

Building capacity to adapt to climate change through local actor support

A case study of an informal settlement in Rio de Janeiro, Brazil

Flavia Speiski dos Santos

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Abstract:

Climate change is expected to increase the frequency and intensity of the most severe weather-related hazards over the coming decades. The poor in developing countries are particularly susceptible to climate change, often living in informal or precarious settlements. In order to reduce the vulnerability in those areas and strengthen people's capacities to adapt to climate change, there is a need for knowledge about the factors that determine people's capacity to adapt to climate change. Particular attention should be paid to the extent to which support from local actors enable the environment for appropriate local adaptation. This study examines how the NGO *Urban Solutions* can better support adaptive capacity for the residents of Morro Vital Brazil, an informal settlement in Niterói, Rio de Janeiro, Brazil, where floods, heavy rains and landslides are frequent. The study thus explores how urban poor adapt to climate-related events at the household and community level, as well as how the adaptation measures can be influenced by the support of local actors that work with the community. The information for the study was gathered through observations and semi-structured interviews with residents from Morro Vital Brazil, informal conversations with staff members from the NGO *Urban Solutions* and a literature review. The results shows that access to resources, knowledge, information and assistance from local actors can play significant roles in determining adaptive capacity. In addition, it demonstrates how the support from a local NGO can provide knowledge and information to people about climate change and help to facilitate knowledge sharing and joint learning experiences. It also suggests that the presence of a NGO in the study area was found to be a contributing factor to people's adaptive capacity by increasing resilience at the household and community level. On this basis, it is concluded that assistance from a local actor may be linked to increase adaptive capacity and thus resilience.

Keywords: climate change, adaptive capacity, resilience, local actor support, slums, Rio de Janeiro

Word count: 13072

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Abbreviations

IBGE	Instituto Brasileiro de Geografia e Estatística
IPCC	Intergovernmental Panel on Climate Change
NGO	Non-government organization
UNISDR	United Nations International Strategy for Disaster Risk Reduction

1 Introduction

1.1 Problem framing

Climate change is expected to increase the frequency and intensity of the most severe weather-related hazards over the coming decades (UNISDR, 2012; UN Habitat, 2007). Some of these hazards will have impacts over the long term, like sea level rise and proliferation of infectious disease, while some have immediate impacts, like extreme weather events (Nicholls & Cazenave, 2010; Mirza, 2003). Extreme temperature, high levels of precipitation and associated flooding represent a bigger sustainability challenge to urbanized cities and their inhabitants (Dodman, & Satterthwaite, 2009; Middelbeek, Kolle, & Verrest, 2014; Hardoy & Pandiella, 2009).

Cities in developing countries are particularly susceptible to climate change, with rapid urbanization and urban population growth increasingly exposing inhabitants to hazards (IPCC 2007; Satterthwaite, 2009; Bicknell, Dodman, & Satterthwaite, 2009; Middelbeek, Kolle, & Verrest, 2014). In Latin America, the level of urbanization reaches above 80 percent (World Urbanization Prospects, 2014). In this region, hundreds of millions of people live in poorly built homes, where problems with overcrowding, inadequate provision of infrastructure, low access to political and social networks are common (Bosher, 2014; Bicknell, Dodman, & Satterthwaite, 2009; Tanner et al., 2009; Tacoli et al., 2015; Hardoy & Pandiella, 2009). As a consequence, the urban poor are particularly vulnerable to climate-related disasters (Wisner et al., 2004; IPCC 2007; UN Habitat, 2007).

Reducing the vulnerability to climate change faced by the urban poor requires actions such as improving urban infrastructure, creating more effective governance which support the poor structures of governance, and building individual and community capacity to address climate change-related challenges (Satterthwaite, 2009; Moser & Satterthwaite, 2008; Vogel et al., 2007).

Although studies have already been conducted on many aspects related to the impacts of climate change, there is a lack of knowledge regarding the adaptive capacities of citizens at the household and community level (Wamsler & Brink, 2014a; Adger et al., 2008; Tanner et al., 2009). It is often argued that urban poor communities tend to have limited capacities to adapt to climate change since they cannot afford adaptive measures and their ability to relocate to a less stressed environment is often limited by political constraints and resources (Moser & Satterthwaite, 2008; Feiden, 2011; McGranahan & Martinez, 2014). However, adaptation strategies in low-income areas do exist, although knowledge of the context and conditions in which they take place is scarce and still at a

preliminary level (Ensor et al., 2014; Romero-Lankao et al., 2014). Particular attention should thereby be paid to the extent to which support from local actors enable the environment for appropriate local adaptation (Ensor et al., 2014; Wamsler & Brink, 2014a; Romero-Lankao et al., 2014; Middelbeek et al., 2014; Wamsler, 2007; Gupta et al., 2010).

1.2 Aims and Research Questions

A growing body of research has highlighted the need to improve our understanding and action regarding local adaptive capacities, particularly in urban poor areas (Adger et al., 2003; Adger et al., 2008; Tanner et al., 2009). This need is based on an increasing consensus that local-level capacities are critical to successful adaptation to climate change (Wamsler & Brink, 2014a). In that context, the main purpose of this thesis is to provide more knowledge on the aspects that shape people's capacities to adapt to climate change. On this basis, my aim is to investigate how the urban poor adapt to climate-related events at household level and how the adaptation measures can be influenced by the support of local actors.

I attempt to fulfil this purpose by answering the following research questions:

RQ1: How are people in low-income urban areas adapting to climate-related hazards?

- rq1a: What are the major environmental problems that people are facing, which may be worsened by climate change?
- rq1b: What are people in low-income urban areas doing to reduce the risk of such problems or events?

RQ2: What are the circumstances that allow people to take adaptive action?

- rq2a: Are their attitudes related to their understanding of climate change and their perception of changes in the climate?
- rq2b: How has local support influenced their adaptive capacity, particularly with respect to knowledge and information?

1.3 Contributions to Sustainability Science

This thesis contributes to the understanding of one of the core questions for sustainability science research: "What determines the adaptability, vulnerability and resilience of human-environment systems?" (Kates, 2011). Within this context, this thesis addresses the social, economic and political

factors that make urban poor people more vulnerable to climate change. In addition, it investigates how households and the community as a whole can be better supported to make adaptive changes to their lives and livelihoods and then increasing resilience in different levels (Ensor, et al., 2014). According to Kates et al (2001) it is particular necessary to pay attention in developing countries, since they are most vulnerable to the several stresses that arise from changes in social and environmental systems (p. 642).

1.4 Thesis Outline

The thesis is divided into seven sections. In the next section I will present the theoretical framework on which the study is based, defining the terms central to the study and reviewing important literature on the subject. The definition and interrelations between concepts such as resilience, vulnerability, adaptation and adaptive capacity are identified based on the literature review. The theoretical framework also presents the finding of recent research on the extent to which support from local actors enable the environment for appropriate local adaption and thus enhance resilience. In addition, it shows how knowledge, information and learning can contribute to foster local adaptive capacity. In the following section I will describe my methodological approach by describing the study area, data collection and data analysis. Thereafter, I will describe how urbanization in slums took place in Rio de Janeiro with a historical background and main structural problems in the slums. The result section is next, outlining the major environmental problems that exist in the studied community and what measures slum dwellers are taking in order to adapt to climate-related hazards. In addition, it analysis the role of people's knowledge and perception of climate change, as well as the role of local actors' support in poor communities. An interpretation of the results is found in the discussion section, with a special attention to the importance of non-governmental support to increase and stimulate adaptive capacity. Finally, the conclusions and the study's main contribution to current knowledge are summarized in the last section.

2 Theoretical Framework

The concepts of resilience, vulnerability and adaptive capacity are rooted in several decades of multidisciplinary research under a range of paradigms and theories (Vogel et al., 2007). They are used with different emphases and meanings and have a wide application to the global sustainability science (Wamsler & Lawson, 2012; Smit & Wandel, 2006; Adger et al., 2003). Authors across different disciplines analyze the diversity of interpretations and reformulations of these concepts and

frequently, they are used with mutual relations or as polar opposites (Klein et al., 2003; Gallopín, 2006; Folke, 2006; McEvoy, Fünfgeld, & Bosomworth, 2013; Adger, 2006).

Since these concepts have become central to the debate on climate change, in this section I will examine the different concepts that build the basis of this thesis and develop accordingly the analytic framing for investigating my research questions. In addition, I will review research on how local actors can play a key role in enhancing adaptive capacity and resilience and also how the support for adaptive capacity at the household and community level needs to focus on interconnected areas (e.g. knowledge and social networks).

2.1 Resilience: the evolution of the concept

Resilience is derived from the Latin word *resilio*, which means “to jump back” (Klein et al., 2003). In the sphere of ecology, the term was first used in relation to the ecological stability theory, being introduced at the beginning of the 1970s by Holling (1973). According to Holling’s definition:

“Resilience determines the persistence of relationship within a system and is a measure of the ability of these systems to absorb changes and of state variables, driving variables, and parameters, and still persist” (Holling, 1973: 17).

According to Folke (2006: 256), “the single equilibrium view that dominated the mainstream ecology led to the interpretation of resilience as return time after disturbance, referred to as engineering resilience”. After Holling’s publication, the resilience perspective began to influence fields outside the ecology, like anthropology and human geography (Folke, 2006; McEvoy, Fünfgeld, & Bosomworth, 2013).

Many academic works on resilience have focused on that perspective; however there is also another aspect of resilience that concerns the capacity for re-organization and development which is crucial for the sustainability discourse (Folke, 2006; Gunderson & Holling, 2002). The emergence of the resilience concept within the field of social-ecological resilience (SER) reflects how our understanding of resilience in natural systems is applied to the interaction between social and ecological systems (Walker et al., 2004; Klein et al., 2003). In that area, resilience is “the capacity of a system to absorb disturbance and reorganize while undergoing change so as to still retain essentially the same function, structure, identity and feedbacks” (Walker et al., 2004: 2).

Within this context, resilience is also about the opportunities that a disturbance opens up in terms of recombination of developed structures and processes, regeneration of the system and emergence of

new trajectories (Folke, 2006: 259). It views learning and adaptation as essential processes that improve system resilience to a variety of shocks (Folke, 2006; Adger et al., 2008). In that sense, the concept of resilience in relation to social–ecological systems includes the idea of adaptation, learning and self-organization in addition to the overall ability to persist disturbance (Folke, 2006: 259).

2.2 Vulnerability

According to Wisner et al (2004: 11), vulnerability is defined as “the characteristics of a person or group and their situation that influence their capacity to anticipate, cope with, resist and recover from the impact of a natural hazard”. This may be shaped by the social, environmental, political and economic features of individual systems (McEvoy, Fünfgeld, & Bosomworth, 2013; Twigg, 2014). It is important to recognize that vulnerability is greatly contextual and should always be linked to particular threats and the exposure to the impacts of these hazards (Kelly & Adger, 2000; Brooks, Adger, & Kelly, 2005).

Although several attempts have been made to better articulate the resilience and vulnerability concept in the context of climate change (McEvoy, Fünfgeld & Bosomworht, 2013), the relationship between both terms is not clear. Some authors argue that resilience is considered to be an important response to reduce the vulnerability of communities to the impact of climate change, and thus is often seen as the opposite of vulnerability (Adger et al., 2005; Folke et al., 2002).

Nevertheless, Chelleri et al (2015) argued that this correlation of “the more resilient the less vulnerable” could be considered as a simplification of the meaning of the concept, hiding the complex relationship between them (p.181). The vulnerability of poor urban citizens to climate change need also to be seen as a failure of urban management to provide infrastructure and services, in which institutions have been unwilling or unable to meet their obligations. This is vital in boosting the resilience of cities to climate change (Dodman & Satterthwaite, 2008; Pelling & Navarrete, 2011). Furthermore, the notion of resilience can hide the social vulnerability as caused by social, economic and political conditions (Cannon & Müller-Mahn, 2010). Thus, it puts the responsibility on individuals and communities to be adaptive and be self-organizing (cf. Adger et al., 2008; Smit & Wandel, 2006).

2.3 Adaptation and adaptive capacity

There are a number of categorizations and meanings for the concepts of adaptation and adaptive capacity (Pelling, 2011; Smit & Wandel, 2006). Some authors have argued that there is lack of knowledge on the relation between them (Acosta et al., 2013). In this thesis, the term adaptation will

be used in the climate change context, referring to the UNISDR (2009: 4) definition: “as the adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploit beneficial opportunities”. The purpose of adaptation is frequently understood as a way to reduce vulnerability or to increase resilience to climate change (Adger et al., 2008). In that sense, differences in how individuals understand or perceive climate change, and the hazards in which it can materialize, can thus lead to different types of adaptation or can determine whether or not adaptation occurs. This is related both to the understanding of the concept of climate change and the understanding of the actual hazards that exist on the ground. Within this context, the implementation of adaptation options depends on the capacity of institutions, organizations and actors (Adger et al., 2008; Folke, 2006).

Adaptive capacity is defined as “the ability of a system to adjust to climate change, to moderate potential damages, to take advantage of opportunities, or to cope with the consequences” (IPCC, 2001: 365). Adaptive capacity greatly influences the vulnerability of communities to climate change hazards (IPCC, 2001; Kelly & Adger, 2000). In addition, it relates to whether people have the right tools and the enabling environment to allow them to adapt successfully over the long term (Levine et al., 2011: 4). At the local level, the ability to undertake adaptations can be influenced by factors such as access to financial, information, resources, infrastructure, etc. (Smit & Wandel, 2006). For residents of low-income urban areas in the Global South, the adaptive capacity of individuals and communities is shaped by means of individual and household asset portfolios, consisting of physical, financial, social and human as well as community assets (Middelbeek, Kolve & Verrest, 2014; Smit & Wandel, 2006).

2.4 Local actors’ support: key determinant for local adaptive capacity

Adaptive capacity is informed by the social and political context, in which organizations that intersect with local communities play a key role in shaping the opportunities and constraints for local level changes (Ensor et al., 2014; Gupta et al., 2010). In that sense, support from local actors can better stimulate the adaptive capacity of communities to deal with the impacts of climate change (Gupta et al., 2010). Since in many informal low-income areas public agencies are less present and do not provide adequate infrastructure and resources to the population, support from non-governmental actors can strengthen adaptive capacities at the household and community level by promoting initiatives that reduce exposure to shocks and stress (Bené et al., 2012, Frankenberger et al., 2014). In addition, efforts to strengthen adaptive capacity generally include improved access to information,

education and skills training to enable a better understanding of the climate change impacts (Bené et al., 2012, Frankenberger et al., 2014).

2.4.1 Knowledge, information and learning

Resilience is a process rather than a static state (Frankenberger et al., 2014; Béné et al., 2012). In that sense, its determinants are continually changing as the social, politics, economic and environmental scenarios within which individuals and societies function also change (Frankenberger et al., 2014: 3). In this context, the main challenge is to build knowledge and learning capabilities that will allow adaptive capacity of local communities (Frankenberger et al., 2014; Walker et al., 2004).

In order to know what to adapt to and to be able to make informed choices, individuals need knowledge, information and the right tools, such as infrastructure and resources (Levine, Ludi & Jones, 2011). In this way, organizational actors (such as NGOs) available to communities can play important roles in facilitating adaptive capacity. In addition, it can help to build a more complete understanding of the problem being faced (Levine, Ludi & Jones, 2011; Frankenberger et al., 2014; Ensor et al., 2014).

2.4.2 Social capital and kinship networks

Recently, an emerging research agenda has focused on identifying the generic determinants of adaptive capacity which are not independent of each other (Wolf et al., 2010; Adger, 2003; Smit & Wandel, 2006). These determinants include the social capital and kinship networks of societies. There is a broad consensus that social vulnerability to hazards is in part determined by the social capital of the inhabitants of a certain place, such as participation in networks and family support (Wolf et al., 2010; Romero-Lankao et al., 2014).

Along the same lines, the presence of a strong kinship network may increase adaptive capacity by allowing better access to economic resources and increasing decision-making ability (Smit & Wandel, 2006: 288). In the case of low-income communities, the lack of human and financial resources can inhibit and prevent adaptive capacity measures, since it might be too costly to make house improvements and buy materials, for example. In that sense, local actors can provide proper resources and enhance the adaptive capacity at household and community level (Gupta et al., 2010).

2.4.3 Participation

In poor communities, the capacity of residents to influence capacity-building can be critical. Creating the conditions for effective participation through which local understandings and needs are understood is a key challenge for promoting local adaptive capacity (Ensor et al., 2014; Patt & Schröter, 2008). Climate-related hazards and adaptation measures need to be made significant in the local context. In that sense, the diffusion of both scientific and local knowledge through multi-scalar organizations is an important process in building adaptive capacity for climate change (Ensor et al., 2014: 3; Patt & Schröter, 2008).

Recently, community-based adaption is presenting an opportunity for local level participation in framing adaption planning and activities. This approach highlights the importance of a participatory identification and implementation of activities that strengthen the capacity of local people to adapt to climate change (Archer et al., 2014: 346). In that sense it “builds on existing cultural norms and addresses local development concerns that make people vulnerable to the impacts of climate change in the first place” (Ayers & Forsyth, 2009: 23).

3. Methodology

In this study, twenty-four residents from Morro Vital Brazil were interviewed. In addition, I had informal conversations with some staff members from the NGO *Urban Solutions* and from the Institute Vital Brazil, which will be discussed further in this section.

3.1 Methodological perspectives

For the ontological guidance I used the constructivism approach. According to this perspective, truth and meaning are created by the subject’s interactions with the world (Gray, 2014). In that sense, the social phenomenon analyzed is produced through social interaction, which is under perpetual state of change and revision. Moreover, it is presented by the researcher through a specific version of reality.

In addition, I adopted the interpretivism as my epistemological perspective in the research. Interpretivism see the research and what is being researched as inseparable, since what we observe is bound up with our life experience. For interpretivists, knowledge of the world is the result on an intentional process on the part of the researcher (Lor, 2011). According to Pickard (2013), in the interpretivist epistemological perspective the results of the investigation are produced by the

interaction between the subject and the investigator. Both are simultaneously changed by this interaction, so that the knowledge that results from the process is not universally valid but contextual and restricted to the particular time of the interaction.

3.2 Case study design

A qualitative research design, using a single case study in a low-income area of Niterói, Rio de Janeiro, Brazil, was employed for this research. I focused on a relatively small sample and valued words over numbers (Silverman, 2011). In addition, inductive aspects are to be found in this research, since the findings from the interviews focus on the participant's perspectives and views of their context.

According to Yin (2009), case studies are appropriate for research that aims to provide deep understanding of complex social phenomena within their real-life context. Punch (2005) explains a case study arguing that “while there may be a variety of specific purposes and research questions, the general objective is to develop as full an understanding of that case as possible” (p. 144). In addition, interview data are seen as particularly useful for the purpose of a case study and qualitative interviews aim to understand the interviewees' view of the world (Bryman, 2012; Kvale & Brinkmann, 2009).

3.3 Description of the study site

I paid particular attention to the following characteristics of the community during my visit: assistance from the NGO *Urban Solutions* to tackle some infrastructure problems in the household and community level, as well as the construction of houses with a better infrastructure in order to minimize the effects of climate change, such as heat waves, heavy rains and floods; and many households constructed in risk areas. This will be further explained in the results section (section 5).

Morro Vital Brazil is located in the neighborhood of Vital Brazil, city of Niterói and state of Rio de Janeiro. The Region of Icaraí, where Morro Vital Brazil is located, is considered to be a rich area of the city with luxury condominiums just a few meters away from the slum. According to the last census carried out in 2010, there are 460 housing units in total in Morro Vital Brazil (IBGE, 2010). The community has its origins in the 1920s and 1930s, in the surrounding area of the pharmaceutical

factory Institute Vital Brazil¹. Its production required an increased labor force, and consequently most of the workers started to live on the hill behind the Institute, but also in its territory (Gôuvea, 2009). After the 1960s, the community started to receive inhabitants that were not necessarily working in the Institute. It is in this period that a growing and unplanned urbanization began. Many houses were constructed on unstable, rocky ground, creating a risk area (Gôuvea, 2009).

Since 2008 the NGO *Urban Solutions* have been implementing measures and actions in Morro Vital Brazil in order to improve housing conditions and create a better living environment in the community. According to the NGO, “unplanned construction of houses in Morro Vital Brazil represents a risk to the quality of the environment for the occupants, as well to other residents within the immediate neighborhood, since it also harms the environmental quality of other houses” (Soluções Urbanas, 2015).



Figure 1: (A) Location of the state of Rio de Janeiro; (B) location of the municipality of Niterói. Source: Google Maps.

¹ The Institute Vital Brazil is one of the official public laboratories in Brazil. It produces serum and human medicines. In addition, it undertakes studies in the pharmaceutical, biological, economic and social field. The Institute was established in 1919 by the doctor Vital Brazil (Instituto Vital Brazil, 2015).



Figure 2: Morro Vital Brazil (Google earth satellite photo from 2009).

3.4 Creating data

For my research, I collected primary qualitative data through semi-structured interviews, informal conversation and personal observations with community members. By spending a considerable time in the field, I got an insight of everyday life in the community which increased my understanding of the complexity of the issues. I believe that is necessary to have a method that is sensitive to the fact that actions have a meaning for the social actor and therefore need to be understood from his or her perspective. Moreover, a large amount of literature was reviewed for the theoretical framework. Academic articles and international reports were studied to gain greater knowledge in the areas of climate change adaption, adaptive capacity, resilience and vulnerability. Also, I had several informal conversations with staff members from the NGO *Urban Solutions*.

3.4.1 Semi structured interviews

According to Whitehead (2005), semi-structured interviews follow the open-ended approach that is characteristic of qualitative research. The interviews were conducted in Portuguese with 24 households² from Morro Vital Brazil during the month of March 2015. I choose random people and dwellers that were provided assistance by the NGO. Interviewees were of both genders and between

² Each one of these interviews lasted ca 10-40 minutes.

20 and 70 years old. All interviews were recorded and transcribed. The participants were approached at the Institute Vital Brazil, in the street, their houses, daycare, medical center and the community center. The interviews took place during weekdays and weekends, at different hours of the day. All interviewees agreed to have their names revealed in this thesis.

3.4.2 Investigative walks, field observations and informal conversations

First, I went on investigative walks and I took pictures of the area in order to be more familiarized and search for possible technical adaptations in the houses. Afterwards, I visited active institutions in the community, such as the Institute Vital Brazil, NGO *Urban Solutions*, daycare and the social center of the community. Once I was familiarized with the area, I started to make the interviews.

Being an observer was an important issue to my study. According to Silverman (2011), to suppose that the researcher's presence will not exert an influence on the data is unrealistic. The observations were used to increase validity and confirm the statements of the interviewees. Some photos of these observations can be found in the results section (section 5).

Furthermore, I had informal conversations with the NGO *Urban Solutions* and workers from the Institute Vital Brazil. Those conversations were very important to analyze the participation and influence of other stakeholders on the actions taken by the community members to overcome the effects of climate change.

3.4.3 Data Analysis

I analyzed my findings paying special attention to how adaptive capacities can be better supported by actions that emerge from external actor's assistance that can enhance resilience at the household and community level. In the realms of resilience theory and the concepts of adaptation, adaptive capacity and vulnerability, I further looked for the underlying relation between the lack of government infrastructure and services in the community and the presence of the NGO *Urban Solutions* as a strong support. Therefore, I focused on the answers given from the slum dwellers of Morro Vital Brazil, in which adaptive capacity strategies to climate change were undertaken, especially those that have received some type of assistance from the NGO. By triangulating the results from the questionnaire with information provided by the NGO, I was able to get a more holistic picture of the current situation and the role of the NGO in the community. In addition, I identified the importance of knowledge, information and learning to increase adaptive capacity and resilience in the community.

3.4.4 Limitations and challenges

As a native Portuguese speaker, I had easy access to a variety of data regarding the urbanization in Rio de Janeiro and the specific case of Morro Vital Brazil. This also includes conversations and interviews with community members and other actors. However, since the community is controlled by organized drug gangs, I could not walk around in Morro Vital Brazil on my own for safety reasons. During my walks and interviews inside the community, I had to be assisted by the NGO staff since they have developed a relationship with dealers and are authorized by them to be inside the community. The presence of the gangs limited the number of interviews because of the regular exchanges of gunfire with the police, which prevented me from visiting the community as many times as I would like. Also, I could not visit houses localized high up on the hill because the drug trade is more dominant in those areas.

4 Urbanization in Rio de Janeiro

4.1. The context of favelas

The *favelas*³ in Brazil are a national reality, although the terminology may vary from region to region. Rio de Janeiro is the Brazilian city with the largest population living in *favelas*, accommodating around 22% of the population of the metropolitan region (IBGE, 2010). In the present thesis, *favelas* will be defined as “heavily populated urban areas characterized by substandard housing” (UN Habitat, 2003: 8-9).

In the case of the *favelas* in Rio de Janeiro, from the late 19th century until the middle 20th century, they were seen as precarious and dirty areas where only poor people live, a justification that made the slums easily subject to eradication. However, later on, many *favelas* were urbanized with basic infrastructure and public services (Magalhães & Di Villarosa, 2012; Carvalho, 2013). Nowadays, there are about 1070 favelas in the metropolitan area of Rio de Janeiro, which includes Niterói (IBGE, 2010; O Globo, 2011).

Although they are often located in inappropriate regions for housing and have precarious infrastructure, not all *favelas* of Rio de Janeiro can be considered as informal settlements. As I will further explain in this section, since the 1980s the government started to transform and implement

³ *Favela* is the Portuguese word for “slum” or informal settlement.

urbanization measures into some slums in order to create formal neighborhoods and integrate the favelas into the city (Delecave & Leitão, 2011; Carvalho, 2013).

4.2 Historical background

The development of the city of Rio de Janeiro, as well as its industrial expansion, occurred in the late 19th century and it attracted a large number of poor migrants, especially from the northeast of Brazil. As a consequence, there was an uncontrolled increase of population and disordered urbanization, which culminated in the emergence of the *favelas* (Carvalho, 2013; Cavalcanti, 2013). The lack of housing and transportation to attend to this accelerated growth caused the spread of this type of settlement, where the only alternative left to the poor population was to live far away in the suburbs or in risky areas, such as hillsides, mangroves and wetland areas (Delecave & Leitão, 2011; Carvalho, 2013). However, at that time the *favelas* were identified by the Government as a social problem.

In this sense, it represented a space marked by undesirable aesthetic standards, an opposition of a civilized urban identity and the concepts of modernity and beauty that should guide the policies of urbanization at that time (Mello & Cunha, 2011: 374). In addition, the *favelas* were characterized by the notion of lack or absence: a place without water, light, sewage, garbage collection and other fundamental infrastructures (Mello & Cunha, 2011: 375; Delecave & Leitão, 2011).

In the first half of the 20th century, the *favelas* were seen as a transitional phenomenon, whose eradication would be a natural process of the development of the city. Later on, in the 1960s and 1970s, the favelas have come to be understood as irregular settlements and its eradication was actively promoted by the state through so-called “removal policies” (transferring population to settlements in suburban areas) (Mello & Cunha, 2011; Delecave & Leitão, 2011). However, these policies proved unsuccessful since the government did not provide basic needs in the new places and did not have enough resources to continue the removal programs (Delecave & Leitão, 2011).

The process of political opening⁴ in the end of the 1970s, in conjunction with social and economic failures of the removal policies provoked a new change in the urban policy. Despite the expulsions, the slums continued to shelter a large part of the population of the city, becoming more than ever a structural reality of the urban fabric (Mello & Cunha, 2011; Carvalho, 2013).

⁴ The military dictatorship in Brazil was a regime established in 1964 and lasted until 1985. The transition to democracy was completed only in 1988 with the enactment of the new Brazilian Constitution (Souza, 2009).

In the beginning of the 1980s, an important politician called *Brizola* developed projects aimed at the implementation of infrastructure into the *favelas*, such as water supply, sanitation and garbage collection. The most important program implemented during his management was called “every family has a piece of land”, which aimed at the regularization of housing in the slums (Carvalho, 2013; Mello & Cunha, 2011). The program represented the first social project that recognized the slums as part of the city. In that sense, this period represented the implementation of policies of recognition of slums and illegal settlements as a solution for the housing problems of the lower classes (Carvalho, 2013; Delecave & Leitão, 2011).

The 1990s and the early 2000s are marked by the maintenance of the policy of the previous governments to provide infrastructure in the areas of the *favelas*, in addition to maintaining the legality of the property. In this context the program *Favela-Bairro*⁵ began in 1995 and is a program that promotes urbanization of the slums and with high public and international investment of the Inter-American Development Bank (Cavallieri, 2003; Carvalho, 2013). This program regarded the *favelas* as the “non-city” and as something that needed to be integrated into the territory of the city. It tried to bring to these places everything that already existed in the city, such as sidewalks, wide streets, sanitation, daycare and health centers, as well as the regularization of properties and relocation of homes in risk areas (Mello & Cunha, 2011; Delecave Leitão, 2011).

4.3 Structural problems in the favelas

Generally, low-income human settlements are associated with a high number of substandard housing constructions, frequently built with non-permanent materials unsuitable for habitation given local conditions of climate and location. In addition, houses may be built on hazardous sites or land unsuitable for settlement (UN-Habitat, 2003: 14). This is also true for the *favelas*, which are often located on hillsides, areas subject to landslides or river banks.

In addition, lack of access to sanitation services, absence of waste collection systems, lack of electricity supply and rainwater drainage is very common in informal settlements (UN-Habitat, 2003; Wamsler, 2007;). As a consequence, unhealthy living is the reality of most of slum dwellers, living with open drains and uncontrolled dumping. The *favelas* in Rio de Janeiro largely have precarious networks of urban infrastructure for accessibility, sewage and drainage; as well as lack of public services such as education, health and leisure, besides irregular land tenure (Carvalho, 2013; Leitão & Delecave, 2011).

⁵ *Bairro* means neighborhood in English.

Morro Vital Brazil is no exception to such structural problems: most of the houses were constructed close to ravines which exposes them to high humidity. In addition, the foundations of the houses were constructed in a poor and unplanned way, causing many houses to show cracks and deformation. Uncontrolled dumping of waste and lack of water are often issues that the community faces.

5 Results

In this section, I will analyze how people in Morro Vital Brazil are adapting to climate-related hazards. First, I will identify the major environmental problems that have been occurring in the community in recent years. I will then describe what the dwellers are doing in order to reduce the risk of such events and adapt to climate change. Subsequently, I will investigate if their attitudes are related to their knowledge and perception of climate. Finally, I will analyze how the NGO *Urban Solutions* influence their adaptive capacity by providing better knowledge and information.

5.1. Environmental problems in Morro Vital Brazil

‘Environmental problems’ was the term I used during my interviews since the *favelas* are faced with a range of “everyday threats” and climate impacts that are product of a variety of developmental and environmental stress mechanisms (Romero-Lankao et al., 2014). In this sense, I avoided words such as ‘disaster’ or ‘risk’ in order to make it clear to the respondents that small-scale hazards were also considered important for the study of the thesis.

Floods

In Morro Vital Brazil, the occurrence of floods was the environmental problem most cited by dwellers. Many respondents indicated that deforestation in the community is a recurrent problem. As the population builds new houses and does construction work, especially on the top of the hill, vast areas are deforested. In that context, the water needs to find a new path to flow downwards which often ends up escalating the problem with run-off water.

Respondents reported that over the past years, heavy rains and floods are becoming increasingly frequent, especially during summer. This could be potentially associated with increasing land use change (deforestation) and changed weather patterns due to climate change. Almost all households have experienced floods in their immediate living environment, perceiving flooding as a direct household and life threat. Also, many respondents reported feeling fear during a heavy rain:

“Every time there is heavy rain I pray to god, because we never know if the walls will fall down and we don’t know the amount of water that will go down” (Cristina, community member).

Landslides

Landslides were also a recurring problem that has occurred in last years. Recently, increased heavy rainfall has been causing landslides and infrastructural damage throughout the community. Most of the interviewees believe landslides occur because of garbage accumulation on the hillsides and construction of houses in high-risk areas.

“During heavy rains, sometimes landslides occur, especially in the top of the hill. In the 2010 floods the landslides destroyed many things of the community, such as garbage buckets and water tanks (Joelcia, community member).

Water shortage

In recent months, the water shortage has been a serious problem within the community. It is related to the water crisis that Brazil has faced since 2014, where the level of the dams supplying water in Rio de Janeiro has been falling dramatically. Rapid urbanization, lack of planning, periods with less rainfall and overload of supply and collection systems are the main causes for this problem in Brazil. As a consequence, slum dwellers are the ones who suffer most, since they do not pay for the water supply and therefore are the first to have the supply cut in times of crisis.

“Here we always had water in abundance (...) however since November 2014, the water supply is irregular. I spent Christmas, New Year and Carnival without water” (Danielle, community member).

Humidity

The issue of humidity was reported by all community residents. Few windows in houses combined with the density of the urban fabric make the indoor environment characterized by lack of solar access, daylight and ventilation. In addition, the vast majorities of houses is built along the slope and are constructed together, which further contributes to the problem. As a consequence, many dwellers related respiratory diseases, especially among children, possibly due to mold in walls and furniture.

“I am very concerned about the humidity in my home. There is a small child in my home and this situation is even more worrying” (Andrezza, community member).

Heat stress

Increased heat, with higher temperatures and prolonged periods of heat waves, is also an issue that occurs in the community although only a few residents perceived increased heat as an environmental problem. According to the NGO *Urban Solutions*, the vast majority of the houses were built without necessary infrastructure, such as poor ventilation, masonry and low roofs. The roof of houses is made with little inclination, which further increases heat in the area. The house infrastructure conditions, exposure to solar radiation and insufficient ventilation rates resulted in air temperatures higher than the outside temperature due to lack of proper infrastructure.

“Lately, it is hotter in the community. I believe this is happening due to deforestation that takes place to build more houses. Every summer gets hotter (Danila, community member).

Energy outage

Energy outage is not a frequent problem in the community, occurring only in heavy rain periods. Just as with water, energy use occurs illegally since slum dwellers do not pay the government. *Gato de energia* (“electricity cat”) is the name given to illegal electrical connection designed to steal electricity. This is a very common practice in slums of Brazil.

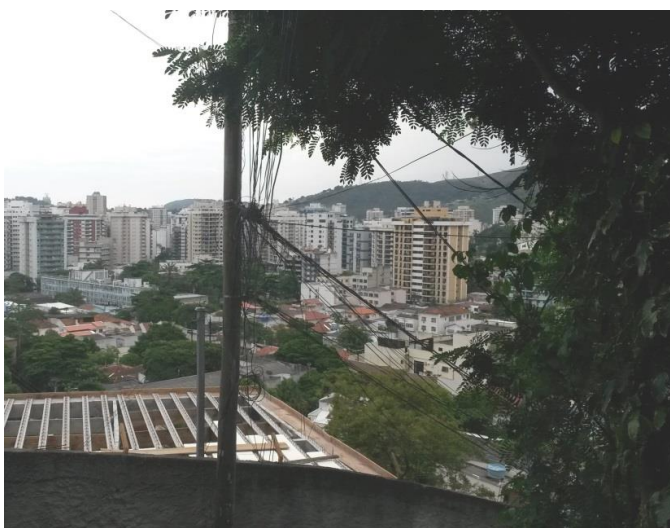


Figure 3: Picture taken during field work (March/2015)

Garbage

The issue of garbage is also a constant problem in Morro Vital Brazil and interacts with and contributes to the negative effects of climate-related issues. Only residents who live in the lower part of the hill have garbage collection, though it is quite irregular. Some residents mentioned that there is only one street cleaner for the whole community. The vast majority of the community does not have access to garbage collection and therefore they have to go down a street in order to deposit the garbage at the community garbage dump. During my visit in Morro Vital Brazil, I could see a lot of garbage in the streets and ditches, even sofas and furniture are thrown on the street.



Figure 4: Picture taken during field work (March/2015)

The garbage accumulation has caused sanitary problems and rats, pigs and mosquitos have become increasingly common in the community in recent years. The problems of pigs caused considerable damage in the community, since they destroyed water and sewage pipes, dirt roads and the foundations of some houses. According to dwellers:

“The pigs were destroying the foundations of my house, water and sewage pipe. Some houses have been toppled due to the pigs” (Ana Claudia, community member).

“In March 2015 we had a heavy rain in the city and due to the lack of awareness of residents from Morro Vital Brazil, my backyard is full of garbage. Many people throw their garbage in inappropriate places, so the water goes and carries everything” (Danila, community member).

Increase of diseases

The transmission of many diseases, such as dengue fever, leptospirosis and respiratory diseases is exacerbated by environmental problems. Lack of waste management, crowded houses, humidity, accumulation of garbage, lack of lighting and ventilation bring as a consequence the spread of infectious and respiratory diseases. In Morro Vital Brazil, all respondents reported that in their family or within the community they knew someone who was infected by dengue fever. The number of dengue cases has increased dramatically in recent years due to strong heat, especially during summer. Only the interviewees that work in the community medical center, called *Médicos de Família*⁶, reported cases of leptospirosis, but it is not a common disease in the community. Some respondents also related respiratory diseases, especially those residing in houses that have a lot of humidity and mold.

“Insects and rodents invade our homes. I live across the garbage heap, so the smell is horrible. They bring a lot of diseases to my house and neighbors” (Andrezza, community member).

5.2 Measures for adaptation and risk reduction

In a total of 24 interviewees, 17 are making small improvements in their house and 7 are not doing improvements to adapt to climate change. In view of the environmental problems reported above, here I will analyze their attitudes towards those problems. Most actions occurred at the household level, not at the community level.

Adapting to floods

Households from Morro Vital Brazil experience various adverse impacts of flooding. Since there is no basic infrastructure provided by the government in Morro Vital Brazil – that is; paved streets and the construction of water channels to facilitate the water flow – the water comes down at high speed, damaging the interior and exterior of the house.

⁶ The Programme *Médico de Família* (family doctor, in English) has the proposal to change the Brazilian healthcare model by prioritizing a greater integration with the poor community. It is implemented in areas considered of social risk by the government, such as the *favelas*. The main objectives of *Médico de Família* are to provide a comprehensive health care system with emphasis on prevention, and the promotion of community activities (Médico de Família, 2015).

In response to these impacts, interviewees implement a range of actions before, during and after flooding. Frequently mentioned actions were cleaning drains during and after the flood; construction work to improve the house before the flood and cleaning up the backyard after the flood.

“In March 2015 we had a heavy rain (...) and in order to prevent flooding and the water entrance in my house, my family and I had to go outside to clean the ditches (...) I am very sick now due to that event” (Danila, community member).

“During heavy rains, I used to get very concerned with the safety of my child and my house (...) so I started to buy materials and planning what I could do to improve my house (...) I took off all the mud behind my house, I changed the entrance of my gate (placing a higher wall) and I decided to make a slab and a low wall to reduce water entrance” (Cristina, community member).

“During the 2010 flood, I had to take my furniture and put it in my mother’s house. The flood destroyed the walls of my house (...) what we could save, we saved. After that episode, I moved to a house in a highest point” (Janete, community member).

“During rains I move my furniture and I keep watching the level of the ditches (...) I always have to clean my backyard after rains, since it accumulate much garbage. I already requested assistance from the NGO Urban Solutions since it is necessary to construct other water ditches and a wall to reduce water entrance” (Joelcia, community member).

Table 1: Overview of household actions before, during and after floods

Before
<ul style="list-style-type: none">• Construction of protective walls• Change roof (material more resistant)• Change direction of roof inclination• Relocate• Clean and maintain the drains
During
<ul style="list-style-type: none">• Clean ditches• Put buckets or towels• Move belongings elsewhere• Be more alert
After
<ul style="list-style-type: none">• Clean and repair property• Clean ditches• Construction of a new floor and roof in order to avoid leaks• Construction of groove to water drainage• Construction of retaining wall• Construction of foundation to walls• Cut slopes• Joint efforts with neighbors to collect garbage• Saving money for larger adaption measures• Request assistance from NGO Urban Solutions

Adapting to landslides

As previously explained, the landslides are also a recurring problem in Morro Vital Brazil, especially during heavy rains. Households recognized the serious risk of landslides to their lives and to the well-being of the community, however various factors limited the effectiveness of individual measures, including the individualistic nature of household's investments and the lack of support from the government (cf. Moser & Satterthwaite, 2008; Satterthwaite, 2009).

Within this context, only 2 interviewees reported actions to prevent future landslides by complaining to the Civil Defense⁷ (although they did not solve the problem), by receiving assistance from the NGO *Urban Solutions* and by taking individual actions, such as shaping the slope in order to avoid landslides.

“The civil defense said that in order to make the removal of the rock, I had to file a lawsuit in the city hall. The bureaucracy is so great that the rock continues in my backyard. The risk is there, the rock is in the same place, risking other parts of my yard. However, with the assistance from the NGO Urban Solutions, I feel a little safer now” (Ana Claudia, community member).

Regarding the assistance from the NGO to the interviewee Ana Claudia, a joint action with family members, neighbors and NGO staffs materialized. As a result, channels were built to facilitate water runoff during rains and a better access to the house, with stairs and ramps. Before the construction of those channels, water used to enter her house during heavy rains and floods.



Figure 4: Pictures⁸ taken during the collective action in the house of Ana Claudia (July/2015). Source: www.facebook.com/solucoesurbanas

⁷ The Civil Defense in the city of Rio de Janeiro was created to articulate, coordinate and manage disaster reduction activities in the city. In addition, it aims to mobilize the population to adopt preventive measures and quick responses in risk situations caused by hazards (Prefeitura do Rio de Janeiro, 2015). Since the heavy floods that hit the city of Niterói in 2010, the Civil Defense has adopted plans and strategies to monitor risk areas, including Morro Vital Brazil. But so far, nothing concrete has been done in the community of Morro Vital Brazil (O Globo, 2014).

⁸ The use of the pictures was authorized by the NGO *Urban Solutions*.

Adapting to water shortage

All respondents reported that in recent months the water supply is very irregular. In order to tackle this problem, people are buying bottle of water or joining with other residents to hire water trucks, although they can only go to the lower part of Morro Vital Brazil. In addition, some people have been calling the water company responsible for the water supply, but so far nothing has been done.

“The community is suffering a lot. We called the concessionaire several times, but they never came here. Sometimes, we only have water once a week” (Danielle, community member).

Adapting to humidity

In informal settlements, houses are frequently built with materials of varied origins and the construction does not always follow accepted techniques. In addition, normally there is a lack of maintenance and with environmental conditions, such as humidity from proximity with hillsides, humidity and mold problems become even more aggravated (see Bicknell, Dodman, & Satterthwaite, 2009).

All respondents from Morro Vital Brazil reported that there is humidity and mold in their homes. Some interviewees mentioned that they have been moving their furniture elsewhere and taking extra steps to counter mold growth. However, these measures are not efficient and do not combat humidity.

The NGO *Urban Solutions* has been making small structural changes in some houses in order to solve the humidity issue, such as construction of water channels and sealing walls. From these small interventions, levels of humidity decrease significantly and move away the risks of respiratory diseases and mold. All respondents who received assistance from the NGO said that the humidity and mold had reduced significantly, even though it is not possible to tackle the whole problem since humidity also comes from the ground.

“The interventions, such as construction of water channels and sealing walls, reduced the moisture intrusion and the proliferation of fungi that causes respiratory diseases. However, the humidity that comes from the ground we cannot solve it” (Lavínia, architect from the NGO Urban Solutions).

Adapting to heat stress

Most low-income groups live in housing without adequate ventilation and insulation, and during heat stress the elderly and people in poor health are mostly at risk (Bicknell, Dodman, & Satterthwaite, 2009). In Morro Vital Brazil, the vast majority of interviewees reported that there has been an increased heat in recent years, in which some interviewees received assistance from the NGO *Urban Solutions* in order to construct reflective tiles made with sustainable materials and the placement of new windows in order to increase air circulation.

“The project Family Architecture by the NGO Urban Solutions raised my roof, created ventilation systems and put more windows in my house. Before, we used to suffer a lot due to the excessive heat. Now, I am in paradise” (Carlão, community member).

“When we measured the temperature of Carlão’s house before the improvements, it was about 4 degrees warmer than the outside temperature” (Lavínia, architect from the NGO Urban Solutions).

“In 2014 I bought an air-conditioner due to the heat. I couldn’t stay inside my house, I was too warm and I used to feel sick. However, not many people can afford to buy an air-conditioner, it is very expensive” (Danila, community member).

5.3 The role of people’s knowledge and perception of climate change

During the interviews, participants were asked to what they attributed the occurrence of the environmental problems in the community, how often such problems occurred, if they noticed increased frequency of these problems and if they ever heard the term climate change. According to the vast majority of respondents, the accumulation of garbage on the slopes and construction of houses in high-risk areas are the main causes of the environmental problems, which no one related to climate change. Most of the interviewees said that those problems occurred many times per year, and that lately there has been an increased frequency, especially the occurrence of heavy rains, floods and increasing temperatures. According to the dwellers of the community, these events have a strong or very strong impact on their livelihoods, and contribute to putting people's lives at risk.

It is important to note that all interviewees from Morro Vital Brazil report to have perceived changes in the climate, especially with respect to extreme weather events. However, the link with global climate change is lacking. Of the 24 interviewees, only 6 reported that they have heard the term

before. While some of them did not know what it means, others gave simple answers such as “climate change is when the climate is changing”, and 3 respondents gave more elaborate responses:

“Before, the seasons of the year were all regular, but nowadays the human being is changing everything, now the seasons are all mixed” (Janete, community member).

“Climate Change is excessive variations in the weather and climate” (Danielle, community member).

“Climate change it is what we are living now, this intense heat and heavy rains that we did not use to have it” (Danila, community member).

In my study case of Morro Vital Brazil, there was no apparent link between the understanding of climate change and the perception of changes in the climate to the socioeconomic status. The level of education of the three women who gave them most elaborate answers regarding climate change ranged from incomplete elementary school to superior level. Conversely, as stated above, the perception of changes in the climate was reported by all residents.

Finally, the adaptive measures adopted by dwellers from Morro Vital Brazil do not seem to be related to the understanding of climate change. While the cost of adaptation was mentioned by several interviewees, suggesting that income is an important factor, the most salient common feature of the people who had taken adaptive measures was having received support from the NGO *Urban Solutions*. In the next part, I will further explain how the NGO support influenced people’s attitudes to adapt to climate change in Morro Vital Brazil.

5.4 The role of local actors’ support

Of the 17 interviewees that are making small structural house improvements in order to adapt to climate change, 13 had received some kind of assistance from the NGO *Urban Solutions*. In contrast, no one had received assistance from the government or private sector.

According to the NGO *Urban Solutions*, there is an interaction between the NGO and the local community in order to understand the main needs of the house dweller.

“Nowadays, I do not have many problems in my house due to the assistance of the NGO Urban Solutions (...) they made infrastructure changes in order to reduce the excessive heat, mold and improvements in the electrical system. In addition, they build a water channel to prevent water flow behind my house” (Andréia, community member).

“Our project is not only about infrastructure changes, but we aim to meet the specific needs of each resident. First, we ask that the resident and family indicate the three biggest infrastructure problems of the house. Then, the NGO and the family discuss together about what should be fixed and improved” (Aline, social worker from the NGO Urban Solutions).

5.4.1 The emergence of the project Family Architects in Morro Vital Brazil

Initially, the NGO *Urban Solutions* had financial resources⁹ to create 100 projects called *Family Architects*¹⁰ that was related to the improvement of housing conditions in Morro Vital Brazil. Of the total 460 housing units¹¹ in the community area, 351 units were registered as potential beneficiaries of the project. In addition, in order to select the 100 housing units, the NGO surveyed the housing units that were aiming to participate in the project.

“We asked the dwellers of Morro Vital Brazil what criteria should be used to choose the house units to be potential beneficiaries of the project. Our initial idea was to choose the houses with more occupants, since we believed that they needed to enlarge the rooms. However, the community residents did not agree with this criterion, since they said “more people in the house means more people to work”. And then we found out that often the houses with many residents were those in which people did not want to work, they did not look for jobs” (Aline, social worker from the NGO Urban Solutions).

Thereby, after the completion of the survey, the NGO produced an environmental risk matrix in order to analyze the geographical (e.g. making sure houses were not in risk areas¹²), technical and socio-economic aspects of the respondents' living situation. It is important to highlight that in Brazil, the environmental legislation prohibits construction in steep areas, which are subject to landslides. In

⁹ The initial budget was donated by the Ministry of the City, state government of Rio de Janeiro.

¹⁰ The project *Family Architect* by the NGO *Urban Solutions* it is an allusion to the programme *Family Doctor*, created by the Brazilian government. The project seeks to follow the program's strategy, with the professional working within the community and with a permanent action. In addition, it aims to improve the perception of the community residents with the environment and health; in other words, it aims to show to the population the importance of living in an environment with appropriate health conditions (Soluções Urbanas, 2015).

¹¹ According to the last census (2010), there are a total of 460 housing units in Morro Vital Brazil. However, only 351 units agreed to participate in the survey by the NGO *Urban Solutions*, since many families thought that it was a survey made by the government with the purpose to remove slum dwellers.

¹² In Brazil, there is a law that prevents houses to be built in hazardous areas or over streams. However, slum dwellers do not take into account this law, constructing houses in risk areas and over streams (Senado Federal, 2011).

that sense, the NGO *Urban Solutions* cannot assist dwellers living in those areas¹³. Within this context, the NGO identified the most vulnerable houses and people. For the NGO, vulnerabilities in the house were related to problems of foundation, cracks in the wall, infiltration, moisture, lack of ventilation and extreme heat. With regard to the vulnerability of people, it was related to the social and economic conditions, such as elderly, young people and level of income.

At the beginning of the project, in 2010, the main goal of the NGO *Urban Solutions* was the total renovation of the house; however they realized that it would be more feasible to act upon a specific house problem, since dwellers from Morro Vital Brazil could not afford the total renovation of the house. In that sense, the execution of constructions and changes in the house will depend if the dweller has economic resources, since the NGO only provides technical assistance and work material, but not manpower.

However, the NGO has been implementing viability strategy in order to promote alternative construction methods. For instance, there are joint efforts – three to five families perform the construction, and every weekend they work on a different family's house. However, it is a very slow process, since they would work only during weekends and intermittently.

“Joint efforts have a greater potential for social development by the ability to promote cooperation actions and facilitate the reproduction of experiences” (NGO Urban Solutions, 2015).

So far, the project has performed interventions in more than 60 houses within the community by supporting residents and increasing household and community resilience, in which, according to the NGO *Urban Solutions*, the participation and involvement of the residents in the project is very important for its success and to be sustainable.

5.4.2 Increasing knowledge, information and learning

Knowledge, access to information and learning are important factors at the individual and societal level in determining whether and how adaptation takes place (Adger et al., 2008). In that sense, adaptation actions are inherently local and are necessarily based on contextual knowledge and therefore, if adaptations are to be understood as both context specific and interrelated, it is

¹³ According to the NGO *Urban Solutions*, the Civil Defense of Rio de Janeiro conducted a risk mapping of the area of Morro Vital Brazil, identifying risk areas and houses that are built in those areas. However, although the government is aware about people living in such areas, nothing was done regarding eviction orders.

important to recognize the existence knowledge of vulnerable actors (Adger et al., 2008; Ensor et al., 2014; Moser & Satterthwaite, 2008).

In the studied case of Morro Vital Brazil, information from the NGO *Urban Solutions* does not only concern structural improvements to houses, but also issues such as waste management. Interviewees related that joint efforts to garbage collection should be made more often, because it reduces the chance of risks during heavy rains and landslides. The NGO also related that they are also learning from the community, in which knowledge exchange is a key aspect for the NGO *Urban Solutions*.

“Families who have embraced the project from the NGO Urban Solutions have a better situational awareness, improving not only their home, but the whole community” (Danila, community member).

“We based our work in the knowledge exchange, since we believe that a participatory construction is the key to our project. Our work is constructive, because we have a partnership with the community (...) until recently, we had to go into people’s house and ask if they wanted to participate in the project. Nowadays, the demand is spontaneous, since the community has created a basis of trust with the NGO and they see that the project is really happening (Aline, social worker from the NGO Urban Solutions).

In addition, the NGO has been providing organizational capacity development, with workshops and courses related to the qualification of construction workers, in which all participants live in Morro Vital Brazil or in nearby slums. Also, together with the Civil Defense of Niterói and the Institute Vital Brazil, the NGO created a course in order to encourage people from the community to join the Community Civil Defense Centers (*Nudec*, in Portuguese). The purpose of the *Nudec* is the prevention and minimization of risks and disasters in the most vulnerable places of the city, such as Morro Vital Brazil. The *Nudec* are formed by local population to work in the community mobilization in both prevention and during a disaster.

“The joint effort which was held at my house involved my neighbors and the staff of the NGO. Together, we are learning that small reforms can make all the difference in our lives” (Carlão, community member).

“The NGO helps and teaches us that certain things should not be done (e. g throw garbage in the backyard) and we reproduce to our neighbors” (Ana Cláudia, community member).

“When the residents assimilate the knowledge, they reproduced and spread to their neighbors. When we were visiting the house of an elderly lady, that did not receive our assistance to improve her house, she said to us “I bought a new window in the community Fair Solidarity Exchanges¹⁴ and now I have a cross ventilation system¹⁵”, which it is a technical term used by our staff and that we explain to the houses benefited from the project” (Aline, social worker from the NGO Urban Solutions).

According to the NGO *Urban Solutions*, the knowledge is staying and multiplying within community. In addition, during the interviews in Morro Vital Brazil, respondents were asked about what information they considered important for the community to know in order to deal with the environmental problems and hazards that have been affecting the community. The vast majority reported that the lack of knowledge and information, especially coming from government authorities, represents an impediment for improvements and better awareness of individuals and the community. In that sense, the presence of NGOs in the community although represents a great improvement in the way the community deals with climate-change hazards, however, it is still not sufficient to fill the void caused by the government absence.

5.4.3 Financial costs of adaptation

Although adaption means to “cope better” with stresses, it does not imply that adaptation allows avoidance of all costs (Satterthwaite et al., 2007: 52). The economic resources at the household level are a critical determinant of the capacity to perceive and respond to hazards (Romero-Lankao et al., 2014). In the studied case of Morro Vital Brazil, the lack of financial resources to adapt to climate-related hazards was a frequent topic related by respondents. In that way, cost could be considered a factor that prevented dwellers from the community to adapt to climate change. The interviewees that did not receive assistance from the NGO in order to take adaptive measures related that although it was possible to make some small improvements, such as moving belongings somewhere and construction of water channels, they did not have enough income for improvements in all issues needed.

¹⁴ The *Fair Solidarity Exchanges* (Feira de Trocas Solidárias, in Portuguese) is one of the strategies from the NGO *Urban Solutions* to ensure that residents that were assisted from the project *Family Architect* can have access to work material to make the reforms and improvements proposed by the project. It takes place every two months in the community center and offers construction materials donated by partners, such as floors, paint, cement, shelves, lamps, stairs, door, taps, etc. (Soluções Urbanas, 2015).

¹⁵ The best way to promote air circulation inside a house is to adopt the cross ventilation system, especially in hot and humid places (Ecologic Construções, 2015).

“I made some small improvements in my house (...) but it is too expensive to make so many changes and I cannot afford it now” (Cristina, community member).

“It is very expensive to do construction works and maintenance in my house, so I am saving money in order to build water channels and construct a new roof (Paulo César, community member).

“Due to the lack of water shortage, many people are buying bottles of water or hiring water truck. However, it is very expensive and not everyone can afford it” (Danielle, community member).

Some interviewees that received assistance from the NGO reported that the fact that they do not help to fund the manpower can be considered an impediment to the execution of construction works.

“Although I received assistance from the NGO Urban Solutions, they do not provide masons to help us, only the work material (...) it is something that we need to provide by ourselves. In order to construct a water channel in my house, it was organized a joint action with my neighbors, since I could not afford to pay a mason” (Danila, community member).

6. Discussion

6.1 Lack of government support

In the vast majority of the low-income areas in Rio de Janeiro, the government fails to meet many of its responsibilities including the provision of infrastructure, resources and regulation of building construction in risk areas (Delecave & Leitão, 2011; Cavalcanti, 2013; Cavallieri, 2003). Also, it seems that there is an unwillingness and avoidance to work and improve life conditions of those who live in informal settlements. The government considers low-income dwellers as a social problem and they are excluded from the benefits of those who live in noble areas of the city. The urban dynamic constitute itself a mechanisms of reproduction of social inequalities, in which spatial segregation undermines people’s opportunities to participate and have access to the wealth generated in society (Brazil, Pereira & Longo, 2015).

Throughout the history of the urbanization of the *favelas* in Rio de Janeiro, housing policies adopted by the government did not include the slums as part of the city but as something external which

should be eliminated through eviction policies or located in peripheral places. However, these policies have failed, since the vast majority of the population did not want to leave their homes (e.g. for work reasons or convenience of living in a central place). In that sense, many slum dwellers prefer to live in places exposed to risk in order to access benefits such as proximity to livelihood opportunities (Pelling, 2011). In addition, from the 1980s the government granted to slum dwellers “extra rights”, such as allowing them to continue to live in risk areas, which resulted in an uncontrollable occupation of those areas. This was done under the pretext of paying a “social debt to the poor” (Delecave & Leitão, 2011). Based on this, I argue that paying a “social debt to the poor” would be a justification from the governments to abdicate from their responsibilities to provide proper infrastructure, services and adequate housing for this part of the population.

The adoption of policies of recognition of the *favelas* turned into a problem of environmental degradation, with houses located in risk areas and thus more vulnerable to climate-related disasters. It is important to notice that this issue does not apply only to the Brazilian urbanization context, but also in many other developing country cities. The vulnerability of marginalized groups and their exclusion from decision making has been documented throughout the world (Adger, 2003).

6.2 Organizations acting in communities and their influence in people’s adaptive capacity

Within this context of lack of governance presence, NGOs have become an important actor in low-income areas by filling the gap of the absence of public policies. In the case of Morro Vital Brazil, the NGO *Urban Solutions* has taken on a role of contributing to change and transforming the environment in which the community lives. However, there are larger processes that the NGO cannot influence, such as high price of city land which gives the poor people only options of either living on risk areas or being moved to social housing in the periphery, far away from the city center and its facilities.

In the literature review, adaptation to climate change is often related to the social and economic conditions of individuals, such as education, income and local actors support (Bicknell, Dodman, & Satterthwaite, 2009; Ensor et al., 2014; Patt & Schröter, 2008). In this study, education and income did not emerge as important factors, but local actors support can be considered an important factor. The material of this thesis suggests that adaptive capacity in low-income areas can be better supported by measures that emerge from local support to communities. The studied case presented on this thesis showed that the NGO *Urban Solutions* is an important actor within the community as it influences and enhances people’s adaptive capacity to climate change. The NGO is helping the

community members with improvements in the house in order to decrease the impacts of climate-related events, as well as by sharing knowledge and information about adaptive practices.

Oftentimes NGOs do not always represent a good change to societies, since they might have interest of power involved, or they represent only a minor part of the population. In the case studied of Morro Vital Brazil, the NGO initially chose only some residents to be beneficiaries of the project, leaving out much of the community. Nevertheless, currently the NGO works with a spontaneous demand, in which families seek their help. Another important aspect to reflect about is that the NGO *Urban Solutions* mostly focus on structural changes in houses, not considering other potential measures to reduce the social aspect of vulnerability or environmental measures. For instance, improved access to jobs and reforestation to reduce floods and landslides are also in need of consideration as important aspects to reduce the risk of slum dwellers. In that sense, such aspects need to be taken into consideration by other actors that could work within the community.

In the case of Morro Vital Brazil, the NGO cannot help people that constructed their houses over streams and also houses that have been identified in risk areas by the government, as mentioned in the previous section. However, those people are the ones most at risk and considering the long-term perspectives of climate change impacts, there is a possibility that more houses become located in high-risk areas. Within this context, there is a need to reflect upon the long term perspective: what is thus the implication of the NGO helping people to invest their money in infrastructures interventions in houses that in a few years may be considered to be in a risk area by the government and at risk of being displaced?

6.2.1 Multiplying knowledge, information and learning

The evidence from this case study shows that local support can provide knowledge and information to people that could remain and be multiplied in the community. Several studies (Ensor et al., 2014; Sanginga, Kamugisha, & Martin, 2010) confirm that local support can help to build more a complete understanding of the problem being faced, by facilitating knowledge-sharing and joint learning experiences.

In addition, many studies (see CADRI, 2011; Scott et al, 2014; OECD, 2006) indicate that a participatory and multi-actors approach is important for establishing commitment and trust relations between NGOs and the community. My studied showed that the NGO *Urban Solutions* sought to involve community participation through a participatory approach in order to build ownership. This in turns would encourage direct beneficiaries to sustain the project for a long-term perspective. In

addition, some staff members of the NGO come from the community, which facilitates the understanding of context and needs.

Many authors (see Ensor et al., 2014; Pahl-Wostl, 2009) suggest that by working together through a participatory approach, shared ways of knowledge are produced. According to Ensor et al (2014: 6), knowledge and information can be seen as an input to power sharing, since each actor brings their own experiences and many sources of information. Still, power remains pertinent since the production of knowledge is part of the wider power dynamics that outline the relationships between the actors (Ensor et al., 2014).

According to the NGO *Urban Solutions*, their work is based on the knowledge exchange, with a participatory approach that includes the community members in the decision planning. However, by speaking with the residents, it was clear that large portion of the community lack information and knowledge to carry out climate change adaptation measures by themselves. In this sense, the NGO becomes their only source of information and it might have a stronger power of voice when compared to the dwellers of low-income areas. Nevertheless, even though the information only comes from the NGO, it is helping the community residents to improve their adaptive capacities.

In Morro Vital Brazil, investing in the local development of the population contributed to improving the quality of life and can somehow influence the control of the expansion of disordered territorial occupations, since the population is more aware of the negative impacts of living in risk areas. In that sense, residents could potentially avoid living in risk areas or even the people located there could look for another location outside the hazardous area.

Finally, NGOs can have important roles in climate change adaptation since they support adaptation activities directly (Dodman & Satterthwaite, 2008; Bickell, Dodman & Satterthwaite, 2009). They can act as conduits for the transfer of information and can also be effective implementers of projects to reduce disaster risk and adapt to climate change (Dodman & Satterthwaite, 2008).

6.3 Increasing resilience in Morro Vital Brazil

Small interventions in the houses of dwellers as well as the dissemination of knowledge and information to the community had helped to build resilience in Morro Vital Brazil. Residents who have been assisted by the NGO *Urban Solutions* reported that knowledge and information increased in the community, and that knowledge is being relayed to neighbors and families. However, it can also be argued that residents in the community had certain capacity that was not influenced by the

assistance of the NGO, such as financial capacity to buy air-conditioner or small infrastructure improvements in the house made by themselves. Knowledge-sharing in the community would probably not happen if there was not an existing social capital, but the NGO help the community as a whole to use their capacity more efficiently.

Finally, although the NGO *Urban Solutions* did not have climate change adaption as a particular focus, the provision of more assets often contributed to better livelihood outcomes, which in turn contributes to better adaptive capacity and increase resilience (Levine, Ludi & Jones, 2011). My case study showed that the NGO represent a significant actor within the community, particularly because of their ability to facilitate climate change adaptation at the local level. By providing information, knowledge and resources to the community, the NGO creates a scenario in which individuals can do things for themselves and adapt their homes and their lives to climatic-related events that are becoming increasingly frequent in the community. In that sense, the role of the NGO *Urban Solutions* in Morro Vital Brazil could be considered as a community-based approach, since it acts with a participatory identification and development activities that strengthen the capacity of local people to adapt to climate change (Wise et al., 2014).

6.4 Future research

More research is needed to confirm the implications and effects that support from local actors may have on adaptive capacity to climate-related hazards and increasing resilience in low-income areas. Also, it is important to have studies that address how poor communities could be more informed about climate change, since it seems to have a lack of knowledge and information in informal settlements about the link between increasing extreme weather with global climate change.

In addition, this thesis has illustrated how poor governance and lack of infrastructure, resources and information can represent an obstacle to people's adaptive capacity. In that sense, it would be interesting to conduct further research on how people in low-income urban areas could be better supported by social-economic infrastructures in order to enhance their adaptive capacity.

7. Conclusion

The increasing climate-related hazards especially affecting the urban poor in developing countries indicates the urgency for vulnerable communities to adapt to climate change. In order to assist those people, more information is needed about the factors that shape people's adaptive capacities.

This thesis investigated the role of local actors support in determining people's capacity to adapt to climate-related hazards. In particular, it examines how support from a NGO can influence people's actions and the learning process. The research is based on a case study of the informal settlement Morro Vital Brazil in Niterói, Rio de Janeiro, Brazil, where floods, heavy rains and landslides are frequent. In addition, it included qualitative analysis of data obtained from interviews, observations and literature review.

The results of this thesis indicate that the adaptive capacity of low-income dwellers can be better supported by measures that emerge from local actors that work with the communities. In addition, it shows how better access to infrastructure, knowledge and information can also play significant roles in determining adaptive capacity.

The presence of a NGO in the community was found to be a contributing factor to people's awareness of how to deal with environmental problems that exist in the community, how to adopt adaptive capacities related to climate change and to increase resilience in the household and community level. By being an actor that tried to remedy the lack of the government presence, the NGO is providing information, knowledge and resources to the community.

In a broader perspective, this study has contributed to a more detailed outlook on how local support may be linked to increase adaptive capacity activities and thus resilience. The existence of adequate infrastructure, resources and information can be determining factors for adaptive capacity measures.

8. References

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Appendix 1 – Interview guide in Portuguese and English

I - IDENTIFICAÇÃO DO MORADOR:

- Nome;
- Sexo;
- Data de nascimento;
- Escolaridade/Nível de educação:
- () 1º grau incompleto
- () 1º grau completo
- () 2º grau incompleto
- () 2º grau completo
- () Superior incompleto
- () Superior completo
- Ocupação:
- Nível de renda
- () 1-3 salários
- () 3-5 salários;
- () acima de 5;
- Tempo de moradia;
- Condição da moradia
- () própria
- () alugada
- Número de residentes na casa;
- Etnia.

II -CARACTERIZAÇÃO DO IMÓVEL:

- Material das paredes:
- Material do teto:
- Número de cômodos
- Tem abastecimento de água? (interno);
- Tem coleta de lixo?
- () Sim () Não
- Se sim, quantas vezes por semana?;
- Tem rede de esgoto?
- () Sim () Não

III - PROBLEMAS SOCIOAMBIENTAIS

- 1) Você pode citar alguns dos problemas ambientais que ocorreram na comunidade, nos últimos 10 anos:
- 2) A que você atribuiu à ocorrência desses problemas?
- 3) Com qual frequência os problemas mencionados geralmente ocorrem?
 - () muitas vezes por mês;
 - () muitas vezes por ano;
 - () raramente.

- 4) Você notou algum aumento da frequência desses eventos?
- 5) Você acha que isso pode ser atribuído as mudanças climáticas?
- 6) Os impactos desses problemas em sua vida podem ser considerados:
 - muito forte
 - forte
 - fraco
- 7) Assinale os impactos dos problemas ambientais em sua vida e comunidade:
 - Doenças, como a dengue e leptospirose;
 - Mortes de familiares;
 - Mortes de amigos e conhecidos;
 - Perda de bens materiais;
 - Perda de locais de interesse afetivo e religioso;
 - Danos ao imóvel (rachaduras, queda de paredes, umidade, mofo)
 - Perda do imóvel
 - Desvalorização do imóvel;
 - Interrupção do abastecimento de água
 - Interrupção do abastecimento de energia;
 - Aumento do calor;
 - Medo e insegurança continuamente.
- 8) Que outros impactos você percebeu?
- 9) Qual o impacto desses desastres para a comunidade como um todo?

IV AÇÕES DIANTE DOS EVENTOS

- 10) O que você fez durante o evento para evitar perdas?
- 11) O que você fez após o evento?
- 12) Recebeu algum tipo de ajuda?
 - Sim Não
 - Em caso positivo, indique a origem:
 - amigos familiares ONGs
 - Poder público
- 13) Você vem tomando/tomou alguma medida para se prevenir de futuros problemas ambientais?
 - Sim Não
- 14) Em caso positivo, descreva as suas ações:
- 15) A comunidade vem tomando medidas para se prevenir de futuros problemas ambientais?
 - Sim Não
 - Em caso positivo, descreva as ações:
- 16) Em relação ao abastecimento de água. O que tem sido feito por você e pela comunidade?
- 17) Que informações você considera necessária para que a população aprenda a lidar com os problemas ambientais?

I – IDENTIFICATION OF RESIDENT:

- Name:
- Sex;
- Date of birth;
- Level of education:
 - () 1^o degree incomplete
 - () 1^o degree complete
 - () 2^o degree incomplete
 - () 2^o degree complete
 - () University degree (incomplete)
 - () University degree (complete)
- Occupation;
- Level of income:
 - () 1-3 Brazilian wage
 - () 3-5 Brazilian wage
 - () Up to 5 (Brazilian wage)
- How long have you been living in the community?
- Condition of the house:
 - () owner the house;
 - () rented the house;
- Number of residents in the house.

II –CHARACTERIZATION OF THE PROPERTY:

- Characteristics of walls:
- Characteristics of roof:
- Number of rooms
- Water supply?
- Garbage collection?
 - () Yes () No
 - If yes, how many times per week?
- Sewage system?
 - () Yes () No

III – ENVIROMENTAL PROBLEMS

- 1) Please indicate some of the environmental problems that occurred in the community for the last 10 years
- 2) What do you assign the occurrence of these problems?
- 3) Frequency of those problems:
 - () many times per month;
 - () many times per year;
 - () rarely.
- 4) Have you noticed any increased frequency of these events?
- 5) Do you think this can be attributed to climate change?
- 6) The impact of these problems in your life can be considered:
 - () very strong
 - () strong
 - () weak

7) Please inform the impacts of the environmental problems in your life and community:

- Diseases, like dengue or leptospirosis;
- Death of family members;
- Death of friends ;
- Loss of material goods;
- Property damage (cracks, falling walls, moisture, mold)
- Property loss;
- Property depreciation;
- Water shortage;
- Energy outage;
- Increased heat;
- Fear and insecurity continuously.

8) Did you notice any other impacts?

9) What are the impacts of these disasters for the community as a whole?

IV- ACTIONS IN FACE OF THE EVENTS

10) What did you do during the event to avoid losses?

11) What did you do after the event?

12) Did you receive some kind of help?

Yes No

If so, please indicate the source:

friends families ONGs

Public power

13) Have you been taking / taken any measures to prevent future environmental problems?

Yes No

14) If yes, please describe your actions:

15) Do you think the community is taking steps to prevent from future environmental problems?

Yes No

16) With regard to water supply. What has been done for you and the community?

17) What information do you consider necessary for the population to learn to deal with environmental problems?