanitation within low-income urban contexts, there is not always an effective demand for action; governments' limited spending on sanitation often reflects political, more than technical or economic constraints (World Bank,2006). As it stands, 20% of the world's urban population does not have basic access to sanitation, which contributes to two million child deaths a year, reduces school attendance, and is a fundamental deprivation of human dignity (World Bank,2006). Extending sanitation services to low-income urban dwellers will require major investments along with sound policies and effective, accountable institutions.

However, the effect of climate change poses an increasing threat to the sustainability of sanitation systems. Informal urban settlements are often situated in locations which are at a higher risk to the impacts of adverse weather (monsoons, droughts, hurricanes etc.) brought about by climate change (UN Habitat, 2003). If we add to this, the increasing vulnerability caused by human activity in these communities, such as the deterioration of the environment, uncontrolled growth in urban areas, deficiencies in infrastructure, we see an increase in the negative impact these hazards have on low-income communities (PAHO book, 1998). The Intergovernmental Panel on Climate Change (IPCC) proclaims there is now little doubt that human-induced climate change is happening (IPCC, 2007). All societies consequently need to learn to cope with the changes that are predicted:

warmer temperatures, drier soils, changes in weather extremes and rising sea levels for example.

Sanitation plays an important role in the development process and in disaster situations, as this basic necessity is vital for the rapid return to normalcy (PAHO, 1998). Furthermore, depending on the level of preparedness that the sanitation systems have adopted, repair can take days, weeks or even months, consuming a major portion of available assets, delaying the development process and reducing the resources for new development investment (World Bank, 2006).

Extreme-weather disasters are now identified as a failure of development, rather than simply as natural events (World Bank, 2006). Therefore, natural hazards are no longer perceived as uncontrollable, as measures can be taken which strengthen sanitation systems to the impact of disasters (PAHO, 1998). This can reduce the vulnerability of sanitation systems to the possible effects of climate change, thus ensuring an efficient ability to 'bounce back' to the normal provision of sanitation, in turn preventing the 'poverty trap' taking grip (PAHO,1998). Adapting sanitation systems to the effects of climate change also works to increase the effectiveness of the immediate post-disaster response and the rebuilding of the systems in a given community (Huq, 2003). There are innumerable measures that can be adopted to attain climate change adapted sanitation; these can be implemented at the household, neighbourhood, municipal and National level; they are not only physical, but also pertain to the governance models and institutional arrangements of sanitation provision (Moser, 2008).

Such knowledge is invaluable as there has been relatively little consideration of what adaptation will be required in urban areas in low and middle income countries; the majority of the IPCC's attention has focused on persuading governments to accept evidence of climate change and the need for mitigation (Moser, 2008). This investigation will therefore contribute to this lack of knowledge which is more important than ever given the possible effects of climate change and increasing urbanisation.

The purpose of this investigation is to uncover how people in low-income urban communities access sanitation, and more critically, whether these systems have been adapted to the possible effects of climate change. This thesis shall look more specifically at the effects of flooding, as this will allow one to gain a more expert insight into this particular hazard. Managua, the capital city of Nicaragua was chosen as the case study in order to investigate the research question; justification for this choice will be explained in detail in the subsequent methodology chapter. In addition, investigation will be made of the roles, practices, and relationships between the actors relevant to the provision of sanitation and climate change adaptation of sanitation.

This thesis will progress in a logical format; following this introduction, the literature review, by way of contextual background explains the conceptual and policy debates surrounding the urban poor's access to sanitation. There will also be a discussion of the current practices of local and National governments, interNational donors, and communities in relation to climate change adaptation, as well a discussion of the actions which would increase the capacity of relevant actors to implement climate change adaptation of sanitation. One will then move on to clarify the aims and objectives of this paper, followed by an in-depth explanation of the research design and justification for the methods adopted to address the chosen research questions. Finally, a thorough description and analysis of research results will be made, which allows one to conduct an informed discussion and draw on a reliable conclusion and recommendations which shall ultimately satisfy the research objectives.

Chapter Two – Literature Review

2.1 Models and Policies of Sanitation Provision

In order to holistically understand the provision of sanitation services in any given city, one must first understand the conceptual debates surrounding sanitation provision and how they manifest themselves within policy debates.

Views on how to resolve the problem of access to sanitation, changes with disturbing regularity; however, three models of local environmental improvement remain vigorously debated and advocated for within the context of urban sanitation development. These models are the Planning Model, the Market Model and the Collective Action Model. They are politically charged models and are built around three different mechanisms: bureaucratic organization, market processes, and voluntary association respectively (Bell,1993). Amongst the urban sanitation systems of many low-income cities, one can detect subsectors whose operations correspond closely to one of the three models. Public utilities traditionally reflect the planning approach; voluntary associations typically engage in improving unserviced areas; and private enterprises compete (or monopolise) in various niches including excreta removal when opportunity allows (McGranahan, 2001). However, there are growing opinions that activities of the state, private sector and the voluntary sector can be merged with considerable positive results for sanitary improvement; one shall elaborate on this later (*ibid*).

Critically, it is not solely the effectiveness of each model's mechanisms that determines whether sanitary improvement is achieved. Social processes have great bearing on the development of sanitary systems. As with most sectors of development, the difference between success and failure depends on the hidden politics of power and meaning between all actors involved in the provision of sanitation, from the institutional to the household level.

One shall now elaborate on each model in turn; however, there will be no attempt to synthesise the 'correct' approach to local sanitary improvement. There may be common problems and principles within a wide range of urban settings; yet, a common solution cannot be applied to all of these settings.

2.1.1 The Planning Model

With this model, experts identify the physical dimensions of the sanitary problem, a public authority plans the sanitary system, and a public utility or other implementing

agency executes the plan (Briscoe, 1993). The utility focuses solely on engineering problems (*ibid*). This model commonly results in the urban poor losing out to a pricing policy where public utilities keep prices low, as required by the government, but then fails to raise the revenue to extend the sewage network to the poor as planned (McGranahan, 2001). Furthermore, if it is centrally decided that there ought to be a price increase for the service, often affluent and politically articulate users protest, causing socio-political instability (*ibid*).

State controlled pricing policy (which typically subsidises the urban elite), reduces public utilities ability to produce 'cost recovery' and ultimately finance the extension of the piped network or provide alternative faecal disposal services in low-income areas. As a result, those not supplied by the formal system are forced to pay for expensive informal commercial services. Furthermore, conventional water closets and household connections to water borne sewage systems are much more expensive than water connections for example; therefore, the expansion of such systems to low-income settings is far less likely to occur (Todd, 2005).

The Planning Model is far less popular relative to the Market Model due to the fall of the Soviet Union in 1991; however this does not mean that planned sanitary improvement is less suitable in itself (McGranahan, 2001). Sewered water closets are suited to the centrally planned models as they are attractive to users; experts can control the system closely; the sanitation system can be described technically in detail; and the demands on the user are relatively minimal and independent of where households are located (*ibid*).

In addition, many ad-hoc projects provide less costly alternative technologies mainly targeted to low-income communities; they are not centrally planned but conform to Planning Model principles (*ibid*). These projects help to fill the 'sanitation vacuum' left by centrally planned systems that only serve the wealthy (*ibid*). Problems also arise with this targeted approach as many projects are usurped by the wealthy, particularly in communities where there is a lack of secure land tenure (WSP, 2009). Additionally, projects have a short-time horizon; many project managers are more concerned to create

a system which operates well during the project's operations, than one which is sustainable in the long run as most are not evaluated years later (McGranahan, 2001). Lastly, the operation of low-cost sanitary systems depends far more on the local physical and social context than more capital-intensive systems (Schafer *et al*, 2007).

How faecal-oral diseases spread has less to do with infrastructure and technology, than local behavioural patterns that are not under planner's control. Due to these complexities it is difficult for a planner to decide what sanitation measures are best suited. Providing each household with a water closet is not a 'magic bullet' as this system ignores the local physical conditions and social practices in place. On top of this, the urban poor have little political power through which to make planners accountable to their needs, and so in this manner the Planning Model is fundamentally flawed (McGranahan *et al*, 2006). Many professionals have recognized this weakness thus engaging with stakeholders has become a standard task assigned to planners (McGranahan, 2001).

The Planning Model's inability to respond to the demands of low-income communities has been a fundamental critique of planned sanitary improvement, and one that the Market and Collective Action Model, in theory have answered with the incorporation of local knowledge and priorities.

2.1.2 The Market Model

In crude terms market led sanitation involves competing suppliers offering a range of services and technologies and local residents paying for those which meet their needs and budget (*ibid*). It is up to the resident to decide where they will spend their money. In the idealised version of a market led sanitary service the state would have no role except for the protection of property rights. However, in practice the Market Model emphasizes getting prices 'right' in public utilities, promoting competition where the private sector operates and privatising public systems and sub-systems when there is no overwhelming reason not to (*ibid*).

The Market Model is now viewed more favourably, particularly with the general disenchantment with planning. Subsidies are blamed for public utilities failing to expand networks to poor communities, and it is assumed that more commercially oriented utilities would service neighbourhoods willing to pay the costs; the problem is that there are far more lucrative opportunities in improving wealthy areas (*ibid*).

Furthermore, at the end of the twentieth century debates emerged that sanitation was a private good, as market advocates only accept the final disposal of sewerage as a public good. Thus, according to public finance principles, sanitation ought to be financed with private resources (Serageldin, 1994). This is in contrast to the Planning Model which views the control of infectious diseases as a public good; thus viewing sanitation as indirectly providing a public good which ought to be financed through public resources. Interestingly, public goods are hard to sell on the market as those that do not buy them can still access them.

The opinion that householders should pay the full cost of sanitation services has been buttressed by how much low-income homeowners are willing to pay for adequate sanitation. However, even if residents will pay a high price to achieve the very minimal level of sanitation, this does not ensure public health (McGranahan, 2001).

The Market Model has also been used to critique the issue of rights according to government provision. The argument questions on what grounds does a government decide that public resources should be devoted to meeting their 'right' to sewage facilities? People could be taxed less and allowed to decide what to do with this money; this is a criticism of planning practice rather than a defence of markets per se (*ibid*).

A final shift concerns monopolisation, where inadequate service is supplied for an excessive price. Market advocates generally argue that regulation rather than public service provision is sufficient enough to avoid this, and that within a Planning Model, private competition alongside a public utility can be used as a way to prevent excessive mark ups in the private sector (Solo, 1999). In contrast, plan advocates view high

commercial prices as evidence to eradicate this sector (Crane, 1994).

Many of the weaknesses of this model are similar to that of the Planning Model; the complex behaviours in low-income settlements are not sufficiently accounted for, and the lack of a legal land title deters householders from investing in private solutions (McGranahan, 2001). The market naively assumes sufficient knowledge about the health benefits of sanitation amongst individual households is enough to make people have informed decisions about where to invest their money, just as the Planning Model does with experts.

Anti-market movements also argue that it is dangerous to place sole responsibility with private enterprises that have little incentive to better neighbourhood conditions (McGranahan, 2006). Finally, if the public sector regulates large private utilities, from a local perspective many of the difficulties in engaging large centralised organisations and have them act accountability to resident's demands remain (McGranahan,2001). Some of the problems inherent in the market and planning model are overcome in the collective action model.

2.1.3 The Local Collective Action Model

Simply put, the Collective Action model sees residents organize; determine their necessary sanitary improvements; decide how they will be achieved; as well as implement and maintain them. Superficially, it corresponds to a bottom-up process and similar to the Market Model, strategies are reactive to the inhabitants' needs, but in this case are the result of a common agenda.

This model sometimes appears as a child of socialist ideals and decentralised politics, and variations of this model are commonly promoted in opposition to the Planning and Market models (Crouch and Marquand, 1995). Alternatively, markets and collective action are often viewed as two sides of the New Policy Agenda combining markets with local democracy, and favouring Non-Governmental Organisations (NGO) for provision

where markets fail (McGranahan, 2001). The perceived failures of the Planning Model have added credence to local action models. Furthermore, local collective action is less threatening to the private sector than planning and so it is possible to envisage NGOs and Grass Roots Organisations (GROs) providing for needs where the market does not in a market led sanitation system (*ibid*).

This model is an obvious choice for sanitary improvement in low-income communities as sanitation can be viewed as a spatially localised public good, requiring a local public response (*ibid*). Additionally, local knowledge about conditions and practices is relevant where centralised service is lacking; this can direct attention to the right problems and reconcile different interests (Ghai and Vivian, 1992). Finally, this model is desirable from a range of political perspectives which one will exam in turn.

Endemic faecal-oral diseases are more restricted to deprived urban areas; however, within these communities poor sanitation still constitutes a major health risk, justifying public sector involvement. And as the threat is localised it is further justification for local collective action. Furthermore, sanitary services are usually communal in low-income communities and the maintenance and development of these facilities depends greatly on the community's ability to act together in shared interests (McGranahan, 2001). As a result, a community with a greater degree of social capital is commonly assumed as better able to manage these public facilities (*ibid*).[2]

However, community level sanitation can ignore the complex boundary problems involved in sanitation (Boesten et al, 1992). If boundaries are between spatially designated communities there will be spillover effects involving excreta and the movement of people so that one community's health depends in part on the conditions of other communities (*ibid*). A higher level of organisation is necessary in order to implement spatial connectivity strategies to address this; however, community based

[2] Though there are a variety of definitions adopted for social capital; however they tend to share the core idea that social networks have value. Social capital is an instantiated informal norm that promotes cooperation between individuals. The norms that constitute social capital can range from a norm of reciprocity between two friends, all the way up to complex and elaborately articulated doctrines like Christianity or Confucianism (Fukuyama, 1999).

organisation has scattered membership constituting a diffused structure, which does not form a model of sanitary improvement (McGranahan, 2001).

Additionally, collective action advocates do not deny that scientific/expert knowledge is hugely beneficial to sanitary improvement, and recent years have seen practices develop which seek to place this knowledge into the hands of the community to improve the effectiveness of collective action (SSA, 2008). This is an advantage over the Planning Model where central authorities take decisions, and the Market Model where householders act individually.

It has not been demonstrated that local collective action should be the primary model for sanitary improvement, but synthesising local and expert knowledge is undeniably advantageous, although difficult and time consuming to achieve (Fischer, 2000). However, this does seem more likely if communities are given greater political leverage; thus advocates of this model also favour local empowerment on broad political grounds which will grant local residents more control (McGranahan, 2001). Unfortunately, government neglect and manipulation has been paraded as devolution of control to low-income communities across the globe (*ibid*). Furthermore, National or local governments who are unable to finance minimal services find an obvious attraction in local inhabitants undertaking their own provision (*ibid*). Allowing this can result in low-income communities financing and organising a sanitary service that is subsidised in other areas of a given city (*ibid*).

It is not possible to gauge whether local collective action is empowering without reference to the broader political context in which all actors are situated. However, it holds true that effective community participation requires great changes in societal power relations so that this approach can become part of a broader process (*ibid*). The best hope for this approach still lies with NGOs and GROs that currently play a significant, if limited role in urban sanitation improvement (Fischer, 2000). Moreover, the advantages of local collective action are political rather than specific to the sanitation field, demonstrating the importance of the political context in which sanitary improvements are

pursued (Edwards and Hulme, 1995).

2.1.4 Hybrid Models

It is tempting to conclude that finding appropriate roles for the state, markets and local communities, and creating a Hybrid Model is the answer. However, contemporary debate argues for the building of each sector's strengths and creating synergies (Evans, 1996). The state would take on an 'enabling' role, 'private-public' partnerships would develop and community participation would be simultaneously promoted (Lewis and Miller, 1987). For example, the condominial system has proved highly successful in Brazil through combining the centralized provision of trunk lines with local involvement in the financing, maintaining, and design of connections at the neighbourhood level (Briscoe, 1993).

As previously discussed, each sector's strengths and weaknesses depend greatly on the cultural, institutional and physical contexts in which they operate. Furthermore, the Hybrid Model's success is particularly dependent on the co-ordination and information sharing process between sectors which can undermine efficiency (McGranahan, 2001).

This model argues for owner occupancy of homes that are open to the market provision of sanitation; the state as a regulator with a redistributive role; and central but circumscribed roles to community based organisations (*ibid*). Much depends on the technologies adopted. For example, piped sewage systems are more suited to central planning than latrines since it is easier to develop and enforce rules for this type of system (Briscoe, 1993). However, the institutional form cannot precede the chosen technology, but the choice of technologies naturally emerges from the institutional structure (McGranahan, 2001). This is partial reasoning why institutional and technical advocacy go together (*ibid*).

However, in practice, sanitary improvement takes place within incumbent institutional settings that do not conform neatly to the three ideal type models, even in combination

(*ibid*). Arif Hasan, an architect in Karchi since 1968, argues that no matter the institutional arrangements, a common theme is the need to face up to local realities (Hasan *et al*, 2008). Within sanitation improvement, provision takes place largely outside the formal planning process and that lessons must be learned from informal providers, including practices worth emulating.

This chapter does not promote a particular model, but forms a robust understanding of roles and powers of government, private enterprise, and voluntary association's within sanitation improvement, which is fundamental if one is to understand sanitation improvement in the chosen case study. Simplification of models is useful to understand the mechanisms that would be obscured when considering all the local and realistic details; but such detail must be accounted for when investigating any site-specific conditions and improvements.

2.2 Adaptation to Climate Change

In this section one shall examine the roles of urban institutions and other actors that affect the integration of climate change adaptation; this will allow one to understand what is necessary from all pertinent actors in order to establish pro-poor climate change adapted sanitation. The particular framework for adaptation to climate change one shall describe is necessary if all sectors of urban development (including sanitation) are to adapt. Therefore, one will describe this common framework, which will then allow the critical assessment of the relationship between sanitation and climate change adaptation more specifically.

As previously stated, low-income communities are frequently located in areas that are at greater risk to the possible effects of climate change, thus, their sanitation systems are more vulnerable to these hazards. When legal land for housing is scarce, low-income groups are forced to choose between different types of land tenure (with the more secure and less vulnerable to disasters being more expensive), accessibility (to income earning opportunities predominantly) and the possibilities of service provision (Moser and

Satterthwaite, 2008). With growing urbanisation and increasing small and large-scale disasters occurring in urban areas, disaster response measures are being tested beyond their capacities, and the impacts of disasters are amplified (Wamsler, 2006). Unfortunately, urban growth (planned or unplanned) is rarely executed with the intention to reduce disaster risk; however, the integration of pre-disaster initiatives to mitigate this risk is a vital component to the realisation of sustainable development of urban low-income settlements (*ibid*).

The vulnerability of sanitation systems to climate change is determined by its physical setting and by the system's opportunity and ability to adapt to weather changes (Adger, 2003). This ability is also dependent on the local population's interest in risk reduction, which will vary depending on land tenure status, with temporary and seasonal tenants less interested in investing in such improvements (Andreasen, 1989). Therefore, the vulnerability of populations is both event based and a product of political and economic structural factors (Pelling, 2008). All societies are fundamentally adaptive and have the ability to enhance their capacity to adapt to the possible effects of climate change. This is not solely dependent on the actions within communities, but all the actors involved in urban sanitation, with a primary challenge being capacity building at the scale of local resource management and of international agreements and actions (Adger, 2003).

The actors that implement sanitation systems must have the knowledge, will and capacity to integrate risk reduction techniques. In consequence, as aforementioned, the assimilation of risk reduction into the urban development of low-income communities is highly dependent on the political and economic arrangements of any urban setting. This is not to disregard the influence of technical factors, as these aspects also play an influential role in risk reduction of sanitation systems. Measures to integrate risk mitigation may introduce innovation in terms of technology or they may focus on institutional development, or build on the existing 'coping strategies'[3] of communities (Adger, 2003).

[3] Based on household level research, the following definition of coping strategy is proposed: "constantly changing and adapting cognitive behavioural efforts to manage disaster risk or disaster impacts" (Wamsler,2007a).

2.2.1 Role of Local Government

The quality of government at the local level greatly influences the levels of risk from climate change. Urban governments that are accountable and able to mainstream or incorporate adaptation measures into relevant sectors and departments will be important (Moser and Satterthwaite, 2008). If given the capacity, local governments are better able to execute climate change risk assessments to identify vulnerable areas, and can adjust local planning, financial, and regulatory frameworks to encourage adaptation by community organisations, households, NGO's, the private sector, and local government (*ibid*). In turn, cross-departmental collaboration and agreement on responsibility for the different measures undertaken individually or jointly is necessary (*ibid*). Unfortunately, this is rare, and so there is a need to assess the limitations of local government's capacity to integrate disaster risk into the planning of sanitation in low-income urban areas (*ibid*).

In high-income countries, it is demonstrated that local government is the key actor for adaptation (*ibid*). If there is a flood, this is seen as the responsibility of government even when homeowners choose to live in vulnerable locations. There is a web of institutions, regulations, and service providers who keep adapting communities to disaster risk and protecting them, consequently there is rarely a large loss of life and damage to infrastructure (*ibid*). Local government or local offices of provincial or National government supply the framework for provision and quality control. City planning and land use regulation is adjusted to new risks that climate change poses, and is supported by changes in private-sector investments (over time shifting from high-risk areas) and changes in insurance premiums and coverage (*ibid*). Households and community organisations in high-income countries have a very limited role with the institutions that ensure their protection (*ibid*).

The web of institutions, services, regulations and infrastructure found in high-income nations is rare in urban centres in low and middle-income nations (Adger *et al,* 2003). Furthermore, the infrastructure and services found in informal urban settlements are frequently inadequate to mitigate the effects of climate change, and there are few

mechanisms allowing low-income citizens to hold their local governments accountable (*ibid*). In addition, many local governments are anti-poor; regarding low-income settlements as 'the problem' of the city, which hinders the implementation of adaptive measures or improvement of services in these areas (*ibid*).

There is little evidence of state institutions in low and middle-income countries taking measures to adapt low-income communities to the effects of climate change (Satterthwaite *et al*, 2007). There is often confusion amongst local government politicians and civil servants about how to respond to climate change, and the literature suggests it is difficult to get local populations and local governments involved in adaptation when there is little relevant data on the possible effects of climate change in urban communities (Ligeti et al, 2007)

2.2.2 Role of Communities

Due to the lack of ability of local governments to provide protection and the capacity for adaptation in low and middle-income cities, agendas for adaptation in these urban centres will be much more dependent on the participation of households and communities (Moser and Satterthwaite, 2008). Literature identifies effective adaptation as locally driven, in part because measures ought to be developed for the particular ecological, social, political, and economic context; local governments are thus needed to work with vulnerable groups (*ibid*). Furthermore, citizen participation can cultivate a sense of 'ownership' which may encourage communities to learn new skills, allowing them to maintain systems in their communities once projects have ended, thus ensuring a long-term strategy for any infrastructure (*ibid*). It is important to note that citizen participation is not independent of government as citizen capacity to work with and negotiate with government (and if needed, to contest the government) is integral to the development of systems that can reduce the impact of disasters. This framework for climate change adaptation thus incorporates collective action alongside public sector involvement.

It is also important to recognise that most low-income groups may have a range of

'coping strategies' they use to reduce the vulnerability of their sanitation systems to the impact of disasters; for example low income communities of El Salvador built embankments to reduce the amount of rainwater entering their latrines (Wamsler, 2007b). Therefore, low-income communities are able to integrate risk reduction management into their sanitary systems at relatively low cost to more capital-intensive technological solutions. However, other risk reduction strategies often conflict with economic priorities and survival needs (Tacoli, 2009). Migration is a coping mechanism used throughout history by societies as a means to cope with climate variability; however, this is frequently not an option for low-income communities who become dependent on the income-earning opportunities which they establish in close proximity to their neighbourhoods (Stephens et al, 1994). Also, the right to migration, particularly international migration, at a time when there are increasing inequities in international labour flow, is likely to be increasingly contested (O'Neill *et al*, 2001).

2.2.3 Role of National Government

If urban governments are to be effective at climate change adaptation they must be provided with this capacity by the National government. National governments are able to set conditions on local development plans that they involve all interest groups and incorporate risk and vulnerability assessments if they are to be funded, in order to encourage locally developed responses and ultimately climate change adaptation (Moser and Satterthwaite, 2008). National governments may also provide the capacity for climate change adaptation through the provision of a National fund in disaster prone countries; this can be used for risk reduction, response when disasters occur, and the rebuilding of areas post disaster (*ibid*). This does not have to be used exclusively for projects which focus on climate change adaptation, but may be incorporated into infrastructure projects in other sectors, such as sanitation; in order to ensure the mainstreaming of climate change adaptation.

2.2.4 Role of International Donors

These agencies can support adaptation by prioritising urban sanitation projects which integrate strategies for risk reduction; they can also provide the financial and regulatory capacity at the National level, which can develop the adaptive capacity of urban governments (*ibid*). They can also work directly with urban governments who are willing to reduce risks and are able to work with the low-income communities (UN-Habitat, 2008). The focus with these actors is to lead and inform National policies which increase the adaptive capacity at the National and local levels. (Roberts, 2008).

In order to be successful, agencies ought to engage with the National systems on a long-term basis as well as give support to the governance processes needed if local government's capacity to implement climate change adaptation is to be developed. Furthermore, climate change adaptation will require a huge increase in risk reducing finances as very little is currently committed to this in low and middle-income countries (MWH, 2006). This does not fall solely on the shoulders of international donors, but there may be municipal or National funding for climate change adaptation as previously stated. In addition, increased funding for adaptation from international donors will achieve little unless local governments have the ability to work with the most vulnerable groups and to use the resources appropriately (*ibid*).

Moser and Satterthwaite also highlight that there must be 'development plus adaptation' as National and local governments are highly unlikely to implement strategies for adaptation to climate change if it will not support the achievement of development goals. Finally, international donors often contain the expert knowledge that can be synthesised with local knowledge in order to generate the most sustainable solutions for adaptation (Moser and Satterthwaite, 2008).

2.3 Reflections on the Literature Review

This literature review has allowed one to form a concrete and informed understanding of the current models and debates surrounding the provision of sanitation. One can also appreciate the financial, political, and social pre-requisites for pro-poor climate change

adaptation. One has gathered that climate change adaptation of sanitation is not only concerned with technical aspects, but also the social domain and that the web of institutions and actors involved must have the capacity and desire to execute climate change adaptation in low-income communities. One can now progress with this robust understanding and investigate the provision of sanitation to low-income communities in a chosen city and whether the system of climate change adaptation identified in the literature review has been established. It is critical to remember that there are universal principles concerning sanitation provision in low-income communities that can be generalised; however, each urban setting has a unique context with local realities that are specific to a particular environment. Through a case study one will be able to identify these and gain a more fruitful and deeper understanding of a particular environment. As aforementioned, the city that shall be thoroughly investigated will be Managua, which is the capital city of Nicaragua.

Chapter Three – Methodology

This chapter outlines and justifies the methodological choices of this project. It justifies the selection of a qualitative and quantitative approach, and the specific data collection and analysis methods used. Attention is also given to how generalization, validity, and reliability are accounted for. Firstly, however the overriding aims, objectives, and research questions are introduced.

3.0 Aims and Objectives

3.1 Research Aim

To investigate how people living in low-income urban communities access sanitation, and whether there is an effective framework for pro-poor adaptation to climate change which ensures sanitary systems are able to reduce the impact of climate change's possible

effects.

3.2 Research Questions

After consideration of the relevant literature the following research questions have been identified in order to achieve the aim of this study:

How do the urban poor gain access to sanitation and why do they use these particular systems?

How do the effects of climate change affect sanitation in low-income communities?

What strategies are used at the community and household level to reduce the vulnerability of sanitation systems?

What are the roles, practices and relationships of relevant actors in the provision of sanitation and climate change adaptation?

Do relevant actors have the capacity to establish climate change adapted sanitation?

3.3 Research Design

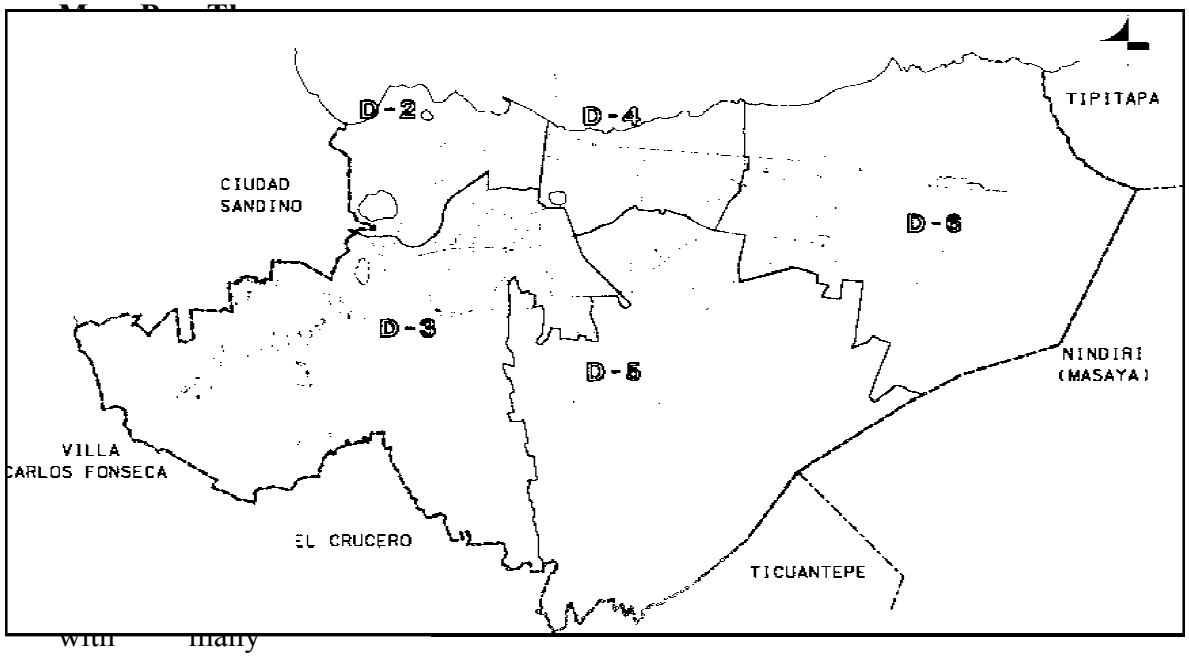
To answer the research question, the research design employed a case study of Managua; data was gathered from the household, neighbourhood, municipal, and National level. Both primary and secondary sources were consulted. The selection of methods was determined by the kind of data needed to address the research objectives as well as the identity of the informants. Both quantitative and qualitative data were gathered, with the latter forming the majority. Data collection was carried out during May to July 2009. The first two months were dedicated to the literature search and the gathering of secondary sources; between July 4th and July 28th one traveled to Managua to gather primary sources and any additional secondary sources. Being able to gather data first

hand and experience in-situ allows one to draw together a wider spectrum of sources and make a more comprehensive analysis, which increases the validity of results and conclusions. The primary reason behind the use of triangulation to answer the research question is because the combination of the two techniques makes it possible to work out an analysis that takes account of the relevant details, a manner to avoid posing conclusions too hasty and generalizing (Rossman and Wilson, 1985).

3.4 Case Study Selection

Nicaragua is a representative democratic republic and is located in the tropics region of Central America; the total population as of 2007 was 6,610, 26 (INIDE, 2006) (see Map A). The capital city is Managua, and is the department and municipality by the same name. It is situated on the South Western shore of Lake Managua (1.042km2), has a total population of approximately 1, 680, 100 residents within its boundaries and is divided into six districts (*ibid*)(see Map B).

Map A: Nicaragua in its regional context (Source: IDRC, 2009)



other parts of Nicaragua) can receive large amounts of rainwater during the wet season; the local impact can be the dramatic rise of Lake Managua. Furthermore, there are many low-income communities situated in the immediate surroundings of the lake; therefore these communities are at a greater risk of flooding. Recent occurrences include Hurricane Mitch in 1998 that caused the lake's level to rise by four metres resulting in severe flooding and damage to these communities (Ahti, 2002). Research evidence also indicates that annual water levels continue to exceed the levels recorded each rainy season (*ibid*).

In addition, Managua is an excellent choice of site investigation; firstly as it is a capital city it will allow one to examine how climate change adaptation of sanitation in low-income communities are dealt with by an urban municipality which holds the political and economic power of the nation. Therefore, it may be possible to generalise results to other urban capitals in other low and middle-income countries.

Furthermore, the experiences felt by low-income communities in Managua are not isolated incidences; flooding of low-income areas located near large natural water bodies is a phenomena which occurs in many urban areas of other low and middle-income

countries around the world. Therefore, the study of Managua may allow for insightful results that may be applied to gain greater understanding of other urban settings.

3.5 Data Collection Methods

3.5.1 Secondary Sources

These sources were gathered from the Internet, and given that this data already existed, permitted one to save time and material resources. Used as a source of information and a tool of triangulation, secondary sources intervened almost permanently in the study.

The thesis work began with a review of literature and policy at National level; information was obtained from websites. First an examination of the institutional arrangements of sanitation provision and climate change adaptation in Nicaragua was made, and an examination of relevant laws and regulations (see appendix 1). One also reviewed documents concerning sanitation improvement and climate change adaptation on the National as well as the regional scale of Central America (see appendix 1)

At the municipal level, the collected data included some quantitative data, namely the 2005 Nicaragua census data on land tenure and population, as well as information about which areas receive sanitation services through the National provider Nicaraguan Company of Aqueducts and Sewage Systems (ENACAL). Information about projects to improve the city's sanitation system was gathered through Internet sources. Examination was also made of the Municipal Emergency Plan for Managua in the event of flooding and the Urban Plan of Managua (see appendix 2).

At the community level, secondary data included online information about current or proposed projects in the low-income communities next to the lake. This also aided one in identifying NGOs who would provide access for in situ observation and interviews within several communities.

3.5.2 Primary Sources

The qualitative shutter, particularly the direct observation and semi-structured interviews made it possible for one to develop a broader vision of the investigation. The qualitative methods are more adequate to apprehend the behavior of people, perceptions, attitudes and so on (Yin, 2003)

3.5.3 Semi-Structured Interviews

Interviews were used to gain an understanding of participant's views and opinions; interviews use open questions to gain greater detail (Chambliss & Schutt, 2006). Interviews were also used to corroborate information from other sources and provide an insight into historical and future situations (Yin,1993). In addition, semi-structured interviews generate a lot of extra information; this will provide not just answers, but also the reasons for these answers (*ibid*).

As time spent in Nicaragua was relatively short, interviews were chosen as the main method to gather primary data. Interviews could be arranged with informants at short notice through e-mail and telephone; plus, this method created the 'snowball' effect once in country to make contact with other potential interviewees.

Interviews were conducted with individuals working at all levels, from National ministries to householders in low-income communities (see appendix 3 for a list of interviewees)[4]. This ensured the research questions were answered, as the relationships, actions and capacity of relevant actors at all levels were examined. A varied selection of interviewees also ensures a range of perspectives which helped one reach the 'saturation point', where further investigation does not yield new information (Chambliss and

[4] Four householders living by the lake were interviewed. For the clarity of this research the two families from Santa Clara barrio shall be referred to as Informant 1 (I-1) and Informant 2 (I-2), with the families from San Sebastion referred to as Informant 3 (I-3) and Informant 4 (I-4). When one is referring to data which was gathered from all four inhabitants I-5 will used to indicate this in the main body of text.

Schutt, 2006). Female informants of low-income communities were preferred as their perception of problems differs to male heads of households (See appendix 4 for the general interview schedule).

All interviews conducted were recorded on audiotape, as one is not fluent in Spanish. Afterwards a translator transcribed all interviews in full. This process limited the ones ability to raise further issues in response to answers given to the pre-written questions, which limited access to additional information.

Semi-structured interviews minimise hierarchical situations and allowed one to probe for details and discuss issues further (Robson, 2002). This is particularly useful as interviews were conducted with residents of low-income areas who may have felt intimidated by the prospect of being interviewed. Also, semi-structured interviews allow local inhabitants to discuss the sensitive issues, such as sanitary habits more easily. Furthermore, field staff from local organisations become acquainted with community members, and so an 'outsider' is often better at interviewing because they are perceived as more objective.

Four individuals from two low-income communities situated by the lake were interviewed; results cannot be generalised to all situations, however this data demonstrated that certain behaviours are occurring, and these may also be occurring in other communities of Managua and even other cities across the world.

3.5.4 Non Participative Observation

This tool for qualitative analysis privileged this study with in-situ inspection or direct observation in low-income communities. The observer is apart from the phenomenon, and one systematically brings back what it observes. People living in communities often had different perceptions of the issue of sanitation; as a result, observation contributed to crosschecking information to have concrete discussions. The purpose of it is to describe,

in an exhaustive way, the objective components of a given social situation (places, structures, people, groups, acts…) to extract from typologies (Strauss, 1990). The advantage is that individuals are observed as they are (intact), in their natural situation (*ibid*).

The data gathered in this form is not as reliable as if there were multiple observers; there is also the risk of a hasty interpretation, instead of a description. In addition, the difficulty associated with the observation is the slowness of the progression of the research task, because of an impossible fence without "the constant deepening of the results" (Peneff, 1996). Seeking a rigorous analysis, this observation could have proceeded over several months; however, the duration of work being for one month it is impossible for one to reach this saturation by the means of the observation. Furthermore, it is acknowledged that the presence of an 'outsider' may affect the behaviour of residents, as they may not feel able to act naturally within their presence (*ibid*). Therefore, one combined this with the technique of interviews in order to maximise the gathering of data and to have several prospects for analysis.

Chapter 4 – Results and Analysis

In this chapter one will systematically explain and critically examine the findings of the data collection period. Attention will be paid to how communities access sanitation and why these particular systems have been adopted. This is because the adaptation of sanitation in these communities is directly related to these issues, as one will demonstrate.

It is important to emphasise that attention has been paid to the institutional measures that are being taken to encourage pro-poor adaptation of sanitation to climate change, as well as the integration of disaster risk management of sanitation. Furthermore, it is critical for one to remember that some findings from this particular case study are not isolated to the context of Managua; results can be generalised to explain phenomena in other urban

contexts. This will be drawn upon throughout this chapter.

4.1 Urban Evolution of Managua

On December 23, 1972 an earthquake struck Managua, destroying 13 square kilometers of the city centre, leaving approximately 250,000 homeless of the 400,000 who lived there at the time (see figure 1) (USGS). Before the earthquake, the city was well planned with city blocks, and a city centre located on the Western shore of Lake Managua where the epicentre was also located.

After the earthquake the land by the lake was completely destroyed and deemed uninhabitable as it was classified as being prone to earthquakes; furthermore, the then ruling Somoza family directed most of the rebuilding efforts to land that the Somoza family owned on the periphery of the city (Blanco, 1983). As a result the destroyed central part of Managua was not rebuilt and was virtually abandoned. The rebuilding effort that did take place created new residential areas east-south-east of the city centre (*ibid*). This gives the city the appearance of a deformed octopus. The tentacles of the octopus reach out along major transport arteries away from the old centre, but the octopus's body is riddled with gaping holes (Wall, 1996). The population of Managua increased steadily afterwards, with low-income families illegally inhabiting the land by the lake (Siles, 2009). At present the population by the lake has also increased dramatically since 1972, with 70, 952 people living in these communities (INIDE, 2006) (see map C).

Figure 1: Managua City in the immediate aftermath of the 1972 earthquake (Source: USGS, 2009)

Lake Managua is extremely polluted as untreated human and chemical waste from the city has been dumped into it since the 1950's (Ramirez, 2009). ENACAL, the public utility for water and sanitation, is guiding policy and implementing a project to clean up lake Managua (Quesada, 2009). The municipality is making great efforts to encourage tourism into the city, in order to raise the municipal revenue. Critically, this plan is hinged on the improvement of the lake which will be the main tourist attraction of Managua (Gerencia PGDM, 2006). ENACAL is currently overseeing the construction of a water treatment plant and collection system, funded by the Inter-American Development Bank, the German Kreditanstalt fuer Wiederaufbau, and the Nordic Fund, which is expected to be completed by 2010 (ENACAL,2008). This plant will receive

human waste from households currently connected to the piped sewage system, and will then transfer treated waste into the lake (Quesada, 2009). The low-income communities by the lake who are not currently connected to the piped sewage system will not benefit from this project (Siles, 2009).

4.2 Why do people live by the lake?

As is the phenomenon in many urban centres across the globe, many people came to settle in the capital from rural areas in order to pursue better income-earning opportunities (Rodgers, 2008). Furthermore, after the end of the Contra War in 1987, migrants who were granted refugee or political asylum status during the conflict began to return to Nicaragua, and many settled illegally by the lake (Siles, 2009). These locations were chosen because inhabitants did not have to pay the state to occupy this land (I-5, 2009). Some inhabitants had been informed by family that there was land available, thus creating a 'cluster' effect by the lake; this is a pattern of migration found throughout the world (I-2,I-3, 2009). Moreover, living in close proximity to the lake brings many income-earning opportunities for low-income families. One observed and spoke to families whom use the lake to catch fish, whilst others use the water from the lake to cultivate crops, particularly tomatoes (I-5, 2009). These are used to sell at local markets and are also consumed by families.

4.3 Access to Sanitation

4.3.1 The Formal Provision of Sanitation

ENACAL is responsible for the provision of sanitation within Managua; in-situ observation and interviews with all informants confirmed that ENACAL was not serving communities by the lake with the piped sewage network. The National Council for Drinking Water and Sanitation (CONAPAS) is responsible for policy setting in the Nicaraguan sanitation sector. ENACAL implements projects that service the city, and the

Nicaraguan Institute of Aqueducts and Sewage Systems (INAA) is the regulatory agency of the sanitation sector (Quesada, 2009). ENACAL funds the maintenance, repairs, and general management of this service through the net income generated through service charges (Ramirez, 2009).

According to the municipal law of Nicaragua, municipalities are obligated to ensure all inhabitants of their municipality receive sanitation services (Siles, 2009). Very few municipalities actually provide these services themselves; instead more than 60% of sewage users in Nicaragua are served by ENACAL, which also serves Managua (Ramirez, 2009). In Managua, the municipality establishes the framework of urban development, including the communities that shall be serviced, and then obliges the competent institutions (ENACAL) to implement projects in the city (Siles, 2009).

However, in recent years CONAPAS and INAA have not been assuming an influential role in the sanitation sector. They are not able to steer the policy of ENACAL, and the responsibilities of INAA have been dramatically reduced, with governance over this sector becoming more centralized in ENACAL (Ramirez, 2009). This institutional arrangement creates an environment where ENACAL have great autonomy over the sector, as they are less accountable to other institutions. As identified in the literature review, there must be mechanisms in place that hold formal providers to account, these may be 'top down' or 'bottom-up'; if not, the status quo can remain, which is currently excluding low-income communities by the lake from the formal provision of sanitation. In the case of low-income communities, a bottom-up approach is more effective, as there is often little political incentive or will within higher governmental levels to improve these areas.

4.3.2 How Communities by the Lake Access Sanitation

One entered the low-income lakeside communities of Santa Clara and San Sebastion. Informants 1, 2 and 3 were using basic pit latrines, with each household having a private latrine. These particular families had built their latrines themselves; the designs were very basic with a hole of approximately four metres deep being dug into the earth. Seats were constructed from concrete or material of a similar sort, and most were built on a small base of concrete which helps to prevent some surface water seeping into the latrine. However, there was no sand placed in the 'pit' in order to avoid human waste leaking into the surrounding soil, and latrines were not elevated off the ground to reduce the amount of water entering pits if flooding occurred. As a result the ground surrounding the pits becomes contaminated, and this contaminated soil eventually enters the lake, causing further pollution (see figure 2).

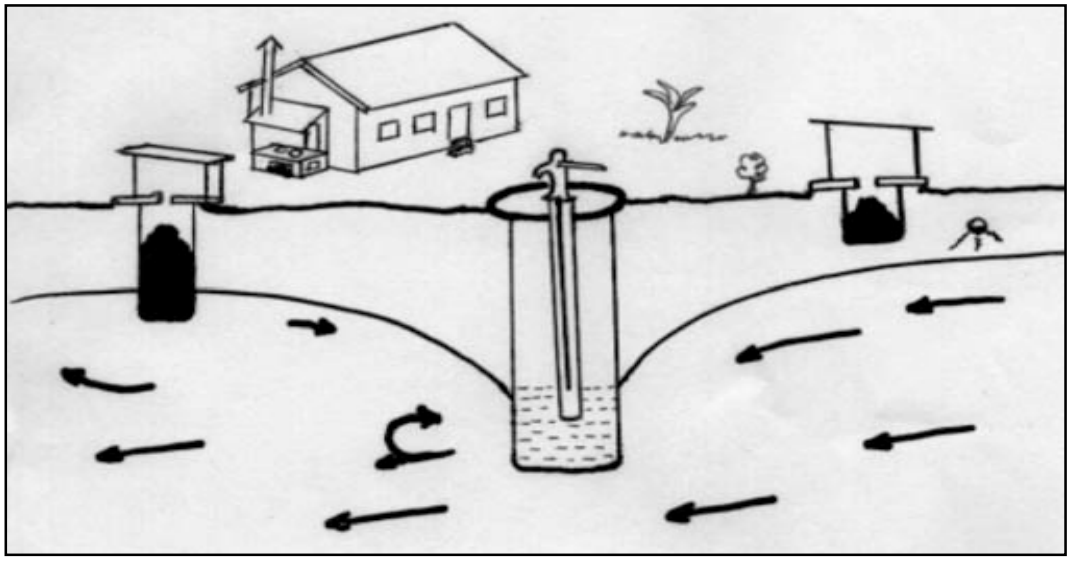


Figure 2: Diagram showing how pit latrines may result in the contamination of surrounding soil

Sheets of corrugated iron, wood, or plastic sheets were also placed around the latrines for privacy, and all three families placed a slab of wood or corrugated iron over the pits to reduce bad odours and flies (See Figure 3 and 4). Once people settle in an area, latrines are the first thing which they construct, but that they are then the last thing which people will choose to invest time and money on improving (Hector, 2009).

Figure 3: Pit latrine in Santa Clara

Figure 4: Pit latrine in Santa Clara

Informant 4 lived on the very edge of the lake, approximately two metres above the lake's water level; they had simply dug a hole in the ground that was approximately three metres from the water's edge, where the soil is extremely moist. Such a basic system was a rarity, and most latrines are built with basic privacy and a seat (Hilda, 2009). Informant 4 was not aware of the health benefits of good sanitation (I-4, 2009). As stated in the literature review, knowledge of the health benefits of sanitation is a fundamental necessity if families are to invest in improving their systems and reducing the vulnerability of these systems. Once again, one cannot make sweeping generalisations; however, it is reasonable to suggest this behaviour is also occurring in other lakeside households in Managua and other urban contexts.

Informants from both communities revealed that they do not pay for sanitation, and only

cover the expenses of any materials used to make their personal latrines. Informants 1, 2 and 3 stated they would be willing to pay for a better sanitation system; a pattern also identified in the literature review (I-1,I-2,I-3, 2009). Informant 2 is a prominent community member in Santa Clara, and she informed one that other inhabitants would be willing to pay for a better sanitary service as it would "get rid of bad smells and improve the cleanliness of homes" (I-2, 2009). However, she was clear that the price charged for such a service should reflect the income of the families. She clarified this by saying that sanitation is a service, which all citizens of the city are entitled too; therefore viewing basic sanitation as a fundamental human right.

4.3.3 Socio-Economic Mechanisms

ENACAL are currently charging users an insufficient amount to receive the formal sanitation service; as a result the cost recovery is by no means enough to fund an extension of the network to the communities by the lake; this was an issue identified in the literature review (Ramirez, 2009). However, within Managua, there is no informal sanitation market working alongside the public utility, which can fill the vacuum of provision which ENACAL has left.

Although the data has shown low-income families are willing to pay a subsidised amount for an improved service, it appears ENACAL nor the municipality are willing to raise the price charged to those currently receiving this service, in order to fund such a venture. The literature review addressed this phenomenon, explaining that such behaviour is likely to be political, as the local government is acting to maintain support from those who receive sanitation, the majority of which will be affluent and politically articulate, who promote a more positive image of the city and have the potential to cause socio-political instability if they are dissatisfied with price increases. The political-economic forces in the city demand low prices that cannot raise the needed financial resources. This is a paradox prevalent throughout the debate of access to sanitation for the poor in Managua

as well as other urban settings across the world.

In addition, it is also likely that ENACAL and the municipality of Managua favour the more affluent areas of the city as they view them as more able to maintain a relationship of trust between duty bearers and users. This phenomena is not unique to Managua city as it occurs in many other urban settings with a distinct urban poor and elite. The issue of trust is pandemic within the discourse of the poor's access to sanitation. Formal institutions have little faith that the urban poor will uphold their responsibilities as users; and the poor do not have a 'culture of payment', in that they do not want to be faced with regimented and costly monthly bills, nor be threatened to be cut off (Swyngedouw, 2004).

The lack of access to sanitation for the poor living by lake Managua cannot be sufficiently explained with geo-climatic, engineering, and finance problems; significant socio-political dynamics lie at the belly of the problem, and they perpetuate the political and economic problems which produce a lack of formal sanitary provision. These processes maintain the status quo, and contain the contradiction between the demands of the urban bourgeoisie and the increasing poor located next to lake Managua. It is important that one acknowledges these issues when analyzing the adaptation of sanitation to climate change as they are interrelated.

4.4 Climate Change Adaptation

In this chapter one shall examine the relationships, strategies and capacity of pertinent actors, which affect the establishment of pro-poor adaptation of sanitation to climate change and disaster risk management in the communities by lake Managua.

4.4.1 National Level

The National System for the Prevention, Mitigation and Attention of Disasters (SINAPRED) is a National governmental system created in 2000 through law 337[5]; this law states the mission of this system is to integrate different social actors, municipal and regional committees and government levels for risk mitigation and prevention, with an emphasis on risk management (SINAPRED, 2000) (see figure 5). This system seeks to collaborate with municipal committees which are set up by the Institute for Municipal Strength (INIFOM).[6] SINAPRED works with the Nicaraguan Institute of Territorial Studies (INETER) to identify vulnerable areas in the country; municipal committees then formulate plans of action, with NGOs commonly implementing projects (Izaguire, 2009). These committees allow synergy between expert and local knowledge which generates more sustainable solutions, as well as strengthening networks and horizontal relations and creating citizen empowerment (Moser and Satterthwaite, 2008). This process also ensures inhabitants are involved in the maintenance of projects once completed, which can increase the longevity of strategies. Furthermore, the costs of projects that engage citizens throughout are less expensive relative to projects that exclude community participation (Izaguire, 2009).

[5] According to law 337 SINAPED is responsible for making the national system operational, ensuring appropriate staffing of Secretariat and of member agencies; preparing and activating a National Emergency Plan, clarifying procedures and standards to be applied, and training System members in the Plan and specifically, in their respective roles in disaster response, prevention and mitigation; establishing a Disaster Management Fund to assure sustained financing emergency response and relief; establishing and maintaining a data base, supported by geographical information systems (GIS), relevant to disaster management, including information on hazard and vulnerability assessments, as well as programmes (Al-Azar and Desantis, 2007).

[6] A municipal committee normally consists of representatives from SINAPRED, the municipality, technicians from the particular sector projects are related to (i.e. Sanitation) an NGO, members of a given community. In this manner, synthesis is made between expert and local knowledge and the transparency of the project is established, which gains the trust of all stakeholders.

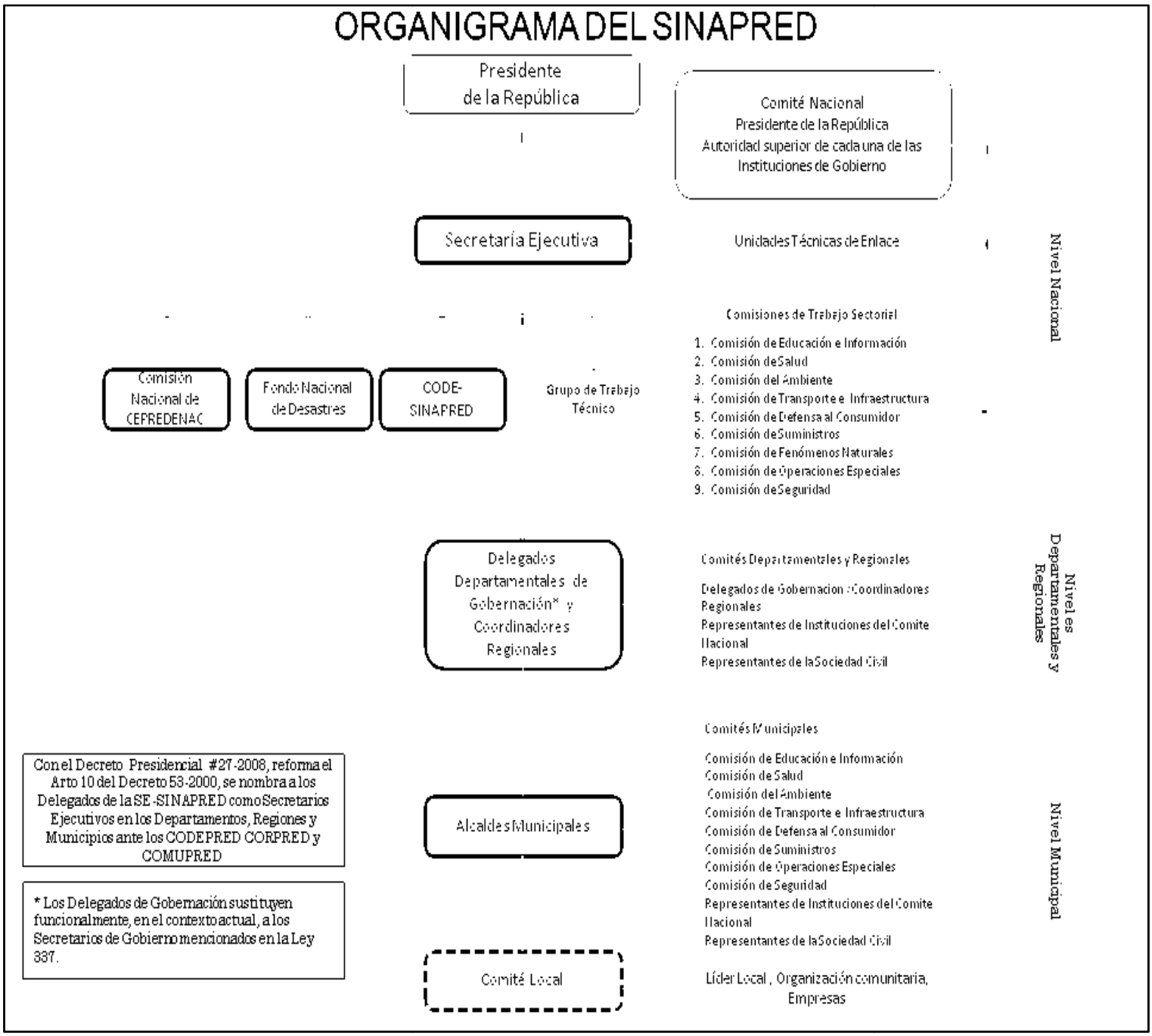


Figure 5: Institutional Context of SINAPRED (Source: SINAPRED, 2009)[7]

[7] SINAPRED has been integrated into a complex web of National, regional and municipal institutions. In theory, SINAPRED is to collaborate with actors on all levels to ensure disaster risk management is mainstreamed into the work of each sector. However, in reality this is not possible for a variety of reasons, which one shall systematically address.

International donors supply SINAPRED's budget, which forms an annual National fund (Izaguire, 2009). SINAPRED then uses this budget to allocate funds to municipalities to implement projects. Article 8 of law 337 establishes that each institution of SINAPRED must include the necessary funds as well as the technical staff and physical resources for the development of all activities related to prevention, mitigation, and preparedness included in the National Natural Disasters Management strategy and plan (SINAPRED, 2009). Allocations of funds are done in theory, but in practice they are mainly devoted to activities of emergency response and a handful of risk reduction projects in certain municipalities (Izaguire, 2009). This is due to an insufficient amount of fiscal resources as well as a limited number of trained staff (*ibid*). As a result SINAPRED agencies do not have the capacity to execute projects which focus on prevention and the mitigation of disasters.

Primary and secondary data demonstrated that disaster risk management is not being mainstreamed into the projects which ENACAL is carrying out, as there is no collaboration between SINAPRED and ENACAL. Revealingly, discussion with the president of public services of the municipality of Managua also revealed that there is very little programmatic mainstreaming of SINAPRED into other municipal departments (Siles, 2009).[8] Although law 337 legally obligates the integration of risk management; there remains little support or incentives for adaptation of sanitation to climate change in low-income communities. Integrating disaster risk reduction into projects incurs higher costs for projects which SINAPRED is currently unable to provide; moreover, climate change is a relatively new concept in Nicaragua, thus municipal departments are still coming to terms with the idea of climate change adaptation (Siles, 2009). It therefore appears that there is a great deal of rhetoric surrounding the work of SINAPRED, whereas in reality, this institution does not appear to have the political weight nor resources to significantly influence the work being carried out in the sanitation sector.

[8] Programmatic mainstreaming is the modification of sector-specific programming in such a way as to reduce the likelihood of any programme measures actually increasing risk, and to maximize the programme's potential to actually reduce and /or finance risk (Wamsler, 2008).

4.4.2a Municipality of Managua

There are 70, 952 people living by the lake; 'The Contingency Plan Before Intense Rains (winter) Municipality of Managua – 2008', which is the strategic plan of the city in the event of flooding, shows that there are 2,825 persons at risk of flooding in District two, 3,024 persons in district four and 7,239 in district six (see appendix 2). If one consults the maps provided, it can be observed that the vulnerable settlements are located near the lake where most low-income communities are situated.

There are no measures being taken by governmental or non-governmental actors to reduce the vulnerability of sanitation systems in these communities (Izaguire,Olley, 2009). There is a National meteorological forecasting system that is used to inform municipalities of any adverse weather patterns; this gives the population time to carry out any existing coping strategies to reduce the impact on their sanitary systems (Izaguire, 2009). The local municipality of Managua then mobilises the contingency plan, which consists of moving affected people to temporary shelters until the level of the lake has returned to the natural level. The measures taken by the municipality are therefore focused solely on post disaster response and not prevention or mitigation.

However, SINAPRED have drafted a National plan entitled 'Quinquenal' to work with thirty municipalities in order to increase the capacity of low-income communities to adapt to climate change. This plan includes just two communities by lake Managua (Benedicto Valverde and Las Torres), which were identified as vulnerable to flooding and earthquakes. Inhabitants will be taught how to use their capacities in order to adapt to flooding and reduce the impact this can have on their livelihoods, including their sanitation (Izaguire, 2009). This plan also includes education about the health benefits of good sanitation and climate change, which is critical if low-income householders are to choose to invest in risk reduction techniques of their sanitary systems (ibid).

Adaptation to climate change is a decentralised process within Nicaragua, as each municipality is responsible for executing risk reduction projects through a municipal committee. However, SINAPRED is a National institution, and is addressing climate change on a National level; therefore it considers the entire country when choosing geographical locations to execute projects. Due to limited financial and human resources, the most risk prone areas of the country are chosen to implement the few prevention and mitigation projects which SINAPRED is able to carry out. This has created an unjust distribution of projects; as a result the communities by lake Managua have been categorised as being at a lower level of risk than other areas in Nicaragua, and so projects are not being implemented here (Izaguire, 2009). In addition, there are currently no NGO's available to work by the lake implementing SINAPRED's projects (Izaguire, 2009).

It appears that SINAPRED is an institution that lacks resources, as well as the necessary actors to implement its projects. Local governments are not receiving the necessary fiscal and human resources to give them the necessary capacity to practice climate change adaptation of sanitation. There is also little pressure from the National government being exerted on the municipality of Managua to pursue adaptation of sanitation to climate change. This is a product of the lack of international treaties which obligate the National government to climate change adaptation, as well as a general disinterest in the issue of climate change on all levels within Nicaragua. Therefore the National government has few incentives for increasing its efforts to attract greater funding from international donors for SINAPRED. And as one has shown, monetary constraints is the fundamental cause which is preventing SINAPRED from carrying out its plans to reduce the vulnerability of sanitation in Benedicto Valverde and Las Torres.

4.4.2b The Municipality's Solution

Consistent with the literature review, the local government has an anti-poor policy in terms of urban development. The public services department of the municipality of

Managua, which is responsible for establishing the framework of urban development, is currently trying to relocate the families by the lake to Huellas de Jesus in the municipality of Tipitapa (Siles, 2009) (see map D). This department holds that people will have a better standard of living there, and that there is nothing that can be done to reduce the impact of flooding on the sanitation systems by the lake without spending excessive amounts of financial resources on technologically intensive solutions (Siles, 2009). This is a naïve standpoint, as there are several low-cost strategies that can be implemented to reduce the impact of flooding.[9] The problem lies in the institutional arrangements of urban planning within Nicaragua; power and decision making is centralised in the municipalities in the form of a 'Planning Model'. As a result, there is no citizen engagement and the informal and low-cost coping strategies used by the lake remain unseen by urban planners. This top-down approach is not working, as local knowledge and realities are disregarded; adaptation of sanitation to climate change in the lakeside communities requires a bottom-up approach and local collective action as we saw in the literature review. Incorporation of local knowledge would highlight the low-cost coping strategies which are available as alternatives to capital-intensive solutions.

[9] Innovative coping strategies include 'Sand Enveloping', where sand is used to line the pits to prevent the surrounding soil becoming contaminated when flooding occurs; the elevation of latrines can be increased by building on a mound of soil or constructing the latrine on top of steps; people can empty their latrines and transport the waste to designated areas, which are not prone to flooding, and rocks or soil can be used to form a small barrier around latrines to prevent water entering.

Map C: The municipality of Tipitapa in its National context (Source: Cosecha Outreach Nicaragua, 2008)

Siles argued that the land by the lake is uninhabitable as there are frequent floods and the land is highly polluted due to the widespread use of latrines and the dumping of untreated waste in to the lake (Siles, 2009). Furthermore, if these families were to remain by the lake using their current sanitation systems, they would hinder ENACAL's project to clean up the lake (Siles, 2009). As aforementioned, increasing the level of tourism in

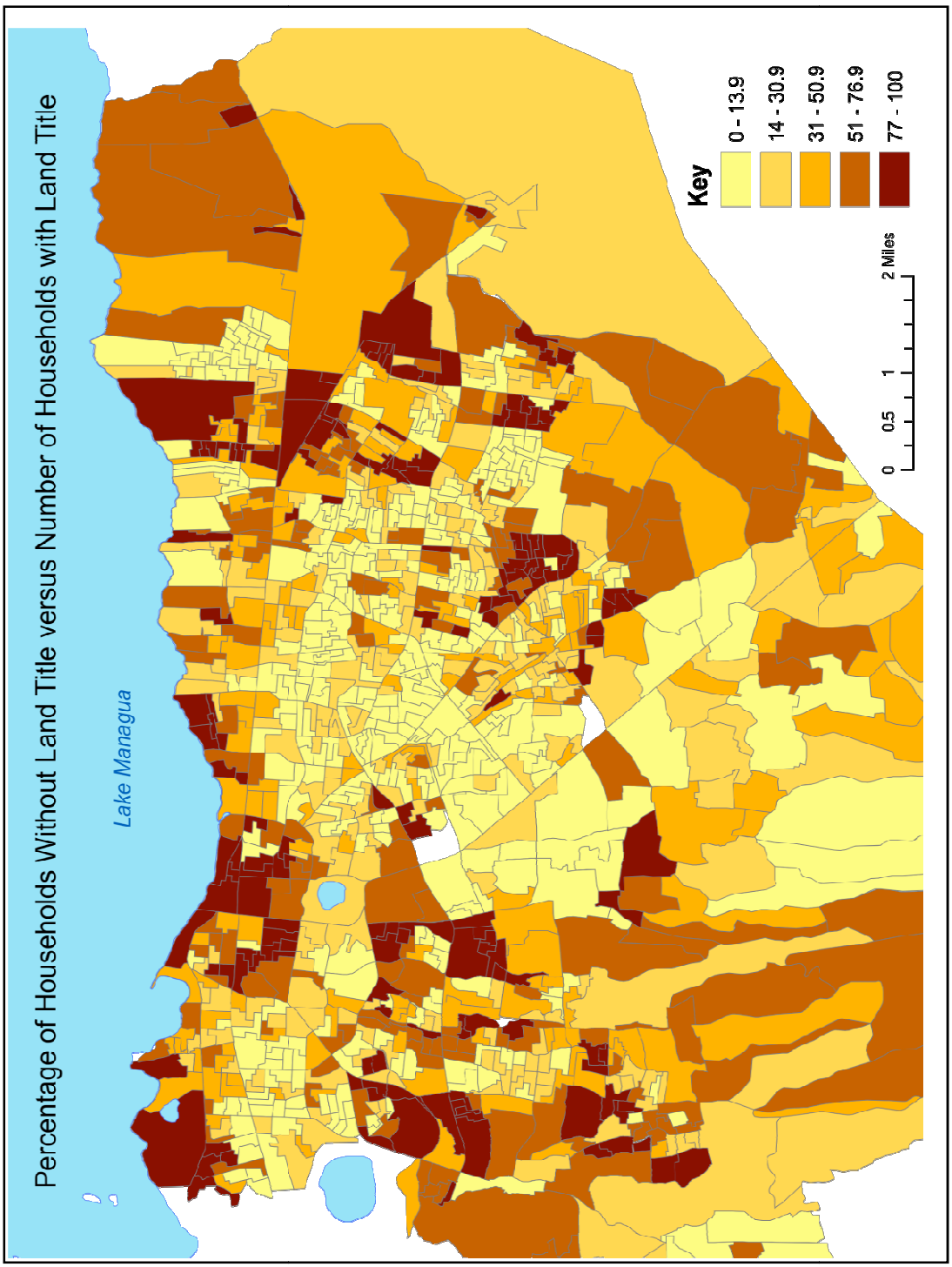
Managua is a core part of the Urban plan of Managua, and this plan is hinged on increasing the attractiveness and cleanliness of the lake (Siles, 2009). Siles then expanded and justified the lack of state intervention to plan these communities into the urban make-up of Managua saying:

*"...the state cannot help these people because they are located in marginal areas which are protected by environmental laws which does not allow construction to take place; furthermore, they are occupying this land illegally" (*Siles, 2009*).*

According to census data, the majority of the low-income dwellings situated by the lake do not have legal land tenure (see map D). Therefore, the municipality does not have the statutory obligation to provide public sanitation to these communities. If land title were to be granted to the households within these communities then the local government would formally acknowledge these communities as part of the city ecology and would then be obligated to provide formal sanitation. This is a strategy employed by urban governments across the world that wish to plan communities (usually low-income) out of a city, as they are perceived as a hindrance to the development and vision of the city's urban plan.

All four low-income informants consulted believe they do not receive publicly serviced sanitation because they lack legal land title (I5, 2009). All were in possession of a 'solvencia', which is a formal document from the municipality which does little more than confirm how long each family has lived in their particular household; it does not guarantee the municipality will provide public sanitation (Ley 278, see appendix 1). Three of the four informants explained that they had formally applied for land title through the Ministry of Property; however, after nearly two years they have received no feedback on the progress of their applications. Some barrios change the name of their particular community to that of a current or rising political figure, in the hope that this will increase their chances of receiving governmental help and land title (Hilda, 2009). The lack of land title and absence of a mechanism for which low-come communities can

hold governmental levels accountable means these lakeside communities are being excluded from the formal political system and are unable to exert pressure on the municipality to improve their sanitation systems and adapt them to the effects of climate change.



Map D: The 'Percentage of Households Without Land Title'. (Source: INIDE,2005).[10]

[10] The darker areas of the map (fewer households with land title) situated by lake Managua demonstrate that low-income communities are less likely to have land title; as opposed to the more affluent areas of the city which have higher levels of secure land tenure (lighter shaded census tracts). It is interesting to note that the communities with lower levels of land title are generally situated around the peripheries of the city.

Izaguire explained that SINAPRED is supporting this strategy for relocation:

"It is not financially viable for SINAPRED or the municipality to improve all areas by the lake, and these families can enjoy a better standard of living free of natural disasters in Tipitapa" (Izaguire, 2009)

Many families from the lake agree to move to Tipitapa; where government built houses have been constructed; however, many families end up selling these houses, and move back to the lake (Siles,I5, 2009). Firstly, the houses are far smaller than the majority found by the lake, and many families find them impractical for their family (I1,I2, 2009). Tipitapa is also a rural area, where the source of income is limited to agricultural work that does not produce as much income as families could earn fishing and farming by the lake (I5, 2009). Families have become dependent on the lake for their income-earning opportunities and as a source of food; the municipality of Managua is not taking these social practices into consideration, thus this solution is unsustainable. This particular case study can therefore be drawn upon as an archetype illustration of the importance of local realities when planning urban development.

4.4.3 Non-Governmental Organisations

There are no sanitation or disaster risk projects being implemented by National or local government institutions, or by NGOs by the lake (Olley,Izaguire, 2009). However, the NGO Habitar has implemented a sanitation project in Barrio Mexico; a low-income community of District five. One was able to enter this barrio, and although the lake does not situate this settlement, it did give an insight into the work that is being done by NGOs in other parts of Managua that are also prone to flooding.

Habitar is carrying out a programme entitled 'Issue 2', which focuses on the

identification and adaptation of technology to improve sanitation in low-income communities (Issue-2,2009). Technicians of Habitar and the municipality collaborate with inhabitants of this low-income community on a grassroots level to identify problems and solutions to improve sanitation. Hilda Delgado, a technician who previously worked on Issue 2 with Habitar, explained that reduction of the impact of flooding on sanitation were not given attention by the community or the local government when she collaborated with both actors during the identification of appropriate technologies (Hilda, 2009). Furthermore, Habitar currently does not have an agenda which focuses on risk reduction strategies (*ibid*).

Data also revealed that international donors are not placing pressure on NGOs to mainstream disaster risk management into their project design; this could be done by setting risk reduction as a pre-requisite for funding (Moncada,Hector, 2009). Incorporating risk reduction strategies into the design of sanitation projects can raise costs; this makes it more difficult for NGOs to receive funding from donors (Hector, 2009). This particular case illustrates that a lack of consideration of climate change is endemic amongst low-income communities, NGOs, the local government, and international donors alike. There does not appear to be incentives, or pressure from above nor below on NGOs to mainstream disaster risk management into the provision of sanitation.

4.4.4 Community Level

Informants 1 and 2 had lived in their current home for twenty-five years, and informants 3 and 4 had resided in San Sebastion for forty years; therefore, these particular families had experienced the impact of flooding, including Hurricane Mitch in 1998. During flooding, there is complete loss of accessibility to latrines (I5, 2009). Flooding caused human waste in latrines to rise to the surface, which can spread disease (I1,I2, 2009). Furthermore, the population by the lake continues to increase and is thus becoming more

densely populated; therefore, the impact of flooding on sanitation in these communities is increasing in intensity over time. Urbanisation is a global phenomenon; thus, it is possible to deduce that the impact on sanitation in other low-income flood prone areas is also rising in severity.

As there are no Nicaraguan institutions nor NGOs providing formal mechanisms for climate change adaptation in these communities, the inhabitants of these communities have adopted their own innovative informal coping strategies. When flooding is forecast some families fill their latrine pit with soil; however, this does not prevent excrement rising to the surface during flooding, which can spread disease and will make the post-disaster reconstruction more difficult (I1,I3,I4, 2009). One family actually transfers the excreta from their pit latrine and dumps it directly into lake Managua when a flood is forecast, in order to avoid the waste rising to the surface near their home (I2, 2009). In addition, some families build their latrines on a concrete base which prevents water leaking into the pit latrine from the soil surrounding the latrine.

All residents revealed that in the aftermath of Hurricane Mitch, their families had to wait for the water level to naturally reduce before they could return to their homes. Once they had returned they did not receive help to rebuild their sanitary systems (I5, 2009). Due to a lack of resources and knowledge about flood mitigation and climate change, the families of all four informants returned and constructed the same basic latrines they had before the flood occurred (I5, 2009). Moreover, the families had to wait until they had accumulated enough materials and financial resources before they could begin reconstruction. Informants 1 and 3 said that they do not have the financial capacity to save and reserve money nor materials to use in the event of a flood destroying their latrines (I1,I3, 2009). Therefore, these families are financially unable to establish recovery mechanisms that can help them quickly 'bounce back' to their normal level of sanitation in the aftermath of a flood.

Inhabitants ought to be improving their sanitation systems incrementally over time, and

integrating risk reduction into the design of their sanitary systems; instead most coping strategies are only executed once intense rain has begun or once the local municipality has warned of intense flooding in the city. This approach is parallel with the municipality, as disaster risk management strategies are not being implemented in a preventative capacity. These families are not 'scaling up' their strategies over time, and as a result, the impact on their sanitation is intense, increasing their chances of falling into the poverty trap which can reverse the development process.

All four informants recognised the impact that flooding has on their sanitation, and that the frequency of flooding had increased; however, there was a consensus that flooding was not a problem which they focus efforts on addressing (I5, 2009). For example, informant 4's attitude towards the prospect of flooding was of seeming acceptance stating "We deal with the floods when it happens and take each day as it comes; we have other things to worry about" *(*I4, 2009*)*. This is incredible given the impact which flooding has on their sanitation systems and their livelihoods in general. Informant 4 explained that although flooding occurs, her family will remain in the same location, not only for the benefits that the lake brings (I4, 2009).

The low-income community members consulted were only concerned with the removal of excrement rather than mitigating the impact of floods on their latrines. This is a common attitude among low-income households, and many householders regard latrines as an effective solution to their sanitary problems (Hector, 2009). Climate change is a concept that is not understood by low-income communities, but is isolated to mainly academics and institutions (Hector, 2009). There is obviously an information vacuum in which low-income communities are not able to access information concerning climate change; so there is little incentive for these families to adapt to climate change and ultimately reduce the impact of floods on their sanitary systems. This is a phenomenon identified in the literature review, and one that is severely hindering disaster risk reduction on the community level.

The low-income communities by the lake are lacking the institutional support they require to help them develop their coping strategies to a more effective level. Firstly, they are not able to access expert knowledge; which would help communities identify more effective risk reduction strategies. Creating synergy between experts of disaster risk management of sanitation, and the local knowledge of inhabitants would naturally generate more sustainable risk reduction strategies, as local realities would be taken into account. This relationship would raise the awareness amongst low-income communities to the effects of climate change, creating incentives for communities to 'scale up' and 'scale down' coping strategies as the intensity of flooding changes. This is not available through SINAPRED due to limited resources. However, local governments have contracted private experts and NGOs to do this in other urban settings, therefore this may be an option in Managua.

The local government and NGOs are failing to recognise the low-cost informal coping strategies that can be implemented on the household level, because there is no engagement with inhabitants of the informal settlements by the lake. If NGOs working in sanitation were aware of these strategies it is likely that they would mainstream these and others into their project design. The local government could also increase the effectiveness of informal coping strategies through financial support as well as providing the communities with low-cost materials that can be used for coping strategies. Because these strategies do not incur excessive costs it is a more feasible approach than expensive and technologically sophisticated strategies.

Both of these capacity building mechanisms would provide homeowners with the knowledge and financial capacity to scale up their coping strategies over time. The result would be coping strategies that are more effective at mitigating the impact of flooding as they are implemented in the pre-disaster phase. This would ultimately allow low-income homeowners to 'bounce back' more quickly, thus avoiding the poverty trap. Of course these strategies are dependent on there being increased pressure from above and below on the local government to pursue adaptation of sanitation to climate change.

Chapter 5 – Conclusions

Now that all the findings from this case study investigation have been gathered, and analysis made throughout, one can progress forward and make informed conclusions which can be used to answer the stated research aim: *To investigate how people living in low-income urban communities access sanitation, and whether there is a framework for pro-poor adaptation to climate change which ensures sanitary systems are able to reduce the impact of climate change's possible effects.*

The low-income families living in informal settlements by lake Managua are unable to access formally provided sanitation for a multiplicity of interrelated reasons, particularly because the local government is politically unwilling to provide here. As a result, people are adopting informal strategies (predominantly pit latrines), which do not guarantee the positive health of users. Furthermore, families are not mainstreaming sufficient risk reduction strategies into the design of these latrines in order to mitigate the impact of floods, which affect these communities. Families are only carrying out individualistic risk reduction strategies in the immediate period before a flood or during intense rain. In addition, they do not have recovery mechanisms in place which will aid them in the post-flood period to efficiently restore their sanitation to its normal working order. As a result, the impact on their sanitation is more severe, and they are less able to 'bounce back' after a flood, which increases their liability of falling into the 'poverty trap'.

Investigation has shown that the municipality of Managua does not have the capacity or incentives to invest in these areas. Reaching these areas through a unitary piping network requires high-cost urban engineering; however the socio-political forces in the city demand low prices, thus there are no fiscal resources available. Access to sanitation in Managua is clearly a socially stratified mechanism, which is used to exploit, marginalize, and generate social power. In relation to this ENACAL are pre-occupied with huge engineering structures; because of this focus on capital-intensive technology, ENACAL fails to recognise that there are low-cost alternative solutions available. Furthermore, the

urban plan of Managua does not envision the communities by the lake remaining, as there are plans to increase tourism by way of de-contaminating the lake and making it a prime tourist attraction.

The municipality therefore perceives these communities as a problem, and a barrier to the development of the city's urban plan; therefore, relocation to Tipitapa is the only solution that it is pursuing. This strategy is fundamentally flawed as it fails to recognise the local realities and social practices which are present within the lakeside communities. In consequence, families are returning to the lake as it can satiate their lifestyle requirements more so than the rural surroundings of Tipitapa. Unsustainable solutions are generated due to the centralised Planning Model, which characterises the Nicaraguan sanitation sector, and ultimately results in a lack of engagement with low-income communities on a grassroots level when formulating plans. Additionally, the municipality is brazenly attempting to exploit its political weight over low-income communities who lack legal land title in order to force its vision of the city into reality, regardless of the consequences this may have on the communities by the lake.

If one juxtaposes the necessary arrangements to achieve climate change adaptation identified in the literature review, against the current institutional framework and context of Managua, one can appreciate that there is a lack of actors, political will, and institutional capacity to establish this. Levels of awareness of climate change are low amongst pertinent actors which also hinders adaptation of sanitation to climate change.

On the community level low-income communities are not being provided with the capacity by the local government, or NGOs to reduce the vulnerability of their sanitary systems. It is critical to remember here that in this particular case, the municipality of Managua sees no incentives for reducing risk in the communities by the lake as they wish to remove these communities. However, the reasons for inadequate pro-poor adaptation of sanitation to climate change go far beyond the municipal level, and show that there is a systemic failure of climate change adaptation throughout the entire framework, including

at the international level.

Adaptation of sanitation to climate change within Nicaragua is hinged on SINAPRED, as the National institution, specialised in the prevention, mitigation, and attention of disasters. However, research has shown this institution to be ineffective as it lacks the political weight and capacity to ensure risk reduction is mainstreamed into sanitation projects on the local level. This inability is predominantly due to the funding mechanisms which support SINAPRED; all fiscal resources are received from international donors. International donors are failing to generate a sufficient amount of resources for SINAPRED to carry out needed work. Several conclusions can be made of this, which give explanation as to why adaptation of sanitation to climate change is failing to make the necessary impact in low-income communities by lake Managua.

Climate change is a relatively new sector of urban development, not only in Nicaragua, but also internationally, and this sector has not yet gathered the political momentum and legal anchorage needed to ensure international donors invest a sufficient amount. Sectors like water, housing, and health continue to attract large investments; it would appear that their needs to be a stronger level of advocacy for climate change if SINAPRED is to attract greater investments. This political and legal pressure will need to be exerted from binding international treaties, which hold National governments to account, and legally obligate them to pursue an agenda for adaptation to climate change. This is currently lacking, thus the National government of Nicaragua is not feeling the 'stick' which would necessitate it to try and attract greater investments for SINAPRED. Such international treaties would also help strengthen law 337, as the National government would be legally obligated from above to ensure municipalities pursue an agenda ensuring sanitation in areas vulnerable to the effects of climate change are adapted. In addition, one has shown that there are no mechanisms in place which allows low-income communities to hold local or National government accountable to their needs. Governmental levels are therefore not receiving pressure from below either.

Furthermore, we see that it is currently not sufficient for the National government of Nicaragua to rely on international donors alone to fund its National agenda for adaptation to climate change. There needs to be a diversification of funding streams; public resources may be one alternative. Contribution towards climate change adaptation does not need to be in monetary terms either; the local government of Managua may collaborate with communities on a local level and harness community members' willingness to contribute in labour.

This thesis has shown that a lack of awareness and a general disregard for climate change on all levels is also a problem which hampers adaptation of sanitation in low-income communities. There is an information vacuum, which results in low-income communities remaining ignorant to the benefits of good sanitation and the effects climate change can have on their sanitation in the future, as well as measures they can take to 'scale up' their coping strategies. Therefore low-income inhabitants have few incentives to take action on the community and household level to mitigate floods.

NGOs and the municipality are neither exposed to information pertaining to the effects which climate change will have locally in Managua, nor the strategies which can be taken to reduce the risk of sanitation in low-income communities. Data has shown that there is a lack of dialogue surrounding climate change on the policy agenda of urban development in Managua, and amongst NGOs. As a result, there is no mainstreaming of risk reduction into project designs, and no agenda to develop expertise on risk reduction. The limited resources of SINAPRED also means that municipalities and NGOs are not receiving the knowledge about risk reduction which they require if they are to have the ability to incorporate this into their sanitation projects and urban plan. This finding demonstrates how Nicaragua cannot depend solely on SINAPRED to supply the necessary capacity for NGOs and municipalities to implement climate change adapted sanitation projects. There must be a diversification of streams by which NGOs and municipalities receive expert knowledge.

The fostering of awareness, education, and capacity building strategies supporting the implementation of climate change strategies is not present in Nicaragua. There is a lack of platforms for sharing of experience and knowledge; therefore, climate change remains a sector of urban development which is given little thought during project design. Ensuring sanitation in low-income communities is adapted to climate change (flooding in this particular case) will require actors on all levels to be exposed to dialogue so that climate change is firmly established on the agenda.

On the local level, the municipality and ENACAL believe that improving sanitation for the communities by the lake would require expensive and technologically intensive efforts. This is because climate change perspectives are not fully integrated within the broader framework of sanitation and there is not a holistic approach which incorporates collaboration with community members and their local knowledge. Despite the Nicaraguan government decentralising power to local municipalities, the local government of Managua is lacking support regarding capacity building, specified tools, and technical expertise, so that they can develop adaptation actions and strategies for reducing the severity of flooding on sanitation. Therefore, even if increased funding and binding international treaties were established, much would still depend on the ability of local governments. There is a clear imbalance between demands at the municipal level and the existing administrative and financial capacities in the context of decentralisation.

Capacity building of municipalities would be a more realistic possibility if SINAPRED were better financed; however, the lack of capacity at the municipal level is not solely due to fiscal constraints, but also a product of the decision making structures in place. Interestingly, data has shown that SINAPRED has centralised decision-making power, so that National institutions take decisions over which municipalities will be targeted for projects. The result is that municipalities are not consulted and so the local government of Managua is not chosen as an area for 'action'. In consequence, the municipality of Managua is without the capacity (fiscal and knowledge based) to implement projects by the lake. This indicates that the National government does not aptly consider local governments as important partners in the articulation of National action plans. The

effects of climate change are mainly experienced at the local level as we have seen, with flooding affecting sanitary systems at the household level. Therefore, decisions over which areas will be targeted must involve actors who are located closer to the community level (communities, NGOs and municipalities), to guarantee that National plans are fully informed. However, the institutional design and structure within Nicaragua is diminishing the possibility that the low-income communities of the lake will be targeted as there are no mechanisms which establish communication between the National level, and the municipal and community level. Decisions of this sort must be decentralised to the municipal level if the most needy areas are to be targeted, and if adaptation of sanitation to flooding is to be achieved by the lake.

As aforementioned the effects of climate change, namely flooding are experienced at the local level, therefore localisation and a strong entry point to address climate change at this local level is necessary. A pre-requisite of this is stakeholder participation, which will generate solutions that are far more effective and sustainable. However, the incumbent arrangements do not allow engagement between the municipal level and the local level, which has created an inconsistency between local realities and the solutions formulated by the municipality, such as the relocation to Tipitapa. Innovative solutions to adapt sanitation to climate change are taking place at the household level; however, government authorities are not formally recognising these and supporting the development of such low-cost coping strategies. The local authority is hyper-focused on the displacement of these communities and planning them out of the city, and in doing so is working against the social and economic structures present at the lake. It would be more effective if the local government worked with these structures and provided the capacity and support for local action.

Fieldwork also demonstrated that NGOs are not placing great emphasis on integrating risk reduction into their projects to improve sanitation. Firstly, because of the difficulties they will face when seeking funds, but also because they too lack the expertise in the field of risk reduction strategies. International treaties are once again lacking as a political and legal mechanism which could be used to pressure donors to prioritise

projects which integrate risk reduction strategies. This would also need to be a reciprocal relationship, as NGOs will also need to begin amending their agendas in order to include risk reduction into their projects.

However, it is not mandatory that NGOs have the expert knowledge of adaptation to climate change. If decentralisation down to the local level and synthesis of expert and stakeholder knowledge is to be achieved it will require an actor which can create this mechanism for communication between these two levels. This is where NGOs can be useful, as NGOs have the capacity to work at the municipal level as well as the grassroots level, mobilising stakeholder support. Unfortunately, as we have seen, there is currently a shortage of NGOs working in the field of sanitation and climate change adaptation within Managua.

We therefore see that the current funding mechanisms and programme of decentralisation is not working and that amendments will be needed to ensure capacity building of local municipalities, as well as communities. This will achieve the necessary synergy between expert and local knowledge.

5.1 Main findings

There are several main findings from this investigation. Local municipalities do not formally acknowledge low-income communities as part of the urban make-up. This is no surprise as this is an urban phenomenon one can observe worldwide. The result is families adopting informal sanitation systems which are ineffective at mitigating the effects of floods. Furthermore, local governments are not taking any measures to help reduce the risk of sanitation within the communities by the lake; instead, the municipality is only carrying out post-disaster strategies in the form of temporary shelters and temporary relocation. In addition, the financial mechanisms for climate change adaptation are not generating sufficient funds to enable National institutions (SINAPRED) with the ability to provide local municipalities and NGOs with the capacity

to implement adaptation of sanitation projects by the lake. This is the factor which is crippling the ability of municipalities to take any action; without funds and expert knowledge the municipality is unable to do very little to reduce the vulnerability of sanitation in the lakeside communities.

Also, the current institutional arrangements prevent stakeholder engagement, which prevents sustainable solutions. Although SINAPRED's projects incorporate community participation once they are active, the decision making process when identifying appropriate locations for projects remains centralised in National institutions, which means areas which are in need of help to adapt sanitation to climate change are ignored. Local governments are also failing to recognise the low-cost alternative coping strategies which take place at the household level; this paper indicates that it would be better for local governments to acknowledge these strategies and work towards their development. In this manner, we see that strengthening, adapting, and protecting the capabilities and assets of households and communities are fundamental for the establishment of climate change adapted sanitation.

Next, one has shown that National and municipal policy agenda's give scarce regard to climate change. Donors, NGOs, and communities are also failing to acknowledge the need for climate change adapted sanitation; some actors choose to ignore climate change adaptation due to the consequences in monetary terms; however, low-income community members pay little attention to climate change adaptation as they are not educated in this matter.

In legal terms climate change has not been sufficiently anchored Nationally through law 337 due to the apparent political weakness of SINAPRED and the lack of support for climate change in general. International treaties are neither proving the pressure which is necessary for obligating National governments to provide municipalities with the capacity to implement projects to adapt sanitation. Low-income communities are also unable to exert collective political pressure on local governments. The result is that risk

reduction of sanitation is not mainstreamed into the urban plan of Managua, or the projects of public utilities such as ENACAL.

In conclusion we see through this investigation that there is a lack of broad synergies and coordination between international donors, National and local government, NGOs as well as community members themselves. Establishing a multilateral web of collaboration, which is legally anchored, would ensure climate change adaptation is established on the agenda for sanitation in low-income communities. Moreover decentralised programmes would guarantee sound policies, which benefit from expert and local knowledge. Currently these arrangements are not established, and the consequences are local governments that lack the capacity and political will to work towards adapting sanitation to climate change in low-income communities. Ensuring climate change adaptation of sanitation is firmly established on the National and local agendas will require advocacy on all levels, capacity building, and a sound legal framework to hold National and local governments to account. This will be a difficult and incremental process, but one that if established can ensure sustainable solutions for risk reduction of sanitation.

Limitations of Research

1. The period spent gathering data in Nicaragua was relatively short which means one was not able to gather all possible data.

2. One is not fluent in Spanish, thus interviews did not always allow further questions to be raised during questioning.

3. There was only one observer during in-situ visits to communities. Therefore, some data may have been missed.

4. Although one entered communities with employees of NGOs who are familiar with inhabitants, members of the community may not have felt completely comfortable discussing their sanitation habits with an 'outsider', and so may have held back information.

5. One was not able to observe any of the communities during a flood, which would have increased the validity of results, and informants were supplying data from memory which is less reliable.

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Appendices

Appendix 1 - List of Laws and Documents Concerning Sanitation and Disaster Risk Management on the National and Regional Scale.

Ley No. 276: Ley de Creacion de la Empresa Nicaraguense de Acueductos y Alcantarillados Sanitarios (ENACAL), (1998), Lotus, Available at - http://legislacion.asamblea.gob.ni/Normaweb.nsf/($All)/607E8EBD8459B8D2062570A1005777A7?OpenDocument (accessed 15 June, 2009).

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Appendix 2 - Municipal Plans of Managua

Defensa Civil, (2008), Ejercito de Nicaragua Direccion (EM), *Plan Contingente: Ante Intensas Lluvias (Invierno) municipio de Managua – 2008*.

ENACAL (2008), *Plan de Desarrollo de Sistemas de Agua Potable y Alcantarillado Sanitario de la Ciudad de Managua 2008-2015*, Direccion de Planificacion, Managua, 2008.

Gerencia PGDM: Alcaldia de Managua (2006), Plan General de Desarollo Municipal', Available at - http://www.managua.gob.ni/index.php?s=1075 (accessed 19 June, 2009).

Appendix 3 – Interviewees Canvassed[11]

Benita Ramirez:	Project Secretary for Sanitation of INAA
Dennis Quesada:	Head Engineer of INAA
Edward Centeno:	Executive President of INIFOM
Hector Delgado:	Project coordinator of Habitar
Hilda Delgado:	Technical supervisor of Prodel
Informant 1:	Inhabitant of Santa Clara Barrio
Informant 2:	Inhabitant of Santa Clara Barrio
Informant 3:	Inhabitant of San Sebastion Barrio
Informant 4:	Inhabitant of San Sebastion Barrio
Jane Olley:	Project supervisor of UN Habitat Managua
Omar Moncada:	Director of Municipal Decentralization of the Ministry of Property and Public Credit
Rito Siles:	President of the Public Services Department of the Municipality of Managua

[11] Some informants wished to remain anonymous and so their names have not been disclosed.

Appendix 4 - General Interview Schedule[12]

A4.1 Interviews with inhabitants of low-income communities were based on the following guidelines:

- in order to gain access to communities and speak to residents one established connections with NGO's working in communities by the lake through e mail communication. One was then able to enter communities with employees of these NGOs whom were familiar with the community, thus gaining the respondent's trust as residents were familiar with the employees of the NGOs;

- all interviews were conducted by the researcher;

- all interviews took place in the communities, either in their homes or in a public space in order to help informants to feel relaxed;

- the duration of interviews varied between 15 and 40 minutes according to the availability of the guarantor and the conditions under which interviews were carried out.

- all informants were full briefed about the study, and were told that they were able to refrain from answering any questions if they felt the need. They were also given the opportunity to remain anonymous.

A4.2 Interviews with other informants were based on the following guidelines:

- all interviews were carried out within the workplace or office of each informant in order to help them feel relaxed.

- all interviews were conducted by the researcher

[12] Due to the variety of informants, questions where changed for each interview in order to gain specialized knowledge; these questions are simply to give a general indication of the sort of questions posed.

- the duration of interviews varied between 15 and 40 minutes according to the availability of the guarantor and the conditions under which interviews were carried out.

- all informants were full briefed about the study and were told that they were able to refrain from answering any questions if they felt the need. They were also given the opportunity to remain anonymous.

Each interview consisted of between eight and thirteen questions. Due to the variety of interviewees, the list of questions was amended for each interview; however, the following list of questions can give an indication of the types of questions posed.

A4. 3 NGOs, Institutions and Governmental Actors:

1. What is the role of your 'institution?
2. What are your objectives and are you achieving as much as you would like? Why?
3. Why are people living in low-income communities by lake Managua?
4. What are you doing for sanitation in the low-income communities situated next to Lake Managua? And in what manner are you effective?
5. How do the communities by the lake access sanitation?
6. Are there mechanisms for this population to hold the government and ENACAL to account?
7. What are the causes which impede these communities from accessing the piped sewage network?
8. What do you understand as climate change?
9. Does your organisation recognise weather changes in Managua?
10. What is your organisation doing to adapt these communities to the possible effects of climate change?
11. What do you understand as decentralisation?

12. What role does decentralisation play in the access to sanitation and climate change adaptation for the communities by the lake?
13. What do you understand as citizen participation?
14. In what manner are the population by the lake involved in the process of sanitation provision and climate change adaptation?
15. What is necessary to improve sanitation in the communities by the lake, and to ensure climate change adaptation?

A4.4 Informants from low-income communities:

1. How long have you lived here?
2. Why do you live here?
3. Do you have land title? Are you able to apply for land title?
4. How do you get rid of your human waste i.e. excrement?
5. Have you received any help to improve your sanitation?
6. Would you pay for better sanitation?
7. Do you recognise weather changes?
8. What happens to your family when a flood occurs?
9. How does this (flooding) affect your sanitation?
10. What do you do once it floods in order to reduce the damage to your latrine?
11. Do you receive any help to improve your sanitation and reduce the impact floods have on your sanitation?
12. Have you taken any steps to try to reduce the damage to your latrines before it floods?
13. Are you able to, and have you contacted the municipality in order to demand better sanitation or help reducing the impact floods have on your sanitation?