Disasters, formal education and adaptive capacity

Does people's level of formal education influence their risk from climate-related disasters? A case study of an informal settlement in Rio de Janeiro

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KEYWORDS

Adaptation, adaptive capacity, Brazil, climate change, coping capacity, disaster risk, disasters, favelas, flood, formal education, income, informal settlements, landslide, Latin America, risk reduction, Rocinha

ABSTRACT

With a worldwide increase in climate-related disasters and the global temperature on the rise, the effects of climate change are already being felt. Among those most at risk are the poor in developing countries, often living in informal settlements or 'slums'. In order to reduce associated risks and strengthen people's own coping capacities, there is an urgent need for knowledge about the factors that determine people's capacity to cope with and adapt to adverse climate conditions.

This study examines the influence of formal education, as opposed to income, in determining the adaptive capacity for the residents of Rocinha, an informal settlement in Rio de Janeiro, Brazil, where floods and landslides are recurrent. The research thereby explores the potential of promoting formal education as a way to increase people's capacity to cope with adverse climate effects. The information for the study was gathered through observations, interviews with residents and key informants in Rocinha, and literature review. Both statistical and qualitative analyses have been made of the data gathered. The statistical analysis investigates how formal education influences people's level of risk, including their coping strategies and the institutional support they receive. In the qualitative analysis, the direct and secondary effects that education may have on risk and people's adaptive capacity are explored.

The research results indicate that formal education has a more significant role in determining people's level of risk and their coping capacities than what has hitherto been acknowledged. In fact, the study identified the importance of people's level of education for their awareness and understanding of existing risks. It was further revealed that in the study area, formal education plays a more determinant role for women than for men to their capacity to cope with disasters. In addition, it became obvious how formal education can have a mitigating effect on factors such as poor health, teenage pregnancy, littering, substance abuse, organised drug trade and illegitimate growth of the settlement – all of which were found to exacerbate people's level of risk.

On this basis, it is concluded that promoting formal education as a way to increase people's coping or adaptive capacities is justified, not only due to its potential influence in increasing people's level of income.

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Vetlanda, Sweden, October 2010   Ebba Brink

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Abbreviations

C	Capacity
CRED	Centre for Research on the Epidemiology of Disasters
DRR	Disaster Risk Reduction
ERC	European Research Council
GDP	Gross Domestic Product
HH	Head of Household
IBGE	Instituto Brasileiro de Geografia e Estatística
IBISS	Instituto Brasileiro de Inovações em Saúde Social
IPCC	The Inter-governmental Panel on Climate Change
IIASA	International Institute for Applied Systems Analysis
LC	Lack of Capacity
MDGs	Millennium Development Goals
PAC	Programa de Aceleração do Crescimento
PAR	Pressure and Release
R	Risk
SL	Sustainable Livelihoods
UNDP	United Nations Development Programme
UNFCCC	United Nations Framework Convention on Climate Change
UNISDR	United Nations International Strategy for Disaster Reduction
V	Vulnerability

Portuguese dictionary

bairro	neighbourhood, district
bala perdida	stray bullet
gato	informally drawn electric cables in informal settlements in Brazil
favela	informal settlement or 'slum'
Prefeitura	the 'city hall' or executive authority of the city of Rio de Janeiro
traficante	a person working for the organised drug trade
tráfico	trafficking (of drugs)

1 INTRODUCTION

1.1 Background and problem definition

Today, 'climate change' is on everybody's lips. With the global temperature on the rise and a worldwide increase in climate-related disasters the effects of climate change are already being felt, and many of the current climate change studies predict a continued rise in the frequency of extreme events such as windstorms, tornados, heat waves, heavy rains, floods and landslides (IPCC 2007:594). Each year, so called natural disasters trigger devastating losses in human lives, economical assets and infrastructure, with the poor in developing countries paying the highest price (UNISDR 2002:45; Wisner et al. 2003).

The trend is for the risk to become urban, with rapid urbanisation and urban population growth in developing countries increasingly exposing populations and economies to hazard impact (IPCC 2007:359). For instance, in Latin America and the Caribbean, 89 percent of the population is predicted to live in cities by 2050 (UN 2009). The urban poor, often living in informal settlements in steep slopes or on flood plains, are particularly vulnerable to climate-related disasters (e.g. Bigio 2002; Wisner et al. 2003; Wamsler 2007b; IPCC 2007:364).

While research has already been conducted on many aspects related to the geological and biological impacts of climate change, little is known about the future wellbeing of the world's population and how it is related to our ability to adapt to changing climate conditions. According to the European Research Council (ERC), knowledge about future societies' adaptive capacities is one of the most important missing links in making predictions about future climate impacts (ERC 2009).

1.2 Research objectives

The main purpose of this thesis is to provide more knowledge on the aspects that shape people's capacities to adapt to new climate conditions. On this basis, it firstly aims to examine how the level of risk of people exposed to climate-related disasters is influenced by their level of formal education[4]. The motivation to focus on formal education, as opposed income, which is conventionally seen as a key factor to disaster survival (Wisner et al. 2003), is based on several studies from the last decade where educational attainment is suggested to enhance people's ability to cope with disasters (e.g. Adger et al. 2004; Toya & Skidmore 2005; Blankespoor et al. 2010). If formal education could, indeed, be identified as a key factor to people's adaptive capacity, this would support promoting formal education in order to increase the coping capacity of people or communities at risk. In addition, it would facilitate forecasting the wellbeing of future populations, since demographic structures based on age and education are subject to slow change and therefore predictable for many decades ahead, which is rarely the case for other social, economic or institutional trends (ERC 2010).

Secondly, this study aims to contribute to knowledge about the complex reality of people living in disaster-prone informal settlements or 'slums', by illustrating how dangerous living conditions and social marginalisation are interlinked with the daily life of the residents in the study area, and in turn how they are related to their level of formal education.

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[4] Formal education is defined in Section 2.5.1

Hence, the information sought in this study include the key factors that influence (1) people's level of risk from disasters; (2) people's strategies used to cope with past disasters and adapt to disaster risk; and (3) the institutional support for risk reduction/adaption offered to people living at risk.

With its results, this thesis aims to provide policymakers and practitioners with information about how to sustainably reduce the risk for people exposed to climate-related disasters, as well as to contribute to the academic discussion on disaster risk and formal education, and to inspire to much needed further research on the subject.

1.3   Methodological approach

This thesis is based on a case study carried out during 2010 in the Brazilian *favela*[5] Rocinha, an informal settlement in central Rio de Janeiro. Rocinha is believed to have about 100.000 inhabitants[6], and landslides and floods are a recurrent problem. The case study has produced both quantitative and qualitative results, which were analysed, evaluated and compared to current research and knowledge.

The study was motivated by the project named "Forecasting Societies' Adaptive Capacities to Climate Change" which is funded by the European Research Council and coordinated by the International Institute for Applied Systems Analysis (IIASA) (ERC 2009). This project specifically builds on one project component, which is to empirically determine key factors that have influenced people's level of risk during past disasters, among others Hurricane Mitch in Central America (Wamsler 2010). Research approaches and methods have been adapted to the context of this study.

1.4   Thesis outline

This paper consists of six different sections. This first section (*1 Introduction*) provides the setting of the study by presenting the research problem, the research objectives and the expected contribution of this work. The following section (*2 Theoretical framework*) presents the theoretical framework on which the study is based, defining the terms central to the study and reviewing important literature on the subject. The interrelations between concepts such as risk, vulnerability and capacity are identified based on previous research, as well as current practices related to holistic disaster risk reduction. The theoretical framework also highlights the findings of recent research on how people's level of risk is influenced by their levels of formal education and income. In the following section (*3 Methodology*), the research methodology is presented; describing the study area, the data collection process and the methods used for the data analysis. The results are found in the fourth section (*4 Results*), which is divided into quantitative results (based on statistical analysis of empirical data) and qualitative results (based on literature review, observations and interviews in the study area). The results chapter shows how different aspects of risk are linked to formal education and other key factors in the study area. An interpretation and discussion of the results is found in the next section (*5 Discussion*). Finally, the conclusions and the study's main contributions to current knowledge are summarised in the last section (*6 Conclusions*).

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[5] *favela*; Portuguese word for 'slum' or squatter settlement
[6] While this is the official number of inhabitants, some claim that the actual number may be more than the double, see also page 18.

2 THEORETICAL FRAMEWORK

2.1 Defining disasters and disaster risk

2.1.1 A general definition of disaster risk

It is generally understood that natural hazards such as floods, landslides and hurricanes do not cause disasters on their own; it is only when they are combined with vulnerable conditions, such as people or systems susceptible to the damaging effects of these hazards, that disasters do occur. Exactly how the concept of risk is defined can be crucial for how risk management or risk reduction is translated into practice (Wamsler 2007b:13).

The United Nations International Strategy for Disaster Reduction (UNISDR 2009:9) defines a **disaster** as:

> *"A serious disruption of the functioning of a community or a society involving widespread human, material, economic or environmental losses and impacts, which exceeds the ability of the affected community or society to cope using its own resources."*

It should be noted that this definition does not explicitly quantify any "minimum level" of loss or impact that is required to classify an extreme event as a disaster[7]. Extreme events that "only" take a few lives or affect a local economy might not cause serious disruption in society, but when recurrent they can have a highly erosive effect on development (Wisner et al. 2003:65). According to a report from Oxfam (2007:10) the average number of deaths per year due to small and medium-scaled climatic disasters has more than doubled during the last decades, outpacing population growth. The report further suggests that while investment in risk reduction has lessened the risk of mega-disasters, it has failed to keep up with the frequency and severity of small ones (Oxfam 2007:11). In view of that, this thesis sees the 'small' disasters as a vital issue, and the term 'disaster' includes in this study both small-scale events and medium and large-scale disasters.

The prevailing definition of **disaster risk**, published by UNISDR in 2004, was recently redefined as *"[t]he potential disaster losses, in lives, health status, livelihoods, assets and services, which could occur to a particular community or a society over some specified future time period"* (UNISDR 2009:9). The new definition is similar to the old[8], but plays down the former focus on the causes of disasters by putting more emphasis on (the possible impacts on) the threatened community or society.

Disasters are commonly seen as the result of an interaction between (natural or man-made) hazards (**H**) and vulnerable conditions (**V**). This is emphasised in UNISDR's definition of **vulnerability** as *"[t]he characteristics and circumstances of a community, system or asset that make it susceptible to the damaging effects of a hazard"*. Vulnerability can arise from a wide range of conditions, as a result of for example physical, social, political, economic or environmental factors (UNISDR 2009:30).

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[7] Such a delimitation is for instance made by the OFDA/CRED International Disaster Database, a worldwide catalogue of disasters, where one or more of the following criteria have to be fulfilled for an extreme event to be entered into the database: (i) *10 or more people reported killed*, (ii) *100 people reported affected*, (iii) *a call for international assistance* or (iv) *declaration of a state of emergency* (EM-DAT 2009).

[8] Former definition of risk: *"The probability of harmful consequences, or expected losses (deaths, injuries, property, livelihoods, economic activity disrupted or environment damaged) resulting from interactions between natural or human-induced hazards and vulnerable conditions."* (UNISDR 2004)

The interrelation between disaster risk, hazards and vulnerability is conventionally expressed in the following pseudo-equation:

$$R = H \cdot V \qquad (2.1)$$

(where **R** stands for risk, **H** for hazard and **V** for vulnerability).

Equation 2.1 is, for instance, the base for the so-called 'Pressure and Release' (PAR) Model presented by Wisner et al. (2003), which is a tool that allows a detailed analysis of the components of risk; hazards and vulnerability. The PAR Model seeks to explain the progression that leads to vulnerability by seeing it as a chain of three stages; 'root causes', 'dynamic pressures' and 'unsafe conditions'. Root causes are the most widespread and general (global) processes in society, such as ideologies and economic and political structures. These produce the dynamic pressures, which are more contemporary or direct conditions, such as deforestation, violent conflict or rapid urbanisation. The dynamic pressures then "translate" the root causes into unsafe conditions where people (on local, community or household level) are prompted to interact with hazards, for example having to live in dangerous locations or engage in unsafe activities to earn a living, being subject to precarious construction standards or lacking proper disaster preparedness (Wisner et al. 2003).

2.1.2 An extended definition of risk

In UNISDR's terminology, a disaster is said to be the result of exposure to hazards (**H**) and vulnerable conditions (**V**) in combination with "insufficient capacity or measures to reduce or cope with potential negative consequences" (UNISDR 2009:9). A growing interest in linking risk with people's capacities to respond to disasters (**C**) made some researchers advocate the introduction of capacity in the risk pseudo-equation, for example expressed as follows:

$$R = H \cdot V/C \qquad (2.2)$$

(where **R** stands for risk, **H** for hazard, **V** for vulnerability and **C** for capacity to respond) (UNISDR 2002), or with a slightly different connotation:

$$R = H \cdot V \cdot LC \qquad (2.3)$$

(where **R** stands for risk, **H** for hazard, **V** for vulnerability and **LC** for lack of capacity to respond) (Wamsler 2007b:19-22). Others, such as Benson and Twigg (2007:114) consider the capacity to already be included in the notion of vulnerability – as its antithesis. Anyhow, it should be noted that the variable **C** is generally only related to people's capacity to respond to disasters, and not to other risk reduction capacities (e.g. people's capacity to address hazards, reduce vulnerability and recover from disasters, or people's capacity to reduce their overall risk). In this thesis, it is preferred to even further separate the notion of risk in different components, so that each one of these components can be linked with the corresponding risk reduction measure (as described in the following section).

2.2 Practices in disaster risk reduction

Disaster risk reduction (DRR) is defined by UNISDR (2009:9) as:

> *"The concept and practice of reducing disaster risks through systematic efforts to analyse and manage the causal factors of disasters, including through reduced exposure to hazards, lessened vulnerability of people and property, wise*

management of land and the environment, and improved preparedness for adverse events."

This allows us to identify several important practices forming part of the disaster risk reduction process, such as risk assessment (analyse the causal factors of disasters), prevention (reduce exposure to hazards), mitigation (lessen vulnerability) and preparedness.

Prevention is defined by the UNISDR (2009:22) to be the "outright avoidance" of hazards, which in practice can be attempted by for instance the construction of dams which eliminate flood risk, or land-use planning which forbids high-risk areas to be inhabited. However, complete avoidance of hazards is often not feasible, and prevention then turns into mitigation (UNISDR 2009:22). With its focus still on the hazard, the notion of prevention can also include measures taken to reduce the expected frequency or intensity of hazards (Wamsler 2007b:91).

Mitigation shifts the focus from avoiding or reducing the hazard to lessening "the adverse *impact* of hazards" (UNISDR 2009:19), which can be achieved by (and is defined by some as) minimising vulnerability to the hazard (e.g. Wamsler 2007b:91). Improved health status is an example of how the vulnerability to the adverse effects of hazard impact can be reduced (Wisner et al. 2003:11). In a climate change context, the word mitigation is often used for the reduction of the greenhouse gas emissions which are known to be the cause of climate change (UNISDR 2009:20). Using disaster vocabulary however, such measures are here better categorised as prevention, as they aim to impede the progression of the hazard.

Preparedness is conventionally related to actions taken in advance that will enable an effective *response*; i.e. to reduce impact and to facilitate that people act suitably during and in the immediate aftermath of a disaster (e.g. UNISDR 2004; Wamsler 2007b:91), for example by making evacuation plans or stockpiling equipment and supplies.

It is important to note that the general view of disaster risk reduction does not mention any actions related to recovery as a part of the risk reduction process.[9] Another limitation to the common view of risk, as represented by Equation 2.1, is that is does not specifically link the components of risk to the appropriate risk reduction measures. The three DRR practices identified above; prevention, mitigation and preparedness, can in fact be directly linked to the extended view of risk reflected in Equation 2.3, expressed as follows:

$$\mathbf{R} = \frac{\mathbf{H}}{\textbf{Prevention}} \cdot \frac{\mathbf{V}}{\textbf{Mitigation}} \cdot \frac{\mathbf{LC}}{\textbf{Preparedness}} \qquad (2.4)$$

(where **R** stands for risk, **H** for hazard, **V** for vulnerability and **LC** for lack of capacity to respond to disasters).

During recent years, it has become clear that for disaster risk reduction to be effective it has to be integrated into development and planning, and there is an increasing number of examples of how (inadequate) development actually can result in an increased risk from natural hazards (Bigio 2002; UNDP 2004; Wamsler 2007b). In her doctorate thesis, Wamsler (2007b) provides a framework for integrating DRR into settlement development programming for the urban poor. In addition to prevention, mitigation and preparedness;

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[9] During the most recent years, it has become accepted by scholars and practitioners to include actions related to recovery in the notion of preparedness. This practice can for instance be seen in UNISDR's up to date definition of preparedness presented in 2009.

two additional measures are identified as important for a holistic disaster risk reduction approach, namely 'risk financing' and 'stand-by for recovery', which she covers under the umbrella term **preparedness for recovery**.

'Stand-by for recovery' are measures to establish appropriate recovery mechanisms and structures which are accessible after a potential disaster, including both rehabilitation and reconstruction (Wamsler 2007b:91). An informal example of this could be having social capital, i.e. residents having a structure for community-based reconstruction should someone's house be damaged by a disaster. 'Risk financing' is a part of stand-by for recovery, and consists of methods to transfer or "share" risks so that households, communities or institutions can receive a "readily available" compensation after a potential disaster impact (both monetary and non-monetary) (Wamsler 2007b:91). A typical example of this is insurance.

Based on these findings, the extended process of DRR; consisting of prevention, mitigation, preparedness for response and preparedness for recovery, is linked by Wamsler (2007b:105) to the extended view of risk in Equation 2.5. It should be noted that the variable **LC**, previously used to represent lack of capacity to respond, is much related to the lack of existing structures or mechanisms to do so (Wamsler 2007b:105). In the following equation Wamsler therefore promotes the connotation **LM**, representing lack of mechanisms to respond and to recover (which also serves to avoid confusion with a person's overall coping capacity, defined further below):

$$\mathbf{R} = \frac{\mathbf{H}}{\textbf{Prevention}} \cdot \frac{\mathbf{V}}{\textbf{Mitigation}} \cdot \frac{\textbf{LM to Respond}}{\textbf{Preparedness for Response}} \cdot \frac{\textbf{LM to Recover}}{\textbf{Preparedness for Recovery}} \qquad (2.5)$$

(where **R** stands for risk, **H** for hazard, **V** for vulnerability and **LM** for lack of mechanisms).

Wamsler (2007b:100) stresses that all measures of DRR, as far as possible, should be built on local patterns of behaviour and existing coping strategies. This includes evaluating which of the local strategies that are effective in reducing risk and supporting and improving these; while scaling down unsustainable practices and, where necessary, offer better alternatives.

Given this, there are two different ways to assist people to cope with or to adapt to changing climate conditions. The first one is focusing directly on reducing specific risk components (with or without the participation of those at risk). The second one is focusing on increasing people's coping capacity, thus enabling them to reduce their level of risk on their own.

Coping capacity is a frequently mentioned concept in this paper, and it is defined by UNISDR (2009:8) as *"[t]he ability of people, organizations and systems, using available skills and resources, to face and manage adverse conditions, emergencies or disasters"*. The skills and resources mentioned in the definition can here be translated into the four available measures of DRR; which would mean that a person's coping capacity is his or her ability to reduce their overall risk using these measures. (The linkage between coping capacity and adaptive capacity is addressed in Section 2.3).

The advantage of the extended view of disaster risk reduction presented above, as opposed to the common view, is that it directly links the different components of risk to the corresponding risk reduction measures. It is also directly linked to the research objectives of this study, which include (1) people's level of risk; (2) their own strategies to cope with

climate-related disasters; and (3) the institutional support they receive. Coping strategies and institutional support can be translated into the DDR measures available to a community, and thus belong under the denominator in the extended risk equation (Equation 2.5). This means that according to the extended view of risk, the last two research objectives are in fact components of the first research objective, i.e. coping strategies and institutional support are part of the factors that determine people's level of risk. Furthermore, the extended risk equation provides a more detailed understanding of risk, which was required to conduct a more systematic and in-depth analysis to identify all the potential aspects that are related to formal education.

2.3 Climate change and adaptation

Climate change is usually defined as a change in climate that can be observed over an extended or comparable period of time, typically decades or longer. Two of the most widespread definitions, by the Inter-governmental Panel on Climate Change (IPCC) and the United Nations Framework Convention on Climate Change (UNFCCC), differ as to the causal processes of climate change. While the definition by the IPCC refers to any change in climate over time, either attributed to natural variability or human activities, the UNFCCC's definition is restricted to a change in climate that is *"attributed directly or indirectly to human activity that alters the composition of the global atmosphere"* (UNISDR 2009:6-7).

According to the IPCC Fourth Assessment Report from 2007, which is considered the most comprehensive and authoritative evaluation to date of the progression of climate change, we will experience some of the following climate alterations (since the case study for this thesis was conducted in Brazil, the listed climate alterations were chosen from a Brazilian and Latin American context):

- ➢ A temperature rise in the range of 0.4°C - 1.8°C by 2020, and 1°C - 7.5°C by 2080.
- ➢ An increased frequency in extreme weather events such as windstorms, tornados, hail, heat waves, heavy rainfall or extreme temperatures ranging from a few hours to several days.
- ➢ An increased frequency in landslides and mudflows in cities due to intense or persistent rainfall, deforestation and lack of land-use planning.
- ➢ High impacts from sea-level rise on people, infrastructure and economic activities. Many of the major Latin American cities are port cities founded during the colonial times, which has resulted in a high concentration of civilisation in coastal areas.
- ➢ Reduction of lands suitable for growing coffee in Brazil, in combination with increased incidence of crop pests such as the coffee leaf miner (*Perileucoptera coffeella*).
- ➢ Desertification and salinisation of 50 percent of agricultural land in Latin America and the Caribbean zone by 2050, and shortage of water for irrigation.
- ➢ Shortage of freshwater and high groundwater pollution in cities.
- ➢ Increased morbidity and mortality from heat waves, floods and droughts.
- ➢ An increased incidence of malaria, dengue, cholera and other water- or vector-borne diseases.

(IPCC 2007:593-601)

Adaptation [to climate change] is defined by the UNISDR (2009:4) as *"[t]he adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities"*. Adaptation to climate variability has always been necessary for humans, but the intensity and the pace of the ongoing climate changes are predicted to create unparalleled challenges (Bigio 2002:94).

While **adaptive capacity** is not defined by the UNISDR, a definition can be found in the introduction to the IPCC Fourth Assessment Report: *"Adaptive capacity is the ability of a system to adjust to climate change (including climate variability and extremes) to moderate potential damages, to take advantage of opportunities, or to cope with the consequences."* (IPCC 2007:21)

What is then the difference between adaptive capacity and coping capacity? One noticeable difference in the definitions is that coping capacity refers to dealing with "adverse conditions, emergencies and disasters" whereas adaptive capacity equals dealing with a changing climate, of which emergencies and disasters are only one ingredient. Moreover, the definitions imply that coping capacity is used to face *ongoing* adversities, while adaptive capacity is used to cope at the present *as well as* making (permanent) changes to reduce damages in the future. This suggests that coping capacity is a subset of adaptive capacity, both time-wise and content-wise.

Another difference is the implication found in the definition of adaptive capacity that although climate change will cause much damage, there is also a possibility to "take advantage of opportunities" and use it to one's advantage (this will typically be done by the best adapted). An example of this could be to grow crops that were less suitable during the previous climate conditions, or to use climate change as grounds to address other topics, such as poverty or women's empowerment, with new arguments.

However, using the extended definition of risk described above, it can be assumed that people's adaptive capacity and coping capacity are determined by the same attributes or factors. The two terms will therefore be used interchangeably in this study.

2.4 Income and its influence on people's level of risk

Income is commonly seen as one of the main factors to people's capacity to protect themselves from potential disaster impact (e.g. Cutter, Boruff & Shirley 2003:246; Wisner et al. 2003:12; Lindell & Perry 2004:90; Kahn 2005:277; Toya & Skidmore 2005:21; Blankespoor et al. 2010:5). It is argued that people who have resources (e.g. wealth, assets, insurance) are more likely to succeed in safeguarding their lives, property and livelihoods as well as make a swifter recovery after disasters, although their economic losses in disasters are often of greater magnitude in absolute numbers (Wisner et al. 2003:93). There are different ways in which wealth and other resources have been identified to influence people's interaction with hazards and hazard impact, both on an individual level and a community and national level. Wisner et al. (2003:12) make, for instance, the following points:

1. People with resources are more likely to be able to choose where to live, and can thus choose not to live in a hazardous environment (cf. **prevention**). The poor however, especially in cities, are often driven to reside in dangerous locations due to their inability to pay rent elsewhere; and in order to make a living. Wisner et al. (2003:13) argue that if residing in a hillside 'slum' will lead to economic opportunities, people will choose to live there almost regardless of the disaster risk.
2. A person with resources living in a place which is exposed to hazard can invest in design and engineering that minimise (albeit do not eliminate) their vulnerability to the hazard (cf. **mitigation**).
3. Should a person with resources (income, savings, insurance, credits) be impacted by a disaster, the outcome is less severe than for the surviving poor. Their homes and possessions are more likely to be insured or can be replaced or reconstructed using

savings and credits, they can more easily find alternative shelter and continue with income-earning activities after the hazard impact (cf. **preparedness for recovery**). The poor, however, often use their homes for livelihood activities and might not be considered creditworthy by banks – resulting in that they are likely to have their entire stock of capital assembled at the site of the disaster (Wisner et al. 2003:13).

Yet another issue is mobility, as pointed out by Lindell and Perry (2004:90). They argue that a low income decreases the likelihood of having a personal vehicle and could also be related to residing in an area of limited access or mobility, both of which could be factors decreasing the possibilities of evacuation (cf. **preparedness for response**). Lack of mobility is also a factor to why people choose to live in 'slums' close to the city centre (Wisner et al. 2003:13).

On a national level, research indicates that economic growth has the potential to reduce disaster risk for citizens, both due to an increased ability to self-protect (consistent with the points mentioned above), and due to improved structures and mechanisms for DRR offered by the state. Kahn (2005:277) hypothesises that richer governments provide "implicit disaster insurance" through effective regulation and planning (cf. **prevention**) and by providing quality infrastructure (cf. **mitigation**). In the same study, richer nations are also considered more likely to have high-quality medical care and suitable crisis management to put in use after the disaster has struck (cf. **preparedness for response and recovery**). Combining statistics from the OFDA/CRED International Disaster Database with macroeconomic data from 73 different nations, Kahn (2005) shows that countries with a higher gross domestic product (GDP) per capita suffer less death from disasters. In a similar study which includes a larger number of countries and new measures of socioeconomic development, Toya and Skidmore (2005) further demonstrate that both a higher GDP/capita and a strong financial sector result in less disaster related deaths and economic damages/GDP. In this context, it should be noted that GDP per capita can sometimes be misleading as an indicator of vulnerability. If the distribution of wealth is very uneven, a country with a relatively high GDP can still contain very poor groups who are vulnerable to hazard exposure (Adger et al. 2004:73).

2.5   Formal education and its influence on people's level of risk

2.5.1   Defining formal education

All human societies have developed systems to educate and prepare their young people for adult life, these systems varying in terms of methods, content and duration (ERC 2009:15). Formal education is characterized by La Belle (in Mazza 2007:2) as the "purposive and structural learning leading to recognised certificates and diplomas" and differs from *non-formal education* (i.e. "any educational activity taking place outside the formal system") and *informal education* (i.e. "the unplanned learning that goes on in daily life"). Although learning experiences are often a result of interaction between these three forms of education (La Belle 1982 in Mazza 2007:2), the standardisation and certification specific to formal education allows it to be more easily measured and compared.

In this paper, formal education is considered to consist of studies at primary, secondary and university levels. The study's focus on formal education does not imply that other forms of education or training are discarded as important factors to the capacity to cope with disasters, but is rather a pragmatic measure to delimit the research (cf. ERC 2009:15). It is also important to note that indigenous knowledge of the environment is considered

increasingly valuable (e.g. in Adger et al. 2004:75; IPCC 2007:142) and should not be seen as adversary to new and scientific methods. Indeed, the two fields of knowledge can rather be mutually beneficial.

2.5.2 Formal education as a factor to coping and adaptive capacities

Although education is quite frequently mentioned in disaster risk literature, it is generally not considered to be a key factor to people's level of risk or their capacity to cope with disasters. For example, a higher level of education is often linked to a higher socioeconomic status and more lifetime earnings (e.g. Cutter, Boruff & Shirley 2003:248), and education can thus be seen to reduce disaster risk through the link between income and risk established in the previous section. Another example is the 'Sustainable Livelihoods (SL) approach'[10], in which education is seen, together with health, as the 'human capital' that people use to obtain a livelihood, thus contributing to their capacity to cope with stress and shocks (such as disasters) (Wisner et al. 2003:96). In recent studies, however, the question is raised as to whether formal education might in fact be one of the *key* factors in determining the coping or adaptive capacities of a population (Adger 2004; Toya & Skidmore 2005; Blankespoor et al. 2010). Three of these studies, which are recited below, combine data from the OFDA/CRED International Disaster Database with different indicators of education, and demonstrate how (formal) education is negatively correlated with deaths or other forms of loss from disasters, independent of income.

In '*New Indicators of Vulnerability and Adaptive Capacity*', Adger et al. (2004:101) conclude that education exhibits "a strong [negative] relationship with mortality from climate related disasters". Among the education proxies, the strongest indicator is the literacy rate among citizens aged 15-24, followed by the literacy rate among all citizens over 15, and the female to male literacy ratio (Adger et al. 2004:92).

Toya and Skidmore (2005:23-24) use data on the total years of schooling attainment for the population aged 15 or over in '*Economic Development and the Impact of Natural Disasters*', and are able to demonstrate that countries with a higher number of years of schooling suffer less disaster related deaths as well as damages/GDP. The correlation is particularly strong for developing countries, for which the level of formal education proves more significant to disaster losses than e.g. level of income.

In '*The Economics of Adaption to Extreme Weather Events in Developing Countries*', where the female educational enrolment rate is used as an indicator, Blankespoor et al. (2010) establish that countries which invest in female education suffer less disaster related deaths.

Summarised, these reports are a strong indicator that formal education, as well as gender equality in education, seem to play a more important role in determining people's level of risk than what has been previously considered. Some of the aspects in which education can be related to disaster risk are listed below:

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[10] The SL approach is a model, promoted by for instance the UK foreign aid ministry, that seeks to explain how people obtain a livelihood by drawing on five types of 'capital': *human capital* (skills, education, health), *social capital* (networks, groups, institutions), *physical capital* (infrastructure, technology, equipment), *financial capital* (savings, credit) and *natural capital* (natural resources, land, water). A livelihood is considered sustainable when it can "cope and recover from stress and shocks" (Wisner et al. 2003:94-95).

1. **Literacy**. As pointed out by Adger et al. (2004:75), literacy plays an important role in determining access to information about the urgency of adaption to climate change and the assistance that will be offered by governments.
2. **Understanding of risks**. According to Adger et al. (2004:75), formal education is the basis for a "scientific" understanding of the world and provides a foundation for understanding the complex nature of hazards and how to respond to them. In addition, Toya and Skidmore (2005:22) argue that citizens with higher education are able to make better choices regarding safe construction practices and location decisions. Several studies suggest that low educational attainment also make people generally less likely to understand or respond to warnings (Cutter, Boruff & Shirley 2003:248) and/or obey evacuation instructions (Lindell & Perry 2004:90).
3. **Social power**. Education is said to be a fundamental determinant of poverty and marginalisation (e.g. Adger 2004:75; UNDP 2004:33). With basic literary and numeric skills, it is argued that people have more means to become engaged in their society and be a part of decision-making processes (UNDP 2004:33). Adger (2004:75) also points out that people with low levels of education are less likely to have a political vote and their welfare is therefore often of low priority for governments.
4. **Equality**. Educating girls and women, thus promoting the empowerment of women, has been found to be one of the major determinants, if not *the* major determinant, of sustainable development (Blankespoor et al. 2010:17). Educated women tend, for instance, to have less children (e.g. Busso 2002:25), and a smaller number of dependents in turn make families less vulnerable to hazardous impact (Cutter, Boruff & Shirley 2003:248).
5. **Income**. As stated in the beginning of this chapter, education is generally considered to lead to better and more diverse livelihood opportunities (e.g. Cutter, Boruff & Shirley 2003:248; Adger et al. 2004:75; UN-HABITAT 2010:52), thus reducing people's disaster risk as indicated in Section 2.4.

On a national and international level, different researchers further argue that a higher educational attainment will be a key asset for finding new solutions for how to tackle the adverse effects of climate change (e.g. UNDP 2004; ERC 2009). According to the UNDP (2004), a more educated population (including girls and women) will be better able to partner with experts in designing ways of protecting urban neighbourhoods and rural communities.

3 METHODOLOGY

3.1 The study area

The case study conducted in the context of this thesis concentrates on two low-income areas, namely **Cachopa** and **Laboriaux**, which are located in the Brazilian favela Rocinha (for a map of Rocinha, see Figure 3.1 and Figure 3.2; for detailed maps of the study areas, see page 50). Rocinha is one of Latin America's largest informal settlements, located on a hillside in the midst of Rio de Janeiro's prosperous south zone. Interviews and observations indicate that the most common natural hazards in Rocinha are floods (mainly in the low parts) and landslides (mainly in the high parts). Falling trees, or rocks from the overhang mountain walls, also form an imminent threat to people and their residences.

Its central location and the proximity to wealthy areas like Ipanema, Leblon and São Conrado where the tourism, commerce and service sectors offer plenty of job opportunities makes Rocinha a much-favoured place to live. According to interviews, Rocinha is often called "a city within the city" because of the wide range of services available – there are supermarkets, banks, gyms, churches, schools and restaurants. Some people do not consider it to be a favela anymore, and in 1993 it was acknowledged as a *bairro* by the Prefeitura of Rio de Janeiro, that is, an officially recognised district. Observations however yield that Rocinha still contains many elements of a so-called 'slum'; such as informal construction processes, sub-standard housing, difficult access, frequent disruptions in water and electricity, poor sanitation and poverty. Another predicament is its state of occupation by the drug trafficking movement, with armed traffickers[11] patrolling the streets and recurrent shoot-outs between state forces and gang members (e.g. Sneed 2003:74).

The number of inhabitants of Rocinha is much-disputed; in 2000, it was estimated to be around 56.000 by the Brazilian Institute of Geography and Statistics (IBGE), a number that was recently found to have increased to about 100.000 inhabitants (O Dia Online 2009; Censo Domiciliar 2010). However, it is believed that Rocinha still contains individuals who have never been counted or registered, and there exist unofficial estimates in which the number of inhabitants exceeds 300.000. Rocinha consists to a large part of first and second generation migrants from the poorer North and North-East regions, with an extensive migration taking place from rural Brazil to Rio de Janeiro.

The study area **Laboriaux** is situated on the crest of the hill, surrounded by the National Forest of Tijuca. It has motor vehicle access from Estrada da Gávea, the road that allows cars and buses to pass through Rocinha, but is more green and secluded (some would say neglected) than the busy, all-paved Cachopa. According to interviews, Laboriaux has always been known to present a certain degree of landslide risk, but this had not caused much notice until April 2010 when heavy rains led to the collapse of a whole row of houses during which two women lost their lives. As a reaction, the mayor of Rio de Janeiro decided that the landslide risk in Laboriaux was **too high**, and that the area should be removed and the residents relocated. Laboriaux was chosen for the study to represent higher risk.

The study area **Cachopa** is situated half-way up the hillside and is accessed through staircases or a steep ramp leading up from Estrada da Gávea. Cachopa is relatively spared from both landslides and severe floods; however interviews yield that lighter floods where wastewater enter people's houses are not unusual during continuous rain. Cachopa was chosen for the study to represent lower risk.

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[11] drug traffickers; in Portuguese these are often referred to as *bandidos* or *traficantes*

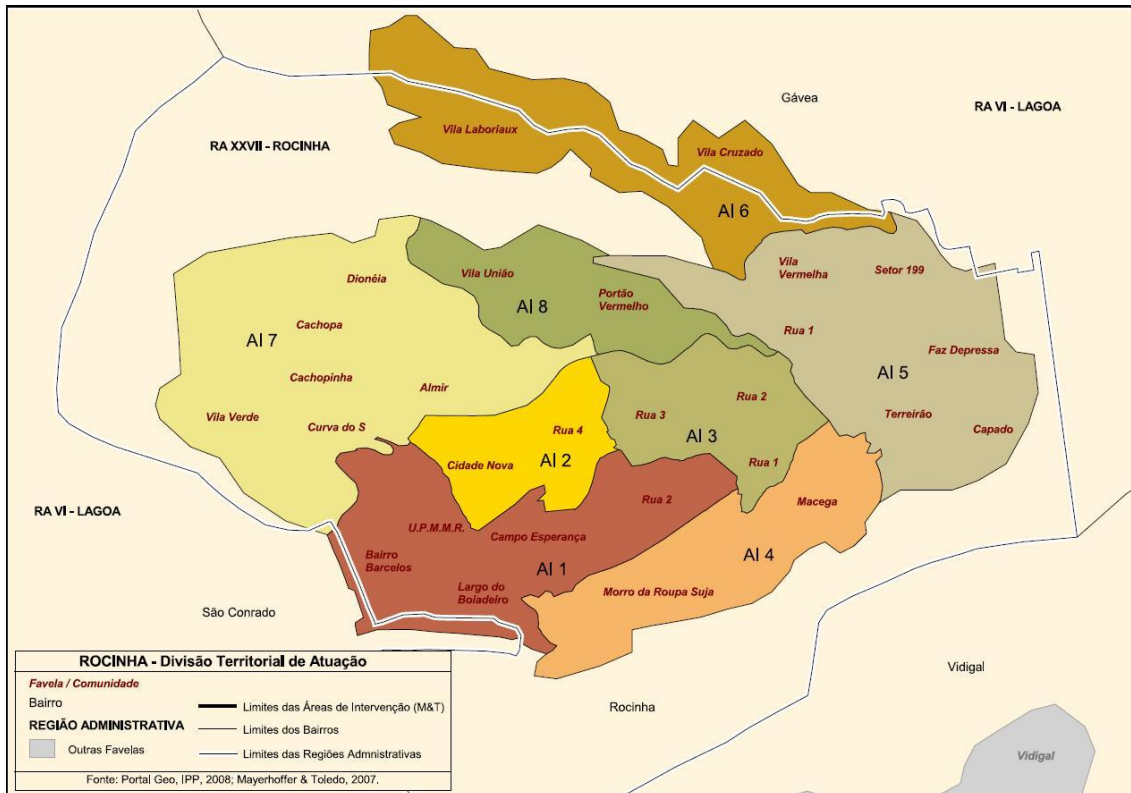*Figure 3.1 Rocinha (Division into "intervention areas" by PAC 2009)*

Figure 3.2 Rocinha (Google Earth: Satellite photo from 2009)

3.2 Data collection

A large amount of literature was reviewed for the theoretical framework, as well as to acquire necessary background knowledge on various subjects such as climate change and cities, social vulnerability, informal settlements, the organised drugs and arms trade, etc. While most of the information was found on the internet, preference was given to academic literature but also included practical guidelines for disaster management.

To collect the numerical data for the study, 94 interviews[12] were made with households from Laboriaux and Cachopa in the informal settlement Rocinha. The participants were approached in the street or in their houses at different hours of the day and all days of the week, and were then asked to partake in the study[13]. The interviews were not limited to heads of households, but people of different age, gender and family status were allowed to provide the requested details about their household. Counting all family members of the interviewed households, the total number of individuals covered by this survey is 325, of whom 212 are 18 years or older.

Of the 94 households in the study, 42 households reported themselves to be at risk. Using the authorities' evaluation, the 49 households located in the area of Laboriaux are considered at high risk. Only 29 households are identified to be at risk by both measures.

Supplementary interviews were made with key informants, such as community leaders and people working with development or DRR in the study area. These interviews served mainly as an additional information source in order to triangulate the information from other sources, and also for discussing issues arising from the interviews with the residents. Both sets of interviews were constructed in line with questionnaires used in the context of the project "Forecasting Societies' Adaptive Capacities to Climate Change" (Wamsler 2010). These were adapted to local conditions in Rocinha and translated to Portuguese (see Appendix A.2).

Additional information was gathered through observations whilst living and working as a volunteer in Rocinha for a period of 5 months during 2010.

3.3 Data analysis

The statistical analysis of the data was done using the statistical software PASW Statistics 18. After the raw data had been grouped as defined below, so called cross-tabulations were conducted between different attributes and their statistical significance was tested using χ^2 (Chi square) tests. A cross-tabulation is a joint frequency distribution based on two (or more) categorical variables. Also known as contingency table analysis, this method of displaying distributions of cases on two or more variables is a commonly used tool for conducting pair-wise comparison. A χ^2-test is then applied to the joint frequency distributions to determine if the variables are statistically correlated (Michael 2001). The method was chosen with the objective of exploring the individual correlations between the specified attributes (including the different evaluations of disaster risk), as opposed to for instance trying to appreciate the risk based on a combination of these attributes. To clarify the relationships found through contingency table analysis, more advanced techniques such as log-linear models or regressions can be used (Michael 2001).

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[12] Each one of these interviews lasted ca 10-30 minutes.

[13] A preferred method would have been to randomly select houses to interview from a map. However, since the drug gangs in the area are not in favour of streets being named and maps of Rocinha being printed, as they think it will facilitate police invasions, it was considered both difficult and unsafe to pursue this method for selecting interviewees.

Based on the research objectives presented in section 1.2, the attributes to be analysed were chosen to people's:

[1] level of formal education
[2] level of income
[3] level of risk
[4] level of impact from past disasters
[5] strategies used to cope with risk/disasters
[6] the institutional help received
[7] other possible key factors or attributes

A short description follows as to how the listed attributes were measured and grouped.

3.3.1 Level of formal education

The majority of the tests were conducted at household level. Since the raw data contained the level of education (in years of schooling) for all the household members, it had to be transformed into variables that described the educational attainment of the household as a whole. These variables were chosen to (a) the educational level of the head of household ('HH'); (b) the mean educational level of the heads of household including all working household members ('Mean'); and (c) the educational level of the highest educated person ('Highest').

This data was then divided into the following classes depending on the number of years of schooling: 'Illiterate', '0-3 years', '4-7 years', '8-10 years', '11 years or more'. These classes were chosen based on the Brazilian educational system[14] (where year 0-4 and 5-8 represent primary school and year 9-11 secondary school) and so that completing a "level" (year 4, 8 or 11) leads to a shift to the next 'class'. Within the group of people who had never attended school, it was considered interesting to differentiate between those who were literate and those who were not. The people who had studied at university level were so few that they were grouped with those who had finished secondary school.

3.3.2 Level of income

The household income levels were represented by a) monthly income level of the head of household and b) total monthly household income level. For both a and b, the households were divided into one 'low-income' and one 'high-income' group, using the median of each category as a classifier in order to achieve groups of similar size. The medians were calculated to 740 BRL (ca 430 USD) for head of household's income and 1140 BRL (ca 660 USD) for the total income. (The minimum salary in Brazil is 510 BRL per month.)

3.3.3 Level of risk

Two different ways to measure the level of risk has been used, the residents' own evaluation (answers to interview questions 3.1 and 3.2), and the classification imposed by the authorities via the decision that one of the research areas (Laboriaux) were to be removed due to the high risk (accordingly, Laboriaux is classified as the 'high-risk' area, and Cachopa as the 'low-risk' area). These measures will be referred to as 'the residents' own evaluation of risk' and 'risk per area'.

3.3.4 The level of impact from past disasters

The households were asked to evaluate how they had been impacted by past disasters, where 0 represent 'No impact, 1 is 'A little' and 2 is 'A lot'.

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[14] This system was actually most recently changed to include another year at the beginning, which now makes the Brazilian primary education 9 years long.

3.3.5 Strategies used to cope with risk/disasters

Here, each interviewee was asked to mention three risk-reducing strategies being used in their household. These were later classified as 'effective', 'half effective' or 'ineffective' (see Table A.2) and given points thereafter, the sum of which is referred to as 'The number of strategies'. In the same category, a variable called 'Risk reduction measures taken' was created to characterise whether or not the household (knowingly) had any strategies at all.

3.3.6 Institutional help received

Households were asked if they had received institutional help; 0 for 'No' and a 1 for 'Yes'.

3.3.7 Risk awareness

As a measure of the residents' ability to identify risks, each interviewee was encouraged to mention three risks (not limited to disaster-related risks or risks that they specifically run themselves). The result is referred to as 'The number of risks mentioned'. In the same category, a variable called 'Ability to point out any risks' was created to represent whether or not the interviewee could point out any risks at all.

3.3.8 Division into focus group and control group

Since the data contains two different measures of risk; the residents' own evaluation of risk and risk per area, there are several ways to divide the households into a focus group and a control group. Therefore, in the analysis each potential correlation was tested using the following groupings of the households:

1. **Grouping according to area**
   Focus group: **High-risk area, Laboriaux** (49 households)
   Control group: **Low-risk area, Cachopa** (45 households)
2. **Grouping according to residents' own evaluation of risk**
   Focus group: **Households stating to be at risk** (42 households)
   (Households reporting on "Some risk", "High risk" and/or "More risk than others")
   Control group: **Households stating *not* to be at** risk (52 households)
   (Households reporting on "No risk" and "Less risk than others")
3. **No grouping: All the data** (94 households)

3.4 Qualitative analysis

The study also included a qualitative analysis of the interplay between the different attributes specified in the research objectives. Information obtained through literature review and interviews and observations in the study area was analysed using the extended view of risk and risk reduction presented in the theoretical framework (represented by Equation 2.5).

3.5 Research limitations

The research has some considerable limitations as regards the quantitative results, mainly due to the insecurities in the method chosen for statistical analysis and the relatively small number of samples. It would have been desirable to support the collected data with existing censes or surveys from the study area, but bureaucracy and time limits hindered the access to such data. Inconsistencies or biases in the interviews may also have contributed to a higher uncertainty in the results. Examples may include missing data (people refusing to answer or not knowing the answer to questions), misunderstandings due to language barriers (mainly in the beginning of the study), and people giving false information (such as not wanting to admit that their children do not attend school, not giving their full salary because of suspicion, denying having received institutional help hoping to get more help or not admitting to being at risk because they do not want to be relocated).

4 RESULTS

This chapter will outline the research results. It is divided into two parts; (a) quantitative results based on statistical analysis on the data; and (b) qualitative results obtained from analysis of interviews, observations and literature review.

4.1 Quantitative results

4.1.1 Summary of quantitative results

In the quantitative analysis, cross-tabulations and χ^2-tests are used to test the relationships between different variables based on the data gathered in the study area.

The most significant result of the quantitative analysis (with an adjusted error rate of $p < 0.0104$) is the correlation between the educational level of the interviewee and his or her ability to mention any types of risks in the settlement. Interviewees with low education were more likely to see their surroundings as risk-free than those with high education. In the same category, it was also found (with an adjusted error rate of $p < 0.16$) that interviewees with higher education were able to point out a higher number of risks in the settlement.

Another result indicates (with an adjusted error rate of $p < 0.16$) that a higher educational level leads to a higher income level only for women in the collected data.

A large number of tests combined with relatively few data contribute to a considerable insecurity in the remaining results. Section 4.1.7 explains how the significance level of each test has to be adjusted when conducting multiple tests; and whereas the results in the sections that follow are individually statistically significant at 5%, most of them cannot be considered as valid at the adjusted significance level. (Note that in this chapter, the *unadjusted* error rate will be given if not otherwise specified.)

The table below show the quantitative results with the lowest error rate (i.e. the most probable results). Allowing a 16% error rate at the adjusted level, the line indicates which results are considered significant.

Table 4.1 Summary of statistical analysis, most significant results

SUMMARY OF RESULTS

The statistical analysis indicate the following correlations as most probable:
- The educational level of the interviewee and being able to point out risks in the settlement ($p < 0.00013$, adjusted $p < 0.0104$)   - The educational level of the interviewee and the number of risks they were able to point out in the settlement ($p < 0.003$, adjusted $p < 0.16$)   - The individual educational level and individual income level for females ($p < 0.003$, adjusted $p < 0.16$)   ---   - The income level of head of household and the degree of impact from past disasters ($p < 0.004$, adjusted $p < 0.32$)   - The educational level of the highest educated person in the household and the total household income ($p < 0.004$, adjusted $p < 0.32$)   - The mean educational level in the household and living in a declared area of risk ($p < 0.005$, adjusted $p < 0.4$)   - Reporting to be at risk and having received institutional help ($p < 0.005$, adjusted $p < 0.4$)

4.1.2 Average levels of education and income

Examining the average number of years of schooling among the focus and control groups, we see a tendency of lower levels of education and income among the households identified as being at risk; both those in the high-risk area Laboriaux and those reporting to be at risk in both areas (see **Fel! Hittar inte referenskälla.**). An exception, as seen below, is the level of education of the highest educated person in the family, which is on average around 9 years in all groups.

When conducting t-tests to statistically compare the means, none of the differences are however statistically significant at the 5%-level.

Table 4.2 Mean and standard deviation for education and income levels in focus and control groups

			Head of Household's Education (Yrs)	Mean Education of HHs and Working Members (Yrs)	The Highest Level of Education in Family (Yrs)	Head of Household's Income (BRL)	Total Household Income (BRL)	Household Income per Person (BRL)
Area	Laboriaux (high-risk)	Mean	5,6	6,5	9,1	818	1258	442
		StdDev	3,7	2,8	2,6	781	972	342
	Cachopa (low-risk)	Mean	7,0	7,1	9,0	801	1478	568
		StdDev	3,4	2,9	3,3	527	874	399
Risk group	Risk	Mean	6,0	6,5	9,0	727	1191	476
		StdDev	3,6	3,0	3,0	536	883	455
	No Risk	Mean	6,4	7,0	9,0	876	1504	525
		StdDev	3,9	2,9	3,0	756	948	296

4.1.3 Relation between education and income

It was considered of interest to establish if higher education actually led to increased income for the people in the study area (and thus to lower risk). A series of cross-tabulations and χ^2-tests were therefore conducted to examine the relation between the education and income levels for the households in the study.

A positive correlation was found between the highest level of education in the households and the total household income. This relation proved significant in the focus group consisting of residents from the high-risk area Laboriaux ($\chi^2(3, n = 46) = 10.292, p < 0.016$), in the control group based on the residents' own evaluation of risk (households stating *not at risk*) ($\chi^2(4, n = 48) = 13.594, p < 0.009$) and in the analysis made on the total number of households ($\chi^2(4, n = 88) = 15.443, p < 0.004$). (See Table A.3.1 – A.3.2 in Appendix)

The above mentioned tests were conducted on household level, which is the basis for all the statistical analysis in this thesis. The relationship between education and income, however, could also be relevant to investigate on an individual level. Therefore, a separate dataset[15] was constructed from all the members of the households above 18 years of age and their

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[15] The alternative dataset consists of 211 individuals, 92 from Cachopa (of which 42 are male and 50 female) and 119 from Laboriaux (62 male and 57 female).

individual educational and income levels. Cross-tabulations and χ^2-tests on this dataset show a statistically significant relation where a higher education leads to a higher income ($\chi^2(4, n = 187) = 14.020$, $p < 0.007$). Interestingly, when separating the sample according to gender the correlation only proved significant for female household members ($\chi^2(4, n = 93) = 16.691$, $p < 0.002$). (See Table A.3.3 in Appendix)

Table 4.3 Correlations between education and income (before Bonferroni type adjustment)

SUMMARY: EDUCATION-INCOME

Correlations between the following attributes were found significant at the 5%-level:

Among the total number of individuals over 18 years of age
- The individual educational level and the individual income level

Among the total number of female individuals over 18 years of age
- The individual educational level and the individual income level

Among the total number of households
- The educational level of the highest educated person in the household and the total household income

Among households in the high-risk area Laboriaux
- The educational level of the highest educated person in the household and the total household income

Among households reporting *not* to be at risk
- The educational level of the highest educated person in the household and the total household income

No relations, however, were found between the following attributes:
- The educational level of head of household and the income level of head of household
- The educational level of head of household and the total income level
- Mean educational level and the total income level

4.1.4 Factors influencing people's level of risk

To investigate how formal education might influence the level of risk, a new series of cross-tabulations and χ^2-tests were conducted using the area-based risk evaluation and the residents' own risk evaluation, respectively, as indicators of risk.

A correlation between a lower mean household education and living in the high-risk area Laboriaux proved significant among the households stating *not* to be at risk (control group – risk based analysis) ($\chi^2(4, n = 49) = 11.473$, $p < 0.022$) and, with a stronger significance, for the total number of households ($\chi^2(4, n = 90) = 14.659$, $p < 0.005$). (See Table A.3.4 in Appendix)

To further investigate the factors that influence people's risk, education and income levels were tested against the households' impact levels from past disasters in the study area. For the people living in the low-risk area Cachopa (control group – area based analysis), head of household's education was found to have a significant relation to the impact from past disasters, where low-educated households were more likely to have been affected by disasters ($\chi^2(8, n = 45) = 21.108$, $p < 0.007$). It should be noted that some of these families did not reside in Cachopa at the time of the impact, as in the case of two households severely affected by floods while living in Valão, in the low part of Rocinha. (See Table A.3.5 in Appendix)

For the residents of the high-risk area Laboriaux (focus group – area based analysis) on the other hand, the results indicate that the impact from past disasters can be related to head of household's income ($\chi^2(2, n = 49) = 7.171$, $p < 0.028$), where low-income households were more likely to have been affected by disasters. Among the households reporting to be at risk from disasters (focus group – risk based analysis), head of household's income was analogously found to be negatively correlated to the impact from past disasters ($\chi^2(8, n = 40) = 10.838$, $p < 0.004$). (See Table A.3.6 – A.3.7 in Appendix)

Table 4.4 Factors found to influence people's level of risk (before Bonferroni type adjustment)

SUMMARY: RISK

Correlations between the following attributes were found significant at the 5%-level:

Among the total number of households
- The mean educational level in the household and living in a declared area of risk

Among households in the high-risk area Laboriaux
- The income level of head of household and the degree of impact from past disasters

Among households in the low-risk area Cachopa
- The educational level of head of household and the degree of impact from past disasters

Among households reporting to be at risk
- The income level of head of household and the degree of impact from past disasters

Among households reporting *not* to be at risk
- The mean educational level and living in a declared area of risk

No relations, however, were found between the following attributes

- The educational level of head of household and reporting to be at risk or living in declared area of risk
- The income level of head of household and reporting to be at risk or living in declared area of risk
- The total income level and reporting to be at risk or living in declared area of risk
- The mean educational level and the degree of impact from past disasters
- The educational level of the highest educated person and the degree of impact from past disasters
- The total income level and the degree of impact from past disasters

4.1.5 Factors influencing people's coping strategies

The coping strategies used by the interviewed households are shown in Table A.2 on page 55. Effective strategies, according to the recommendations of the Brazilian Civil Defence (Secretária Nacional de Defesa Civil n.d.), include keeping the slopes and the area around the house free from litter, planting[16] or avoiding to cut down trees or plants, channelling water that falls on the roof or runs over the plot, and having plans for evacuation. Continuous maintenance of the house, in particular being observant of potential water leaks, is also recommended by the Civil Defence (the importance of this is described in the example on page 38). Another commonly mentioned coping strategy was investments in or improvements of the house, the effectiveness of which depends of the nature of the reconstruction (inadequate "improvements" might actually contribute to a higher risk, cf. Wamsler 2007a:117).

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[16] The recommendations from the Civil Defence include examples of plants and trees which contribute to stability (e.g. guava, orange, lemon, jasmine, roses and mint) of those less suitable (e.g. mango, banana, coco and other large trees) (Secretária Nacional de Defesa Civil n.d.).

To examine how the level of education may affect the coping capacity in the study area, a series of cross-tabulations were conducted. As a first step the different measures of education, including the level of education of the interviewee, were tested against whether or not households had taken measures to reduce risks, and the number of different (effective[17]) risk-reducing strategies that the households reported on using.

A relationship was found between the highest education and the number of (effective) strategies, where the higher the education of the most educated person in the household, the more likely was the use of multiple strategies to reduce risks. This proved significant for the residents of the high-risk area Laboriaux (focus group – area based analysis) ($\chi^2(9, n = 49) = 19.577$, $p < 0.021$) as well as for the total number of households ($\chi^2(12, n = 93) = 23.719$, $p < 0.022$). (See Table A.3.8 in Appendix)

In a similar way, income levels were tested against whether or not measures had been taken to reduce risks, and the number of (effective) strategies used, respectively. Here, head of household's income was found to positively influence the number of strategies used for the residents of the low-risk area Cachopa (control group – area based analysis) ($\chi^2(3, n = 41) = 10.301$, $p < 0.016$), for all the households stating *not* to be at risk (control group – risk based analysis) ($\chi^2(3, n = 50) = 9.894$, $p < 0.019$) and for the total number of households ($\chi^2(3, n = 90) = 10.567$, $p < 0.014$). (See Table A.3.9 – A.3.10 in Appendix)

As an evaluation of the risk awareness for the people in the study, each interviewee was encouraged to mention three risks or threats associated with living in Rocinha (not limited to disaster/climate-related risks, or risks that they specifically run themselves). The result was tested against their education. A positive correlation was found between the level of education of the interviewee and number of risks that they mentioned, suggesting that the interviewees with higher education were able to point out more risks than those with lower education. This relationship proved significant in both control groups – among the households reporting *not* to be at risk (control group – risk based analysis) ($\chi^2(16, n = 52) = 30.283$, $p < 0.017$) and in the low-risk area Cachopa (control group – area based analysis) ($\chi^2(16, n = 45) = 35.801$, $p < 0.003$) – as well as in the analysis on the total number of households ($\chi^2(16, n = 94) = 36.271$, $p < 0.003$). (See Table A.3.11 – A.3.12 in Appendix)

An even stronger positive relationship seems to exist between the level of education of the interviewee and his or her ability to mention any risks at all. This suggests that people with lower education are more likely to see their surroundings as risk-free than those with higher education. The relation was found to be significant in the low-risk area Cachopa (control group – area based analysis) ($\chi^2(4, n = 45) = 16.875$, $p < 0.002$ and highly significant for the households reporting *not* to be at risk (control group – risk based analysis) ($\chi^2(4, n = 52) = 23.043$, $p < 0.00013$) and the total number of households ($\chi^2(4, n = 94) = 23.004$, $p < 0.00013$). (See Table A.3.13 – A.3.14 in Appendix)

Table 4.5 Factors found to influence people's coping strategies (before Bonferroni type adjustment)

SUMMARY: COPING STRATEGIES

Correlations between the following attributes were found significant at the 5%-level:

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[17] The strategies were simply classified as non-effective, half-effective and effective (see Table A.2).

Among the total number of households
- The educational level of the highest educated person in the household and the number of (effective) coping strategies used by the household
- The income level of head of household and the number of (effective) coping strategies used by the household
- The educational level of the interviewee and the number of risks they were able to point out
- The educational level of the interviewee and the ability to point out any risks at all

Among households in the high-risk area Laboriaux
- The educational level of the highest educated person in the household and the number of (effective) coping strategies being used

Among households in the low-risk area Cachopa
- The income level of head of household and the number of (effective) coping strategies being used by the household
- The educational level of the interviewee and the number of risks they were able to point out
- The educational level of the interviewee and the ability to point out any risks at all

Among households reporting *not* to be at risk
- The income level of head of household and the number of (effective) coping strategies being used by the household
- The educational level of the interviewee and the number of risks they were able to point out
- The educational level of the interviewee and the ability to point out any risks at all

No relations, however, were found between the following attributes
- Educational levels and if or if not measures were taken to reduce risks
- The educational level of head of household the number of (effective) coping strategies being used by the household
- The mean educational level and the number of (effective) coping strategies being used by the household
- The educational level of the interviewee and the number of (effective) coping strategies being used by the household
- Income levels and if or if not measures were taken to reduce risks
- The total income level and the number of (effective) coping strategies being used by the household

4.1.6 Factors influencing the institutional support received for risk reduction

Interviews indicate that some of the past risk reduction measures in Rocinha by government and municipality include building barriers to prevent landslides and trenches to redirect rainwater. An important intervention completed in 1979 was a channel that captures the water descending from the Dois Irmãos Mountain and leads it away from the settlement.

Only 17 percent of the households in this study state that they receive, or have received, direct institutional help (20.4 percent of the households in the high-risk area Laboriaux, 13.3 percent of the households in the low-risk area Cachopa, 11.3 percent of the households stating not to be at risk and 23.8 percent of the households reporting to be at risk). Four different types of direct institutional support were mentioned by the interviewees. The most common type is Bolsa Família, or "family grant", a popular government programme that allows cash transfers to poor families provided that the children attend school and do regular health check-ups. Some people stated to have received microcredit loans to start a small-scaled business or improve their house from a Rocinha-based NGO named VivaCred. Some have received support from the Prefeitura to deal with material damages after small-scale disasters. After the landslides in Laboriaux in April 2010, in which a row of houses were completely destroyed, the residents of these houses received compensation from the Prefeitura. Shortly after this it was decided that the risk for new landslides in Laboriaux

was too high and that all its residents should be relocated. In order to move to somewhere else people were offered a compensation for their house, and if they chose to accept, their house was demolished by the Prefeitura to prevent others from moving in.

To examine if there are any patterns in who have received institutional help, cross-tabulations were used for testing whether or not the households had received help against their levels of education and income, and the impact from past disasters. No such relations were found.

A relationship was however found between being at risk and having received help, where the households stating to be at risk seemed more likely to have received institutional support than the households stating not to be at risk. This proved significant for the households in the high-risk area Laboriaux (focus group – area based analysis) ($\chi^2(2$, $n = 49) = 10.452$, $p < 0.005$) and for the total number of households in the study ($\chi^2(2$, $n = 94) = 10.469$, $p < 0.005$). (See Table A.3.15 in Appendix)

Table 4.6 Factors found to influence the institutional support (before Bonferroni type adjustment)

SUMMARY: INSTITUTIONAL SUPPORT

Correlations between the following attributes were found significant at the 5%-level:
Among the total number of households • Reporting to be at risk and having received institutional help **Among households in the high-risk area Laboriaux** • Reporting to be at risk and having received institutional help
No relations, however, were found between the following attributes
• Educational levels and having received institutional help • Income levels and having received institutional help • The degree of impact from disasters in the past and having received institutional help • Living in a declared area of risk and having received institutional help

4.1.7 Bonferroni type adjustment for significance level

The test results presented in the quantitative analysis are individually statistically significant with a 5% confidence level, meaning that in each test the probability (p) for erroneously finding a correlation is at most 5%. However, when making many tests the error probability increases, and there is a need to adjust the confidence level accordingly. This can be done with a so-called Bonferroni type adjustment, which for a confidence level α and a number of tests n calculates the confidence level for the entire set of tests as α/n (Goldman 2008). With this adjustment, even if an error rate of 10% is allowed for each test, the resulting α-value for the circa 80 tests conducted in this analysis will be $0.10/80 = 0.00125$. The only result in the statistical analysis which is significant on this level is the correlation between the educational level of the interviewee and his or her ability to point out any risks for people in the settlement ($p < 0.00013$). This inconsistency will be further discussed in Chapter 5.

4.2 Qualitative results

4.2.1 Summary of qualitative results

The qualitative analysis of this study aims to illustrate how formal education may influence disaster risk, coping strategies and institutional mechanisms for risk reduction in a settlement like Rocinha. It was found that education may influence risk and risk reduction directly, for instance it was considered to be linked to the ability to perceive risks; or via a

number of factors which were identified with the help of interviews, observations and literature review. These factors include *extensive littering, poor health, organised crime, teen pregnancy, substance abuse* and *illegitimate growth of the settlement.*

4.2.2   Education as a direct factor to risk and risk reduction
The research has identified several ways in which formal education is directly influencing risk and risk reduction in the study area.

4.2.2.1   *Education, risk and coping capacities*
The Civil Defence of Rio de Janeiro, in an interview made for this study, states that based on their experience of working with disaster risk in informal settlements, they consider formal education to be "directly linked to the ability to perceive risks" [citation 1][18]. In fact, education was considered to be more important for the residents' level of risk than their income.

Also in the majority of the interviews with residents (67 percent), the hypothesis that formal education has an influence on coping capacity was confirmed. Besides increasing a person's chances for a steady income and thus enabling them to afford living in an area with lower risk, residents suggested that education has the following effects on risk and coping capacity[19]:

- Education allows people to be more informed about the existing risks; educated people know more and have a different way of thinking; they are more likely to opt for the "safer" alternative regarding choosing where to live/construct, building more stories to one's house or evacuating in case of emergency.
- Education allows people to be more informed about the law and to search their rights; they are more likely to "chase after" opportunities to improve their situation.
- Educated people have more means to express themselves; other people (including authorities) are more likely to listen to them.

4.2.2.2   *Education and acceptance of institutional support*
The Civil Defence of Rio de Janeiro maintains that one of the principal reasons to why some residents are more at risk than others in the same community is their negligence of the warnings and alerts issued by the Civil Defence, something which in several studies has been linked to low levels of education (Cutter, Boruff & Shirley 2003:248; Lindell & Perry 2004:90).

Another key informant, a community worker residing in Laboriaux, affirms that formal education often proves valuable for people at risk in their contact with emergency officials. Besides giving people more capacity to communicate their needs, he suggests that education make residents less suspicious towards the authorities and more likely to accept institutional support [citation 2]:

> *"[A person with higher education] is more likely to have knowledge of the facts. You know about reality. You know that the professional standing there has two functions: to protect you and to help you. [... If] you don't have that vision, it's because you don't have the knowledge."*

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[18] For original citations in Portuguese, see Appendix page 67.
[19] It should be noted that experience of living in the settlement and facing and solving problems related to risks in the past was also considered as valuable for the capacity to cope with disasters.

4.2.3 Risk mapping in Rocinha – six additional factors

By comparing the information obtained from key informants, observations and literature review, and taking into consideration the frequency with which different issues were mentioned during interviews; six additional factors were identified as determinant in increasing people's level of risk and reducing their capacity to cope with disasters in the study area. These are the following:

1. Extensive littering
2. Poor health
3. Organised crime
4. Teen pregnancy
5. Substance abuse
6. Illegitimate growth of the settlement

In this section, it was considered more constructive to separate the findings according to the risk components represented in Equation 2.5 than by the research objectives (risk, coping strategies and institutional support). The above listed factors do not only influence the different components of risk and risk reduction, but they can also be linked to education, and to each other. To facilitate for the reader, all six factors will be explained using the following structure: (a) start from the context of the study area and state the "problem"; (b) specify how the "problem" can exacerbate people's disaster risk; (c) describe how education can have a mitigating effect on the "problem", and thus on risk; and (d) if possible, make the connection to the other problem factors in the area, to show how they are mutually reinforcing.

4.2.3.1 Littering – affects the hazard

(a) An extensive littering was observed throughout the settlement of Rocinha. Although a majority of people seemed to dispose of their household waste in the designated "trash heaps" which are emptied regularly by the Prefeitura, observations and interviews yield that many still throw it literally out the window from their residence, or in the surrounding slopes and water ducts. (b) The extreme contamination of the settlement can lead to the amplification of several natural hazards. According to interviews in the study area, flooding is a common consequence when solid waste clogs the already precarious systems for drainage of rainwater. After the heavy floods in Rio de Janeiro in the beginning of this year, urban waste was identified as one of the main contributing factors (Geckler 2010). Analogously, according to the Brazilian Civil Defence, heavy littering in the slopes of informal settlements contributes to unstable soil conditions and adds to the weight of the soil, both of which increase the risk of landslides. In fact, about 90 percent of the reported landslides in Salvador (the largest city on the northeast coast of Brazil) are said to be caused by an excess of solid waste in the mountain slopes (cf. Civil Defence of Salvador in Fraga & Rebouças 2010). Furthermore, organic waste produces methane gas that may explode and trigger landslides, which was identified as the cause of the landslide that this year buried more than 50 houses in the settlement Morro do Bumba in Niterói outside Rio de Janeiro (Estadão 2010). There is thus an obvious causal role of littering in urban disasters. (c) The question is if littering can be linked to formal education.

Formal education can be seen as a determinant for a person's access to information about urban waste management and disasters, for example through increased literacy or computer skills. However, education may be an even more important determinant to people's ability to interpret the information they receive and to understand the processes in which waste and disasters are linked. As a result of information campaigns, for instance by

local television channels, many of the study's interviewees were able to identify the avoidance of littering as a measure for risk reduction. In reality however, observations yield that it can be difficult for people to go from this information to action without further knowledge or understanding of the causal role of littering in disasters, for which education may provide a basis. A key informant working with urban disaster risk exemplifies that it is formal education, rather than income, which promotes the understanding of how throwing a candy wrapper on the ground, or a refrigerator in a river, contributes to local floods and landslides. Moreover, avoiding littering may require additional personal conviction when the degree of contamination is so high that one's own contribution seems pointless, as was observed in Rocinha. A young interviewee said [citation 3]:

> *"To be honest, no one does anything around here. I know that we shouldn't throw rubbish in the slopes, but it gets out of control, people lose hope. It worries me."*

Adequate waste disposal in favelas is further complicated by the lack of infrastructure for waste management and the authorities' past and present failure to provide regular waste collection services in these areas, according to interviews. In some cases, as described by Wamsler (2007a:117), people from better-off areas have been reported to add to the problem by tipping their solid waste onto the slopes of informal settlements or into nearby rivers.

(d) In addition to triggering natural hazards, littering may exacerbate the risk in the study area by contributing to another risk factor, namely poor health. Household waste is for instance known to attract the carriers of vector-borne diseases such as dengue and leptospirosis (Confalonieri 2003:195).

4.2.3.2 *Poor health – affects vulnerability, capacity to respond and capacity to recover*

(a) Observations and interviews indicate several factors which contribute to a degradation of health in the study area and thereby undermine people's capacity to cope with disasters. These include nutritional deficiencies, poor infrastructure for waste and wastewater, poorly ventilated houses and a high population density. Interviews further show that many of the low-educated residents of Rocinha are forced to take on physically demanding jobs like cleaning or construction work, often in the informal sector with unregulated work hours and few safety restrictions; which may lead to an accentuated number of injuries related to accidents or physical wear. Moreover, living in an area subject to marginalisation, violence and disaster risk can negatively affect people's psychological health (e.g. Enarson 2000:19; Uchtenhagen 2004). For instance, a mother of four in Laboriaux explained that she used to take on temporary jobs to supplement the family income, but since the recent landslides her psychological health had deteriorated and she was not able to work anymore [citation 4]:

> *"... it affected my health a lot. You know, I'm not the same person anymore, you know, I don't feel that safety anymore, that I live here, I am safe here. My way of being, my way of thinking and my way of acting... I don't feel safe anymore. With all this that happened there, it makes you think [...] today it was her, suddenly it might be [my house collapsing]."*

(b) Health can influence several of the different components of risk, in fact, good health is said to be a key resource to disaster survival (e.g. Enarson 2000:3; Wisner et al. 2003:11). Deficiencies in health make people more vulnerable to disasters, for instance by reducing their possibilities to earn a living. The interviews in the study area imply that since the jobs available for low-educated people often are physical and informal, they may in fact run

a greater risk of losing income opportunities due to an injury or a debilitating illness. Interviews also suggest that some conditions, for example being disabled or HIV-positive, are likely to increase vulnerability by adding to the existing stigma of living in a favela.

Furthermore, health is a determinant to people's capacity to respond to disasters. For example, interviews and observations show that a timely evacuation in the steep stairways and winding alleyways of Rocinha may be very difficult for a person with a reduced physical capacity. Analogously, an already weakened immune system decreases the chances to withstand the infectious diseases that are often spread in the aftermath of disasters (Wisner et al 2003:54).

People's health is also likely to affect their capacity to recover. The woman from Laboriaux cited above had not suffered any direct impact from the disaster that took place in her community, but due to already having a history of psychological illness, the landslides affected her greatly and she found it difficult to return to the way she had lived before.

(c) It can be assumed that formal education allows people to be better informed about health risks and to make decisions that promote good health. As an example; compared to the rest of Brazil, Rocinha has a disproportionately high concentration of tuberculosis cases; one article goes as far as to equate it with the tuberculosis concentration in some countries in Africa which lack basic healthcare programmes (Verly 2009). The progression of the disease is exacerbated by frequent abandonment of treatment, something that in several Brazilian studies has been linked to low levels of education (Ferreira, da Silva & Botelho 2005). In general, level of education is often considered to be an important determinant to people's state of health, and research has shown that the number of years of schooling is the second most relevant variable to the health status of adult Brazilians, after age (Fonseca 2000:78).

4.2.3.3   Organised crime, police and associated stigma – affects all aspects of risk and risk reduction

(a) Rocinha, like many other favelas in Rio de Janeiro, is controlled by the drug trafficking movement[20]. Interviews, observations and literature (e.g. Sneed 2003:74) show how Rocinha, with armed traffickers patrolling the streets, constitutes a "lawless land"[21] to where the police only make sporadic raids in search of drugs, contraband firearms and stolen goods. During interviews with the residents, the most frequently mentioned risk after landslide risk was to be caught in the crossfire during one of these raids (what is referred to as being hit by a *bala perdida* – a stray bullet). (b) However, the state of occupation by the drug traffickers may also have secondary effects on the risks related to so-called natural disasters, which will be evaluated below.

The escalating violence between criminal gangs and the state security forces in Rio de Janeiro and São Paulo has by some been compared to a state of civil war (Mir 2004 in UN-HABITAT 2010:68), and it cannot be denied that this long-standing conflict contains some war-like elements; including civil victims, child 'soldiers', the use of military artillery and extrajudicial executions (e.g. Dowdney 2003:74-83). Violent conflict is mentioned by Wisner

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[20] The organisation is top-steered with orders going out from the self-proclaimed leader of the favela, called *o chefe do tráfico*, but it also includes collaboration schemes with criminals from other favelas belonging to the same gang, or faction. Rocinha belongs to the faction "*Amigos dos Amigos*", friends of friends, while the rivalling gangs in Rio de Janeiro are "*Comando Vermelho*", the red commando, and "*Terceiro Comando*", the third commando (cf. Dowdney 2003).

[21] "lawless land"; at least with regard to regular enforcement of Brazilian law, see comment below on the trafficking acting as law-enforcement.

et al. (2003:54) as one of the dynamic pressures that can increase the impact from disasters; this is thus likely to be the case also for the drug wars in Brazilian favelas.

Abandoned by regular law-enforcement the people of Rocinha have to rely on the traffickers to keep order, which they were observed to do to some extent, allowing the residents to lead their daily life in the favela[22]. Interviews yield that because of the violent operations in the community, many residents fear the police and see them as corrupt and brutal. Some interviewees claim to have suffered unprovoked harassment or violence from police officers. This widespread mistrust for the authorities undoubtedly has consequences for officials and emergency services in their work with the prevention, mitigation, response and recovery related to disasters.

A major impact from the organised criminality is the associated stigma and the difficulties that the residents of the informal settlements of Rio de Janeiro face on the formal job market, which in turn make them more vulnerable to disaster impact. The favelas' reputation as violent and lawless areas creates mistrust for the people living there (even though the majority of them are rather the victims than the perpetrators) and leads to that they are often denied formal work based on their address. This was described during interviews in the study area, and is also mentioned by Perlman (2010:190). Moreover, it was observed how the mobility of the residents becomes severely reduced during shoot-outs between traffickers and the police. Such shootings, called *tiroteios*, may impede residents from making it to their jobs without risking their lives, adding further weight to employers' discrimination of people with a favela address.

According to Perlman (2010:194), the organised drug trade in Rio de Janeiro also has an eroding effect on trust and social capital *within* favelas, weakening the coping mechanisms based on mutual aid between neighbours (such as community efforts to prepare for or recover from disasters) and diluting the flow of information about jobs and other opportunities that is generally spread through informal community networks (including information about coping strategies or available institutional support). Many Residents' Associations, one of the few institutions that represent the interests of the favelas, are said to have been threatened or taken over by drug gangs, and participation in community organisations has drastically decreased (Perlman 2010:193). Meanwhile, observations and interviews in Laboriaux after the landslides in April showed that the affected people were still highly dependent on the nearest community, for example for immediate shelter after their houses were destroyed. Loss of social capital due to organised crime can thus be assumed to have serious effects on the coping capacity in informal settlements.

The trafficking movement based in the study area can be seen as tightly interlinked with (lack of) educational activities. Children who do not attend school are more easily recruited by criminal gangs, where they might start off as *olheiros* (lookouts) or *aviãozinhos* (carriers of messages or small quantities of drugs) (Dowdney 2003). A recent report from IBISS (The Brazilian Institute for Innovations in Social Healthcare) estimates that more than 15,000 people under the age of 18 may be working for the drug trade in the metropolitan region of Rio de Janeiro (MidiaNews 2009). Furthermore, young men with little education and without vocational skills might see no other way to make a sustainable living than to work for the trafficking movement (Dowdney 2003:111). On the other hand, the glamorisation of

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[22] Observations and interviews yield that unauthorised crime within the favela is often severely punished by the traffickers, paradoxically leading to Rocinha being a safer place to walk around at night than tourist areas such as Ipanema and Copacabana, even for a non-Brazilian like the author of this study.

the gangster culture may also be the reason why some youths choose to leave school early: as traffickers, young men quickly obtain a good salary, attractive women, status items like sneakers and IPods, and maybe most importantly; respect and inclusion (Dowdney 2003:112). The difficult access to the employment market for favela youth in Rio de Janeiro can be seen as a contributing factor to the steady inflow of new recruits to criminal gangs (Perlman 2010:307). Unfortunately this creates a vicious circle where the favelas' infamous drug gangs and turf wars only add to the employers' discrimination of people with a favela address.

(c) One way to combat the organised crime in favelas is to address the grounds for why young people choose to join criminal gangs. The idea that formal education may influence this choice is supported by Dowdney (2003:185) in an in-depth study about children and youths in the organised drug trade in Rio de Janeiro. In this study, providing primary and secondary education is listed as one of the most important measures to sustainably reduce the enrolment to the drug industry.

(d) The organised drug trafficking can be seen as a direct factor to the availability and abuse of illegal substances in Rocinha, which can lead to an increased risk according to the findings of this thesis. Interviews and observations further describe the trafficking movement and the associated violence as a threat to health and wellbeing in the study area, for example through increased mortality and psychological stress for residents (cf. Uchtenhagen 2004).

4.2.3.4 Teenage pregnancy – affects vulnerability, capacity to respond and capacity to recover

(a) When discussing risks "off the record" in Rocinha, early and unwanted pregnancies are almost as frequently mentioned as the risks related to drug trafficking. Interviews and observations indicate a high frequency of teenage and pre-teenage pregnancies in the community, which may lead to an increased risk from disaster impact.

(b) Interviews yield how teenage mothers in Rocinha face a variety of challenges that may contribute to their vulnerability to disasters, such as increased expenses, difficulties to continue with studies or income-earning activities, potential health complications during and after the pregnancy (including psychological problems) and possible rejection from their family or partner. Several of the interviewees in the study link their current situation of economic vulnerability to having "started their life very early" with planned or unplanned pregnancies, instead of devoting more time to studies or work. Interviews and observations also show that the early and unplanned pregnancies in the study area often lead to vulnerable family constellations such as single mothers, and/or add to the responsibilities of the parents of the young mother. According to disaster literature, single mothers, who are often already vulnerable and overburdened, pay high costs in disasters (Enarson 2000:15). Analogously, high birth rates and large numbers of dependants are said to increase the wear and workload on women and may amplify families' risk from disasters (Enarson 2000:6; Cutter, Boruff & Shirley 2003:248).

Being responsible for a small child (or several) is also likely to affect the way that girls or women are able to respond to hazardous impact. A young mother of three children, living close to the collapsed houses in Laboriaux, had for instance sent her 6 and 7 year old sons to stay with her mother in another state, fearing that she would not be able to run out of the house with all three children if there would be another landslide.

Analogously, conflicting work and family responsibilities, dependency of childcare and reduced mobility might delay the recovery of mothers. For example, Enarson (2000:20) describes how having to evacuate to a temporary shelter makes it much more difficult for women to both care for their children and resume their income-earning activities.

A community leader from Rocinha's Residents' Association links teenage pregnancy to disaster risk and education as follows [citation 5]:

> *"People with little education end up having a very large family growth [...particularly] in this part where the risk is highest, which is the area of Macega, maybe due to the lack of education, the people haven't had much opportunity to study and gain knowledge about things [...]. The quantity of children binds the mother in the home, and the father [too]. The mothers had to quit their studies because they became pregnant very early, very young; and the responsibility to care for a child, two children, was too much for them to be able to dedicate themselves to anything on top of that, to school."*

(c) Teenage pregnancy is known to be more common among girls with low levels of education (Busso 2002:25; Observatório da Educação 2006; Stern 2002:7); in fact, the educational level can be a direct determinant in teenage girls' knowledge with respect to fertility and contraceptives[23], as well as in the total number of children that a woman is expected to have during her life (Busso 2002:25-26). A Brazilian study further indicates that the risk of becoming pregnant is higher for teenage girls who are currently not attending school (Observatório da Educação 2006).

Some suggest that the lack of opportunities for poor and low-educated young women often leaves them with few other options than to be wives and mothers to gain social inclusion and to secure their livelihoods, by linking their life to that of a man (Stern 2002:3; Observatório da Educação 2006). According to this reasoning, providing opportunities for poor and marginalised young girls, for example through education, could help to reduce the number of pre-teenage and teenage pregnancies, and thus also reduce vulnerability to hazardous impact.

(d) Teenage pregnancies can also amplify hazard impact by increasing the risk of health complications for mother and child, due to the fact that young girls are physically and psychologically immature for reproduction (Banerjee et al. 2009:228).

4.2.3.5 Substance abuse – affects vulnerability, response and recovery
(a) Observations in Rocinha show how the lack of adequate police control and the availability of drugs due to the trafficking movement create a free-zone where illegal substances can be openly purchased and used. Alcohol is cheap and easily available at almost any hour from the many *mercadinhos* (grocery shops) and *biroskas* (corner bars) that are found across the favela. Moreover, according to Uchtenhagen (2004), poverty, unemployment and low education all contribute to higher prevalences of substance use disorders. In fact, it is also believed that increases in drug use and heavy drinking in many developing countries may be attributed to increased stressors such as urban migration, high levels of violence and overcrowded and polluted environments (Uchtenhagen 2004). The presence of these stressors and the observed availability of drugs and alcohol in

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[23] Although interviews yield that sexual education is often not provided in Brazilian schools, the possibility to access such information may increase with the educational level.

Rocinha can be assumed to contribute to an increased prevalence of substance use in the area, which may amplify the impact of a disaster.

(b) Alcohol or drug abuse may affect people's vulnerability in several ways, for example by causing economic hardship, difficulties to manage a job, or lead to social disintegration (Uchtenhagen 2004; NIDA 2010), thus increasing the impact of a potential disaster. Interviews yield how substance abuse can transmit vulnerability to whole families, by eroding the family income, increasing the risk of domestic violence and making parents less apt to care for their children, for instance by making sure that they go to school.

Furthermore, being under the influence of drugs or alcohol can be assumed to influence a person's response to a potential disaster. For instance, marijuana intoxication (marijuana being one of the most common intoxicants in the study area, Sneed 2003:64) can cause distorted perceptions, impaired coordination and difficulty with thinking and problem-solving (NIDA 2010), which may result in an impaired performance during an emergency event. Substance abuse has also been found to increase in areas impacted by disasters (Enarson 2000:19), and may thus complicate people's recovery to their way of living before the disaster.

(c) While alcohol and drug abuse can be found among people at all educational levels, it can be assumed that education allows people to be more informed about the risks related to substance abuse. Uchtenhagen (2004) states how low education or educational deficits may be factors contributing to higher prevalence of substance abuse. For young people, attending school means that they spend more time under supervision of adults and away from the "bad influence" that they may encounter on the streets, according to interviews.

(d) In addition to direct effects, substance abuse may exacerbate disaster risk by contributing to other risk factors discussed in this chapter. It is well documented how drug and alcohol consumption is causally related to disease and injury (Uchtenhagen 2004; NIDA 2010), thus increasing the risk of health problems in the study area. Moreover, the use of illicit drugs (both in and outside the favela) can be seen as a factor that nurtures the organised criminal activities based in Rocinha.

4.2.3.6 Illegitimate growth of the settlement – affects all aspects of risk and risk reduction

(a) Alongside all the difficulties mentioned above, there exists a great ingenuity in Rocinha. Observations yield how materials and furniture are constantly sold and recycled to fill new functions in Rocinha homes, and small-scaled entrepreneurship blossoms – everywhere there is a small business, from the lady who sells sponge cake from a table on the corner, to autonomous workers serving as one-man staffing firms. Problems like insufficient living space or not enough electrical outlets are solved by simply constructing another floor or drawing another cable, and many residents work in the informal sector. However, there is a downside to the fast-paced informal development of Rocinha. Overcrowding, construction without adequate engineering, speculation on the housing market and deforestation in order to expand one's living area were all mentioned as risk factors during the interviews in the study area. (b) The informality and illegitimate growth of the settlement inevitably affect all aspects of risk and risk reduction.

Firstly, these informal processes have a direct influence on hazard and hazard prevention. Rocinha is one of many favelas situated on a steep hill susceptible to landslides. Deforestation is often mentioned as a contributing factor to landslide probability (e.g. Benson & Twigg 2007:21); and interviews in the study area illustrate how the remaining

trees in the densely populated settlement pose a complex problem, in which their roots are needed to provide stability in the ground, while branches, or entire trees, threaten to fall and cause substantial damage during extreme weather. As illegitimate occupants of land, many residents may not benefit from land planning and risk evaluations made by the authorities.

Secondly, the informal or illegitimate growth of settlements leads to increased vulnerability. Informal building processes result in housing constructions vulnerable to the impacts of disaster; for example the interviews yield that as families grow in Rocinha, more stories are often added to houses that were originally not meant to be multi-storey constructions. The informally drawn electric cables that can be observed throughout the settlement, so called *gatos*, can be assumed to increase the risk of fires and electricity related accidents in combination with hazard impact. One interviewee described how he had discovered a large part where the brick wall of his house had gone soft, on the first of three stories. He then found that it was due to a pipe from a neighbour's house discharging wastewater on the other side of the wall. This is an example of how cramped housing conditions and inadequate water outlets can make people's homes more vulnerable to collapse (with or without the stress of a natural hazard).

Living in an informal settlement also influences people's vulnerability through their ability and likelihood to take part in decision-making processes in society, which for instance is facilitated by having an address. A majority of residents in Rocinha do not receive mail to their address (Censo Domiciliar 2010), and some of the interviewees claimed that their address had been changed so many times that they do not know it anymore. Observations yield how taking part in Brazilian society often requires a "proof of residence", that is, paid bills documenting a fixed address. Perlman (2010:302) reports how favela residents may have to use their employer's address to register their children at a school, whereas others run the risk of being excluded from political elections due to not having a recognized address or residence (UN-HABITAT 2010:21).

Thirdly, the infrastructure of informal settlements influences the response mechanisms available to the residents when exposed to a potential disaster. For example, the observed lack of proper streets complicates an efficient evacuation and limits the access ways for emergency vehicles. Buildings are less likely to follow regulations and may thus lack emergency exits and evacuation plans. Analogously, the access to structures and mechanisms for recovery might be problematical for people who are not legally entitled to the land where they live, as well as for informal workers who lack rights such as compensation for loss of work due to disasters.

(c) Interviews with residents and key informants indicate that the poor quality of the education in public schools in Brazil particularly affects children in informal settlements and thus leads to an amplification of the inequalities between people living in "formal" and "informal" areas. It was explained that most pupils in public schools only have classes on a half day basis, and in addition, classes in favela schools are often cancelled due to power cuts, shootings and absent or striking teachers. Perlman (2010:104) reports how teachers in favelas are afraid to come to class and typically only show up a few times a week. The director of a school in Cidade de Deus in Rio de Janeiro affirms (Gonçalves 2010) [citation 6]:

> *"Not every teacher wants to work in a favela. Not only for considering it to be unsafe, but also for the social devaluation that this place exhibits. If there is a shortage of teachers in Rio, the shortage is much greater in the favelas."*

In addition, key informants and literature (e.g. Perlman 2010:104) confirm how the introduction of a new school system in Rio de Janeiro, which auto-transfers children to the next grade without controlling if they have the adequate knowledge, has further deteriorated the quality of the education and made it possible to attend school for years without even learning how to read. Meanwhile, those who can afford it send their children to private schools where the quality of the education is generally much superior. Interviews yield how the inequalities in education become blatantly clear when the publically schooled favela residents often lack the adequate knowledge to pass the admission tests for the popular public universities. It is thus evident that the educational differences affect people's risk both in terms of their learning, and their livelihood opportunities.

Despite the devaluation of education for those in informal settlements, formal education may be a determinant for the prospects of moving to a formal part of the city, where risk and risk reduction are less shaped by informal processes. In a longitudinal study about Rio de Janeiro's informal settlements, Perlman (2010:233) found three factors which increased the likelihood of a person moving from the favela to a bairro. In the study, the people who moved tended to be the ones who (1) had fathers with relatively more education; (2) had more education themselves; and (3) were more knowledgeable about Brazilian politics (which may also be attributable to education). In contrast, the study found no correlations between moving out from the favela and having a specific gender, skin colour, family size or income level.

(d) Making the connection to the other factors which the qualitative analysis found to influence disaster risk, the informal structure of Rocinha may contribute to the extensive littering that takes place; since the informal building processes are less likely to have included planning for waste management and the limited access complicates the collection and removal of refuse. In addition, informal infrastructure was mentioned by key informants as a factor to health degradation, for instance due to the lack of adequate water sanitation.

5 DISCUSSION

5.1 Evaluation of quantitative results

The link between education and the ability to point out risks or dangers in the settlement is the most significant finding of the statistical analysis. In an area afflicted by armed conflict, dangerous infrastructure, infectious diseases, chaotic traffic and that has recently been impacted by landslides, there were still residents who claimed that living there was completely risk-free. The most common motivation for this answer was that they considered themselves "used" to their environment, and therefore did not think that it posed any risks or dangers. It could be argued that a certain denial of risks may be necessary to endure living in such a hazardous place; in fact, downplaying risks is mentioned by Wamsler as a sort of coping strategy (2007a:121). What the results reflect, though, is that this view was only found among interviewees with little or no education. An objection might be that these residents simply did not understand what was meant by the words "risk" and "danger", However, follow-up questions were always asked to reduce the possibility of misunderstandings. At any rate, people who deny the existence of any type of risks are likely to be more reluctant to undertake measures for risk reduction, which was repeatedly observed during this study.

Another key finding is the link between the level of education and level of income for the women in the study. Interviews and observations yield that there are considerable differences in traditional "male" and "female" professions in Rocinha, and many of the better-paid jobs that do not require a higher education, such as bartender or moto-taxi driver, are generally dominated by males. The findings indicate that women with low levels of education may be at higher risk from disasters than men due to their limited possibilities to earn a sustainable living.

As regards methodology, this thesis has shown the importance of selecting suitable risk proxies when conducting research that seeks to analyse the correlation between education and risk. In fact, whether the risk evaluation is made by the authorities or the residents themselves can have a major impact on the results. For instance, of the 92 households in this study, of which 42 households reported themselves to be at risk and 49 households were located in the area considered at risk by the authorities, only 29 were found to be at risk by both methods.

Residents can prove an invaluable source of knowledge about risks, past experiences from the area and local coping strategies; however, if the educational level is linked to the ability to identify risks like the results of this thesis imply, it is possible that the risk for low-educated households is actually higher than they have stated, due to lack of knowledge about the risks. Conversely, some households might exaggerate their risk, hoping that it will lead to participation in development programmes. Evaluations or decisions made by the authorities are more likely to be based on an objective or standardised assessment model, but they might on the other hand be politically biased or include other motives than risk reduction. In addition, classifying an entire area as being at risk does not take into consideration the specific standard of each house or the individual vulnerability of its inhabitants.

Because of the insecurities in the statistical analysis, the remaining quantitative results might be better viewed as indications of potential correlations than actual evidence. While they hint that education may have further influence on disaster risk and risk reduction, more research needs to be conducted to confirm these relations with statistical significance.

Methods that could be used to achieve more significant results in future research are discussed in Section 5.4.

5.2 Evaluation of qualitative results

The qualitative results illustrate how formal education may influence the risk situation in the study area, either directly or through more long-term effects. Education was considered to be directly linked to people's risk awareness and responsiveness to warnings. It was also said to provide a base for increased knowledge of one's rights and more successful communication with for instance emergency officials. In the reviewed literature, responsiveness to warnings and social power have both been linked to higher levels of education (see theoretical framework, page 16-17).

In the long term, formal education was found to have a potential to reduce overall disaster risk through a number of factors considered to exacerbate risk in the study area, namely littering, poor health, organised crime, teenage pregnancy, substance abuse and informality and informal growth of the settlement. The qualitative analysis showed how these factors could be related to specific risk components using the extended view of risk presented in the theoretical framework, represented by Equation 2.5. None of the studies reviewed for this thesis have shown the significance of such factors by linking them to both formal education and disaster risk.

5.3 Comparative analysis

5.3.1 How formal education was found to influence people's level of risk[24]

Comparing the quantitative and qualitative analysis of this thesis, both have identified people's level of formal education as a factor to their awareness of, or ability to identify, existing risks. Earlier studies in this context (e.g. Adger et al. 2004:75) have suggested that formal education provides a basis for understanding hazards and how to respond to them. In addition, integrating disaster risk reduction into formal education, that is to say, purposely teaching about disasters in schools, has been identified as an important measure to raise risk awareness (UNISDR 2002). However, a specific correlation between people's educational level and their awareness of existing risks has not been provided in the literature reviewed for this thesis.

The results further show that education may play a more important role to the level of risk for women than for men. In the quantitative analysis, education could be linked to a higher income for the women in the collected data. In addition, the qualitative analysis highlights how higher levels of formal education among girls may help to delay or prevent teenage pregnancies, the frequent occurrence of which was considered to contribute to a higher disaster risk in the study area, for example by augmenting the number of single mothers. These findings may help to provide a better understanding of why investments in female education are an effective measure for disaster risk reduction, as has been proved by Blankespoor et al. (2010).

Although existing literature often links higher education to a higher income and more livelihood opportunities (e.g. Cutter, Boruff & Shirley 2003:248; Adger et al. 2004:75), in fact, a recent study from São Paulo shows that education is *the* most relevant factor to the

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[24] It should be noted that according to the theoretical framework presented for this thesis, coping strategies and institutional support are actually part of the concept of risk (cf. page 12-13). To avoid repetition, issues which can be directly linked to coping strategies or institutional strategies will be evaluated in Section 5.3.2.

inhabitants' level of income (UN-HABITAT 2010:52); no statistically significant relation could be established between education and income among households and male individuals in the collected data. One explanation for this may be the favela residents' difficult access to the employment market, which was found to be fuelled by factors such as inequalities in the educational system and devaluation of trust due to the organised crime in the favelas.

The findings above indicate that for residents of favelas, higher education might not always lead to a higher income as commonly presumed in existing literature, at least not to the same extent as in the city as a whole. However, since education (independent of income) in this study has been linked to risk and risk reduction, which also supports the results of other recent studies (e.g. Adger et al. 2004; Toya & Skidmore 2005; Blankespoor et al. 2010), this thesis may be a reason to reappraise the general understanding that education only affects people's level of risk via their income.

5.3.2   Factors found to influence coping strategies and institutional support

The coping strategies used by the interviewed households are shown in Table A.2 on page 55. This thesis, for example by identifying a link between formal education and awareness of existing risks, indicates that education may influence the use of coping strategies. According to UNISDR (2002), risk awareness is a necessary condition to engage in disaster risk reduction. The results further suggest that by increasing the understanding of the processes in which for example littering or deforestation lead to disasters, formal education may help to discourage such actions. In addition, people with higher levels of education were considered more likely to make safety-oriented choices regarding construction practices or evacuation. These findings are supported by various earlier studies presented in the theoretical framework (see page 16-17).

Of the coping strategies that were mentioned by the residents, few were based on mutual help between neighbours. One interviewee in Laboriaux complained that the residents living together in the high-risk area "don't talk, don't communicate and don't join together" [citation 7]. Although they are likely to use strategies based on mutual help without being aware of it, the lack of coordination and cooperation between residents indicated by the interviews might be an example of how the reign of violent criminal gangs has eroded social capital in favelas, as reported by Perlman (2010:194).

The mechanisms for institutional support that were directly offered to the people in the study included (1) Bolsa Família ('family grant'), (2) micro credit loans, (3) support to reconstruct damages from small-scale disasters and (4) support to relocate from areas at high risk from disasters. Of the listed mechanisms, only (3) and (4) are directly related to disaster risk reduction[25].

Bolsa Família, a government programme consisting of small cash transfers to mothers provided that their children attend school and do medical check-ups, is very popular in Brazil and now includes over 12 million households (The Economist 2010). Though the programme is seen as a great success and is partly responsible for the considerable reduction in poverty achieved under the reign of Luiz Inácio 'Lula' da Silva, it has been criticised for not addressing poverty and child-labour as efficiently in urban areas as in rural Brazil. For instance, due to the higher cost of living in the city, including greater

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[25] It should be noted that additional institutional support has been provided in Rocinha in the form of added infrastructure, cement walls to prevent landslides and constructions by the government programme PAC (for instance a hospital unit on the main road near Cachopa). Some residents indicate that their risk situation has improved due to these investments (see Table A.03 on page 56).

earnings to be made by working children, the family grant (which is the same size across the country) has not provided the same economic incentive to take children out of labour and put them into school in the cities (The Economist 2010):

> *"[T]here has been a tendency to treat Bolsa Família as a magic bullet [...]. Rômulo Paes de Sousa, the executive secretary of Brazil's social-development ministry, talks about "old" and "new" poverty—old being lack of food and basic services; new being drug addiction, violence, family breakdown and environmental degradation. These "new" problems are more complex."*

Through micro credit loans, which is the second type of institutional support mentioned in this study, people can obtain the start capital to open a small company or make other investments to increase their income, which may lead to a reduced disaster risk. The citation above implies, however, that while financial support is a way to address issues associated with traditional poverty (often still seen in rural Brazil), it may not be as efficient in solving the complex contemporary problems found in informal settlements like Rocinha, and which this study has linked to risk and risk reduction.

Readily available support for replacing property damaged by disasters – either through financial compensation (risk financing) or assisted reconstruction (stand-by for recovery) – was identified by the theoretical framework as an important mechanism in order to reduce adverse impacts from disasters. However, for the relatively few interviewees who had sought such help from the authorities, repeated requests and a long wait was generally needed before the support was received. Adger et al. (2004:75) state that education, particularly literacy, will be a determinant for the access to information about available institutional support for adaptation to climate change. The results of this thesis further suggest that people with higher levels of education have more means to communicate their needs to and be heard by the authorities.

Finally, the relocation of residents from areas of high risk is not entirely uncontroversial. The majority of the households in the study area Laboriaux (a green, tranquil part of Rocinha with pebble stone streets and a marvellous view of Rio de Janeiro) did not at all want to be relocated after the landslides that took place there in April. Many residents maintained that the compensation they were offered to move did not buy a house of the same standard as their current one, nor did it cover the cost of transporting or replacing their possessions. People expressed worry about what would become of their livelihoods if they were forced to move to another part of the city, as many residents had a small business accommodated in their house, and others had their jobs in the wealthier areas near Rocinha. Such relocations or evictions may in fact contribute to a higher social vulnerability (Perlman 2010:289). On the other hand, the Civil Defence of Rio de Janeiro in an interview made for this study states that with the large number of people who die each year from floods and landslides, their first priority is to remove these families from areas of high risk and place them in safety, "even though it may sacrifice some things like their social life" [citation 8].

In summation, the majority of the direct assistance that has been received seems to be based on the understanding that money (or location) is the solution to the existing problems. However, the results of this thesis indicate that helping people to increase their level of formal education is in fact also a viable institutional strategy for risk reduction.

5.3.3 Future sustainability of the current coping mechanisms

It is important to consider the difference between past and future disasters, and the sustainability of the coping mechanisms that are being used today. As stated in Section 2.3, extreme weather such as rain- and windstorms is likely to become more frequent in the future, in turn triggering more landslides and mudflows in urban settlements. Several researchers also predict that climate change will bring an increase in vector borne diseases such as dengue and leptospirosis (Confalonieri 2003:195; IPCC 2007:600), which may further amplify the risks from disasters. In addition, climate impacts such as a rising sea level, harshened conditions for agriculture and more disasters in rural areas (see Section 2.3) can be expected to increase the rural-urban migration, and will most likely drive even more people to reside in hazard-prone locations such as urban hillsides and city dumps (Bigio 2002:92). Other predicted problems like shortages of freshwater in cities or increased competition for living space might contribute to conflicts between groups or individuals.

This thesis has shown how formal education is linked to health, and increased investments in education may thus be a way to moderate the health risks associated with a changing climate. While climate change is predicted to augment the migration to informal settlements, level of education was identified as an important determinant for moving from a favela to a formal part of the city (cf. Perlman 2010:233). Adger et al. (2004:75) further argue that literate, educated populations will be in a better position to negotiate equitable solutions to conflicts triggered by climate change.

Most of the key informants interviewed for this thesis do not believe that the coping mechanisms currently used in Rocinha will be sufficient if the climate-related hazards should change in type or intensity in the future. The strategies used by the residents in Rocinha (see Table A.2 on page 55) are important measures to reduce risks, but it should be noted that with Rocinha's high population density, most of the mentioned strategies depend on that many people abide by them. For example, avoiding littering and having proper water outlets does not offer much protection for a household if none of the neighbours take such caution (see example on page 38).

The efficacy of future institutional support is likely to require a certain level of trust between the authorities and the residents of potential risk zones. In fact, lacking confidence in and compliance with warnings from officials may be partly due to the many evictions of favela residents that occurred under past policies, often using environmental protection as a pretext to remove settlers from high-priced city land (Perlman 2010:271; UN-HABITAT 2010:76). Increased levels of education may facilitate the residents' communication with the officials, but in order to increase the confidence in the authorities and to be sustainable in the future given the predicted increase in urban disasters, institutional mechanisms for risk reduction also need to become more reliable and easily available.

5.3.4 The potential of promoting education to increase the current coping or adaptive capacity

Defined in the theoretical framework, coping capacity and adaptive capacity denote the capacity of people, organisations or systems to face and manage disasters or adapt to the adverse effects of a changing climate. The chosen framework indicates that there are two ways of assisting people at risk; reducing specific risk components, or increasing people's capacity to reduce the different risk components on their own.

Based on the results of this thesis, it is reasonable to believe that education has both a direct and indirect influence on disaster risk and risk reduction. Promoting education in

order to increase the current coping or adaptive capacity is therefore considered to be justified.

One reason to why education may be superior to for example financial or location-based measures for risk reduction is that it is a life-long investment; once given, it cannot be taken away and it will undoubtedly have beneficial effects on many other aspects of development (e.g. Blankespoor et al. 2010:17). In addition, promoting education to increase people's coping capacity, as opposed to making investments to address specific risk components which may or may not be an issue under future climates, is a better insurance for the uncertainties and variations of a changing climate. (It should be noted, however, that the thesis does not suggest that formal education is the *only* way to improve adaptive capacity.)

While this thesis has shown both (1) the documented and potential risk reducing effects of formal education; and (2) the deficiencies in the public educational system in Brazil, which is considered to disproportionately affect the poor; it can be assumed that increased investments in education in Brazil are both necessary and potentially rewarding from a risk reduction perspective.

5.4   Further research

Due to relatively few data and a large number of tests, the method chosen for statistical analysis did not yield many statistical significant results. A better method could have been using a regression, where the risk would be expressed as a function of several variables, such as income, education etc.

$$risk = f(income, education, ...)$$

In a more advanced model, more data would be desirable, and the data used as risk proxies could be more refined: preferably address-specific (considering the risk of each separate house) and based on a standardised assessment model, for example using satellite photos or on-site inspections by engineers. By means of the regression, these risk proxies could then be tested against indicators of social vulnerability, such as people's level of education, to investigate how they influence the level of risk. Another method would be using actual records of people who lost their lives in disasters and analyse factors such their level of education, if such information could be provided and it would be considered ethically justified.

More research is also needed to confirm the secondary effects that education may have on risk through the factors that have been suggested in this paper; namely littering, poor health, organised crime, teenage pregnancy, substance abuse and informal growth. Another concept which could be included in further studies is the influence of non-formal education, such as courses offered by NGOs, on disaster risk. In addition, this thesis has illustrated how poor governance (such as the reign of drug gangs and the corruption in the police force) contributes to the disaster risk in a settlement like Rocinha. Against this background, it would be interesting to conduct further research on the correlation between disaster risk and indicators of governance and corruption.

6 CONCLUSIONS

A worldwide increase in climate-related disasters, disproportionately affecting the urban poor in developing countries, indicates the urgency for communities at risk to adapt to climate change. In order to assist those at risk, more information is needed about the factors that shape people's adaptive capacities.

This thesis investigates the role of formal education in determining people's capacity to adapt to changing climate conditions. In particular, it examines how formal education can influence people's level of risk, including their coping strategies and the institutional support they receive. The research is based on a case study of the informal settlement Rocinha in Rio de Janeiro, Brazil, and includes statistical and qualitative analyses of data obtained from interviews, observations, literature review.

The results of this thesis indicate that a higher educational attainment among citizens has more effects on their level of disaster risk than what has been previously considered.

Firstly, formal education was found to be a contributing factor to people's awareness of risks in their environment, which is a necessary condition to engage in risk reduction, such as using coping strategies or accepting institutional help.

Secondly, the study has shown how formal education plays a more important role in determining the level of risk for females than for males, for example through increasing the chance of making a sustainable living.

Thirdly, the study has illustrated how formal education influences people's disaster risk through having a mitigating effect on factors such as littering, poor health, organised crime, teenage pregnancy, substance abuse and informal growth of the settlement; factors which were found to exacerbate disaster risk in the study area.

In a wider perspective, this work has contributed to a more detailed outlook on how formal education may be linked to different components of risk; but also how disaster risk and formal education are linked with the daily problems of the residents in a Brazilian favela; such as marginalisation, violent drug gangs, poor quality of public education and sub-standard housing and infrastructure.

Based on the findings of this thesis, it can be concluded that increased investments in formal education in order to improve people's adaptive capacity are justified, not only due to its potential to lead to a higher income. Furthermore, the results of this thesis may be an incentive to invest more in female education in order to increase the coping capacity to disasters, which supports the results of other recent studies (e.g. Blankespoor 2010).

In particular, considering the deficiencies in the Brazilian educational system, which were found to disproportionately affect poor people, it can be concluded that investments in public education in Brazil (to increase the access to *and* the quality of formal education) are both necessary, and potentially rewarding from a disaster risk reduction perspective.

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APPENDICES

A.1 Maps of Cachopa and Laboriaux

Figure A.1 Satellite map of Cachopa with relevant street names added
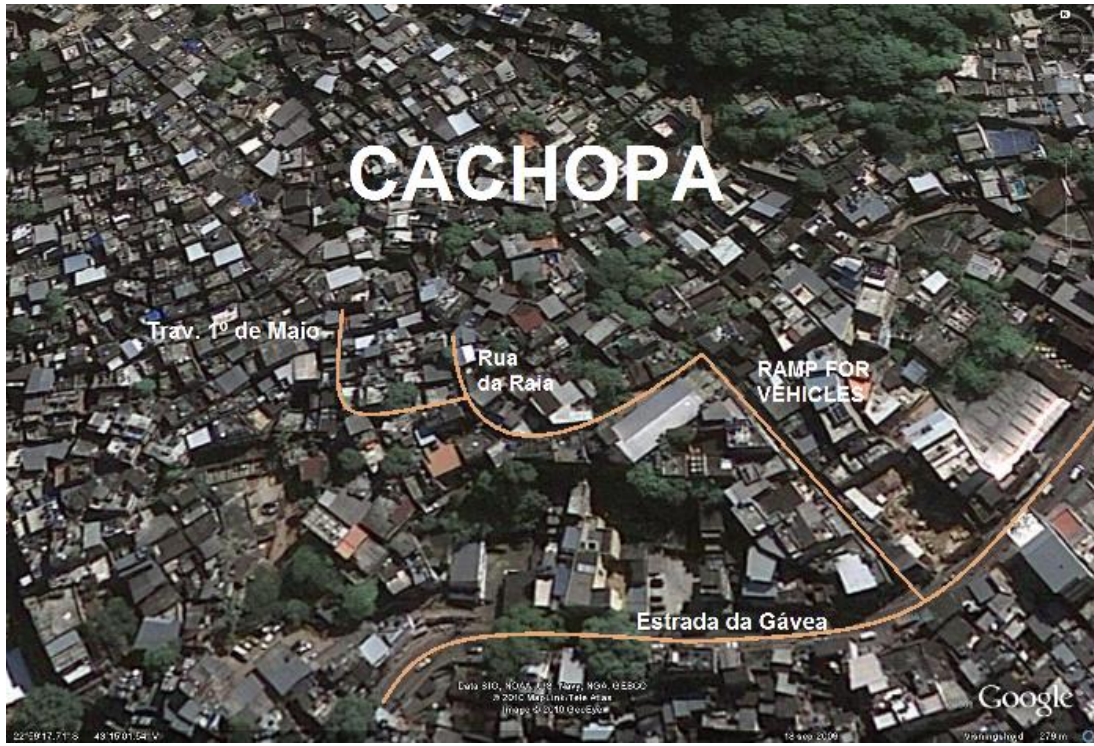
Image Source: Google Earth

Figure A.2 Map of Laboriaux with relevant street names added
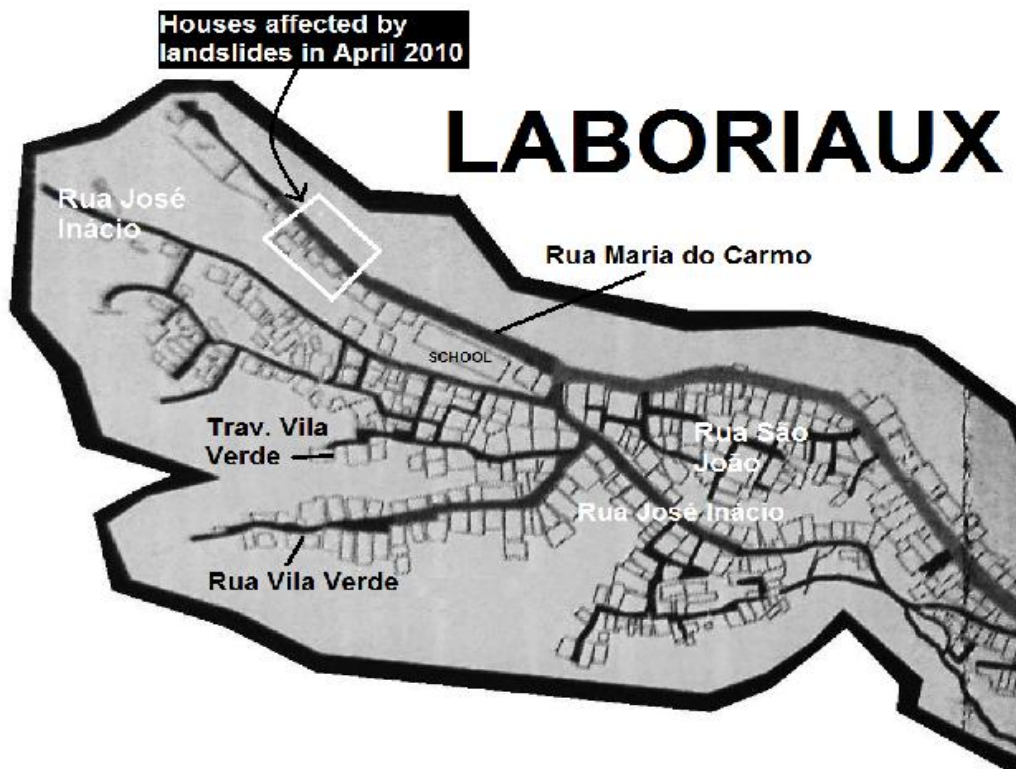
A.2 Interview guide

A.2.1 Interview with Rocinha residents – English version

Interview with Rocinha residents

Community/zone		Date and time	
Interviewed person		Household code	

1. Classification of Household

1.1 Address

1.2 Since when do you live in this community? (month/year)

1.3 Have you or your family been affected by....

	Yes, a lot	Yes, a little	No	(Details)
...landslides?				
...floods?				
...other 'natural' disaster?				

2. Education and income dates for the household members

2.1 Name (1 name and 1 surname) From the oldest to the youngest	Age	Occupation	Are you employed/working at the time?	Education (last year of schooling)	Average monthly income
HH1 1.					
2.					
3.					
4.					
5.					
6.					
7.					

Mean years of schooling for Heads of Households and working household members

Total household income (monthly)

Only for the Head of Household / main provider

2.2 Name (name and surname)	Level of income in 2000	Level of education in 2000

2.3 Do you have any household members who moved from the slum for work/study reasons or after having improved their level of income/education? (Yes/No; Details)

3. Opinion

3.0 In your opinion, which are the main risks/threats for the residents of Rocinha? (You may mention three risks/threats. If the risks of disasters is not included, how do you think it relates to the risks you mentioned?)

a.

b.

c.

3.1 Do you think that your house is at risk from 'natural' disasters? Yes, a lot Yes, a little No

3.2 Do you think that your house is at more risk than other households in Rocinha? Yes No

3.3 If you answered yes. Why?

a.

b.

c.

3.4 If you compare your risk situation to that of 5-10 years ago, how do you feel now?

a. Better (lower risk)

b. The same (same risk)

c. Worse (higher risk)

d. Doesn't know

e. Doesn't answer

3.5 Explain your latest answer. Why do you feel better, the same or worse?

a.

b.

c.

⇒ 3.5b (If the answer is related to education or income) Explain how these aspects have influenced your level of risk!

3.6 Have you received any type of institutional help or support during the last 10 years (in order to reduce your risk level)? Yes No

⇒ 3.6b If you answered yes, please specify:

	Examples	From which organisation?
Support to reduce material damages	Construction for mitigation, micro-credits to improve the residence, etc.	
Support to augment level of income (in general)	Credits for micro-company, occupational training, etc.	
Support to augment level of (formal) education	Support to local schools to improve the education, financial help to study or to reduce study-related costs, etc.	
Support to improve the level of organisation and preparation of the households and/or the community to risks	Community organization, instruction/training related to 'natural' disasters, etc.	
Other type of help:		

3.6c Do you know of any project that the Prefeitura of Rio de Janeiro conducted in your community to reduce risks? What do you think of the support from the authorities?

3.7a What are the 3 most important measures that your family has taken to reduce the risks of disasters in the future? (Own efforts, without institutional help or support)

3.7b How do you think that the Prefeitura's work with disaster risks affects the residents' own efforts to cope with disasters? Why?

It makes it easier to cope | It doesn't affect the effort to cope | It makes it more difficult to cope

3.8 Do you think that the disasters in the past have had any effect on the level of education in your household? Yes No

⇒ 3.8b If you answered yes, how?

	Examples:
a. Difficulties to pay for education	Lack of money as a result of disaster impacts, there was a need to take credit/loans in order to pay for uniform, books, bus, etc.
b. Members of the family had to end their studies sooner than planned	Children had to start working instead of studying to help recuperate from the effects of the disaster
c. Lack of space for studying	Reduced living space, destruction of local school
d. Other:	

3.9 Do you think that the disasters in the past have had any effect on the level of income in your household? Yes No ⇒ How?

a. Temporary loss of employment

b. Permanent loss of employment

c. Temporary reduction of monthly income | For example: it was necessary to reduce the working hours in order to work on the recuperation or in reconstruction projects, there was a reduction of consumption in the affected community etc.

d. Other:

Entrevista com moradores da Rocinha

Comunidade/zona	Data e hora
Pessoa entrevistada	Código do lar

1. Classificação do Lar

1.1 Endereço

1.2 Desde quando você mora nesta comunidade? (mês/ano)

1.3 Você e a sua casa/família têm sido afetado por....

	Sim, muito	Sim, um pouco	Não	(Detalhes)
...deslizamentos de terra?				
...alagamentos/enchentes?				
...outro tipo de desastre natural?				

2. Dados de educação e rendimento dos membros do lar

2.1 Nome (1 nome y 1 sobrenome) Do maior ao menor	Idade	Ocupação/A que se dedica	Está empregado/A trabalhando atualmente?	Ensino (matéria/último ano de estudo)	Rendimento médio atual (mensal)
Cdl. 1.					
2.					
3.					
4.					
5.					
6.					
7.					

A média de anos de ensino dos chefes do lar incluso os membros que trabalham

Rendimento total do lar (mensal)

Somente para o Chefe do Lar / o provedor principal

2.2 Nome (nome e sobrenome)	Nível de rendimento em 2000	Nível de educação em 2000
	?	?

2.3 Você tem algum membro do lar que mudou da favela (para um lugar de menor risco) por motivo de estudos ou emprego / depois o por causa de ter melhorado o nível de educação ou rendimento? (Sim/Não, Detalhes)

3. Opinião

3.0 Na sua opinião, quais são os **riscos/perigos principais** para os moradores da Rocinha? (Pode mencionar três tipos de riscos. Se o risco de desastres naturais não estive incluído, como você acha que se relaciona aos outros riscos que mencionou?)

3.1 Você acha que a sua casa está em perigo/risco de desastres naturais?

	Sim, muito	Sim, um pouco	Não

3.2 Você acha que a sua casa está em **maior risco/perigo** comparado com outros lares na Rocinha?

	Sim	Não

3.3 Se você respondeu "sim": Por quê?

a.

b.

c.

3.4 Ao comparar a sua situação de risco atual com a de 5 ou 10 anos atrás, como se sente agora?

a. Está melhor (menor risco)

b. Está igual (igual risco)

c. Está pior (maior risco)

d. Não sabe

e. Não responde

3.5 Explique a sua resposta anterior. Por que se acha melhor, igual o pior?

a.

b.

c.

⇒ 3.5b (Se a resposta anterior estivesse ligada à educação ou ao rendimento) Explique como estes aspectos têm afetado o seu nível de risco/perigo.

3.6 Você tem recebido algum tipo de apoio ou assistência institucional nos últimos 10 anos (para diminuir o seu nível de risco ante futuros desastres)?

	Sim	Não

⇒ 3.6b Se responderam "sim", especifique: — De que organização?

Apoio para reduzir danos materiais	Exemplos:	Construção de obras de mitigação, créditos para melhorar a residência, etc.
Apoio para aumentar o seu nível de rendimento (em geral)		Créditos para microempresa, treinamento laboral para emprego, etc.
Apoio para aumentar o seu nível de educação (educação formal)		Apoio as escolas locais para melhorar (o acesso) a educação, apoio financeiro para fazer estudo o para reduzir os itos relacionados aos estudos, etc.
Apoio para melhorar o nível de organização e preparação dos lares e/ou da comunidade ante riscos		Organização comunitaria, instrução/treinamento ligado aos desastre naturais, etc
Outro tipo de apoio:		

3.6c Você conhece algum exemplo dum trabalho que fez a prefeitura do Rio de Janeiro na sua comunidade com respeito ao risco de desastres? O que você acha do apoio do poder público?

3.7a Quais são as 3 medidas mais importantes feitas pela sua família para diminuir o risco de futuros desastres? (Esforços próprios, sem apoio ou assistência institucional)

3.7b Como você acha que o trabalho da prefeitura afeta os próprios esforços dos moradores de se proteger contra desastres? Por quê?

Facilita os esforços de se proteger	Não afeta os esforços de se proteger	Atrapalha os esforços de se proteger

3.8 Você acha que os desastres passados tiveram algum efeito sobre o grau de ensino dos membros do seu lar?

	Sim	Não

⇒ 3.8b Se responden "sim", como? — Exemplos:

a. Dificuldades para pagar a educação	Falta de dinheiro como resultado dos impactos dos desastres, necessidade de tomar crédito/empréstimo para pagar uniformes, livros, ônibus, etc.
b. Membro(s) da família terminaram os estudos antes do planejado	Crianças tiveram que começar a trabalhar, em vez de estudar, para ajudar a recuperar do desastre
c. Falta de espaço próprio para os estudos	Redução do espaço para viver, destruição da escola local
d. Outro:	

3.9 Você acha que os desastres passados tiveram algum efeito sobre o nível de rendimento do seu lar?

	Não	Sim	⇒ Como?
a. Perda de emprego de forma temporária			
b. Perda de emprego de forma permanente			
c. Redução do rendimento mensal de forma temporária			

⇒ Redução do rendimento mensal de forma temporária exemplos: foi preciso reduzir as horas de trabalho para trabalhar na sua reabilitação o nos projetos de reconstrução, teve uma redução do consumo da comunidade afetada, etc.

d. Outro:

A.2.3 Interview with key informants – English version

Interview with community leaders and institutional personnel

Name: _____ Date and time: _____

Position:

Community/zone:

Organisation:

Telephone and contact address:

1. Do you know of any census or surveys conducted in Rocinha where it has been asked directly of the households the names of the family members and the levels of income and education?*

a. Date:

Organisation responsible:

How it can be obtained:

b. Date:

Organisation responsible:

How it can be obtained:

c. Date:

Organisation responsible:

How it can be obtained:

*Note: If it has not been possible to obtain all the basic information about the residents of the community (names, age, occupation, income and level of education), ask if the interviewee can give such information.

2. Based on your experience and knowledge of this community, do you think that it runs a higher risk of being impacted by natural disasters than other communities in Rio de Janeiro? (Give the 3 most important reasons.)

a.

b.

c.

3.1 Do you know of any areas in which the risk of natural disasters is higher than in others?

3.2 Based on you experience and knowledge of Rocinha, mention 3 reasons to why some residents are more impacted by natural disasters than others in the same community.

a.

b.

c.

4. The reasons or factors that you mentioned, are they related to the affected people's level of education? In other words, how do you think that the level of education affects people's vulnerability?

5. The reasons or factors that you mentioned, are they related to the affected people's income level? In other words, how do you think that the income level affects people's vulnerability?

6. In general, how do you think that the levels of income and education determine the level of impact that a person suffers in a disaster? In the concrete cased that you know of, which is more determinant – income or level of education?

7.1 If you compare Rocinha's current situation with the situation 10 years ago, do you think that Rocinha is safer and more prepared with regard to natural disasters?

YES   NO

⇒ Only if the answer is YES:

7.2 In this context, which were the most important measures that have been taken by the community during the last years to reduce the risk of disasters in the future (for a long term reduction of the risk)?

7.3 In this context, which was the most important institutional support given to reduce the risk of disasters in the future?

8.1 Do you think that the measures that were taken in Rocinha will be enough if the rains become more frequent and intense, or if other types of disasters occur in the future?

YES   NO

⇒ Only if the answer is NO:

8.2 Which additional measures should then be taken by the community in order to be better prepared for disasters in the future?

8.3 And what type of institutional support will the community need to be better prepared for disasters in the future?

A.2.4 Interview with key informants – Portuguese version

Entrevista com líderes da comunidade y pessoal institucional

Nome:	Data e hora:

Cargo:
Comunidade/zona:
Instituto/organização:
Telefone e endereço de contato:

1. Você tem conhecimento de alguns censos ou pesquisas feitos na Rocinha onde se tenha perguntado diretamente aos lares os **nomes dos membros das famílias, a renda e o grau de ensino deles?***

a. Data:
Organização responsavel:
Como se consegue:
b. Data:
Organização responsavel:
Como se consegue:
c. Data:
Organização responsavel:
Como se consegue:

*Nota: Se não for possível obter toda a informação básica sobre os moradores da comunidade (quer dizer, os nomes, a idade, a ocupação, a renda e grau de ensino), pergunte se o entrevistado mesmo pode dar tal informação).

2. Baseado na sua experiência e conhecimento desta comunidade, você acha que ela corre um risco mais alto de ser impactada pelos desastres naturais do que outras comunidades do Rio de Janeiro? (Mencione as 3 razões mais importantes)
a.
b.
c.

3.1 Você sabe de algumas vizinhanças da comunidade onde o risco de desastres naturais é mais grande do que em outras?
(Mapa)

3.2 Baseado na sua experiência e conhecimento da Rocinha, mencione 3 razões pelas quais alguns moradores são mais impactados pelos desastres naturais do que outros moradores da mesma comunidade?
a.
b.
c.

4. As razões ou fatores que você mencionou, estão relacionados com o grau de ensino das pessoas afetadas? Em outras palavras: Como você acha que o grau de ensino afeta o nível de vulnerabilidade das pessoas?

5. As razões ou fatores que você mencionou, estão relacionados com o nível de renda das pessoas afetadas? Em outras palavras: Como você acha que o nível de renda afeta o nível de vulnerabilidade das pessoas?

6. Em geral, como você acha que a renda e o grau de ensino determinam o nível de impacto que uma pessoa sofre em um desastre? Nos casos concretos que você conhece, o que é mais determinante – a renda ou o grau de ensino? Por quê?

7.1 Se você comparar a situação atual da Rocinha com a situação de há 10 anos, você acha que agora ela está mais segura e mais preparada com respeito aos desastres naturais?   SIM | NAO

⇒ Somente se responda SIM:
7.2 Nesse contexto, qual foi as medidas mais importantes que tem tomado a comunidade durante os últimos anos para diminuir o risco de futuros desastres (para reduzir o nível de risco ao longo prazo)?

7.3 Nesse contexto, qual foi o apoio ou a assistência institucional mais importante para diminuir o risco de futuros desastres?

8.1 Você acha que as medidas que se tomaram na Rocinha serão suficientes em caso de que as chuvas aumentem em frequência e intensidade, ou se acontecer diferentes tipos de desastres naturais no futuro?   SIM | NAO

⇒ Somente se responda NO:
8.2 Então, que medidas adicionais deveriam ser tomadas por parte da comunidade para ela estar melhor preparada para futuros desastres?

8.3 E, que assistência institucional será precisa para a comunidade estar melhor preparada para futuros desastres?

A.2.5 Answers to selected interview questions

Table A.1 The risks mentioned by the residents (answer to interview question 3.0)

RISK	CACHOPA	LABORIAUX	TOTAL
There are no risks	8,9%	10,2%	**9,6%**
Landslides/Mudslides/Collapse	68,9%	67,3%	**68,1%**
Drug trafficking and violence	44,4%	34,7%	**39,4%**
Rain	35,6%	18,4%	**26,6%**
Trees	6,7%	22,4%	**14,9%**
Steep slopes	8,9%	16,3%	**12,8%**
Diseases	26,7%	0,0%	**12,8%**
Traffic accidents	22,2%	2,0%	**11,7%**
Littering	22,2%	0,0%	**10,6%**
Floods	20,0%	0,0%	**9,6%**
Unstable soil conditions	2,2%	14,3%	**8,5%**
Lack of social structure/attention from officials	4,4%	12,2%	**8,5%**
Lack of infrastructure	8,9%	6,1%	**7,4%**
The illegitimate growth of the settlement	6,7%	6,1%	**4,3%**
Deforestation	2,2%	4,1%	**3,2%**
Falling rocks	2,2%	4,1%	**3,2%**
Being evicted due to living in a risk zone	0,0%	2,0%	**1,1%**
Poor quality of education in public schools	0,0%	2,0%	**1,1%**
Psychological ill-health due to disaster risk	0,0%	2,0%	**1,1%**

Table A.2 Coping strategies mentioned by the residents (answer to interview question 3.7a)

STRATEGY	CACHOPA	LABORIAUX	TOTAL
Ineffective/passive strategies			
No strategy	24,4%	24,5%	**24,5%**
No strategy (Lacks money to reduce risks)	4,4%	6,1%	**5,3%**
Believing in God	2,2%	4,1%	**3,2%**
Half effective/passive strategies			
Avoid constructing in a risk zone/Believing that the house is not in the risk zone	24,4%	16,3%	**20,2%**
Stay at home during heavy rain	6,7%	2,0%	**4,3%**
Depend on other people for protection	2,2%	6,1%	**4,3%**
Effective/active strategies			
Keeping plot and surrounding terrain clean from litter	33,3%	12,2%	**22,3%**
Investing in the house (general)	11,1%	18,4%	**14,9%**
Evacuating the house during heavy rain	6,7%	14,3%	**10,6%**
Moving permanently to a safer house	8,9%	10,2%	**9,6%**
Construct walls to prevent landslides	6,7%	8,2%	**7,4%**
Channel water than falls on the roof or runs over the plot	8,9%	4,1%	**6,4%**
Continuous maintenance of house (repairing, painting etc)	6,7%	2,0%	**4,3%**
Constructing the roof without loose parts that can fall/blow off, or for better water runoff	2,2%	6,1%	**4,3%**
Grooming trees close to house	0,0%	4,1%	**3,2%**
Fight for the right for one's house	0,0%	6,1%	**3,2%**
Planting on plot/Avoiding cutting down trees in order to preserve the stability of the soil	0,0%	4,1%	**2,1%**
Staying informed about the risk, talking to neighbours	0,0%	4,1%	**2,1%**
Sending children to study in another area	2,2%	2,0%	**2,1%**

* Each interviewee was allowed to mention multiple risks and strategies.

Table A.03 Changes in perceived risk over time (answer to interview question 3.4)

Area * Risk Situation Compared to 5-10 Years Ago Crosstabulation

		Risk Situation Compared to 5-10 Years Ago			
		Worse	Same	Better	Total
Area	Cachopa	17,8% (8)	26,7% (12)	55,6% (25)	100,0% (45)
	Laboriaux	32,7% (16)	30,6% (15)	36,7% (18)	100,0% (49)
Total		25,5% (24)	28,7% (27)	45,7% (43)	100,0% (94)

Table A.04 Motivations for changed level of risk (answer to interview question 3.5)

PERCEIVED CHANGES IN RISK OVER TIME	CACHOPA	LABORIAUX	TOTAL
Reasons to why people feel worse than before (higher risk)	% out of the people stating increased risk in Cachopa, Laboriaux and total		
The growth of the settlement (overcrowding, deforestation to increase living space, neighbours building more stories to their houses, wastewater from others running on one's lot)	75,0%	18,8%	**37,5%**
Feels the risk is higher after the landslides in April 2010/because of the information from officials after April 2010	0,0%	50,0%	**33,3%**
The weather seems to be more extreme (more rain, more mud and rocks coming down from above)	25,0%	25,0%	**25,0%**
Lack of attention from officials	0,0%	18,8%	**12,5%**
The house is in worse condition than before (due to extreme weather)	0,0%	12,5%	**8,3%**
Where they lived in the North-East there wasn't as much risk (or littering, or violence)	25,0%	0,0%	**8,3%**
Feels more at risk due to aging process (worse eyesight, reduced mobility)	12,5%	6,3%	**8,3%**
Psychological health worsened after the landslides in April 2010	0,0%	6,3%	**4,2%**
Feels insecurity due to being a renter	0,0%	6,3%	**4,2%**
Reasons to why people feel safer than before (lower risk):	% out of the people stating decreased risk in Cachopa, Laboriaux and total		
There is more infrastructure (paved streets, water, electricity, basic sanitation)	52,0%	33,3%	**44,2%**
They improved their house	20,0%	27,8%	**23,3%**
They moved to a safer house	16,0%	22,2%	**18,6%**
The PAC constructions (community centre, hospital unit, investments in the favela)	28,0%	5,6%	**18,6%**
They improved their quality of life in general	20,0%	11,1%	**16,3%**
Better job conditions	24,0%	0,0%	**14,0%**
They own their house	4,0%	11,1%	**7,0%**
More barriers have been built to prevent landslides	4,0%	5,6%	**4,7%**
There is more access to education and other activities for the children	4,0%	5,6%	**4,7%**
There is no longer loose water running over their lot	0,0%	5,6%	**2,3%**
They have become more used to their living circumstances	0,0%	5,6%	**2,3%**
The children are grown up and can support themselves	0,0%	5,6%	**2,3%**
The residents are more conscious about risks	0,0%	5,6%	**2,3%**
Reasons to why people feel the same as before (same risk)	% out of people stating the same risk in Cachopa, Laboriaux and total		
They never experienced any risk	25,0%	60,0%	**44,4%**
They haven't been able to change their situation, their life is the same	58,3%	20,0%	**37,0%**
They always experienced risk (and the situation has not improved)	16,7%	20,0%	**18,5%**

A.3 Cross-tabulations

Table A.3.1 Highest Education Class * Household Income Group * Area Crosstab

Area			Household Income Group		Total
			Low-income group	High-income group	
Cachopa	Highest Education Class	Illiterate	1	1	2
		0-3	1	0	1
		4-7	5	2	7
		8-10	7	8	15
		11 or more	4	13	17
	Total		18	24	42
Laboriaux (p < 0.016)	Highest Education Class	0-3	2	0	2
		4-7	7	1	8
		8-10	7	3	10
		11 or more	9	17	26
	Total		25	21	46
Total (p < 0.004)	Highest Education Class	Illiterate	1	1	2
		0-3	3	0	3
		4-7	12	3	15
		8-10	14	11	25
		11 or more	13	30	43
	Total		43	45	88

Table A.3.2 Highest Education Class * Household Income Group * Risk Group Crosstab

Risk Group			Household Income Group		Total
			Low-income group	High-income group	
No risk (p < 0.009)	Highest Education Class	Illiterate	1	0	1
		0-3	3	0	3
		4-7	3	1	4
		8-10	10	8	18
		11 or more	4	18	22
	Total		21	27	48
Risk	Highest Education Class	Illiterate	0	1	1
		4-7	9	2	11
		8-10	4	3	7
		11 or more	9	12	21
	Total		22	18	40
Total (p < 0.004)	Highest Education Class	Illiterate	1	1	2
		0-3	3	0	3
		4-7	12	3	15
		8-10	14	11	25
		11 or more	13	30	43
	Total		43	45	88

*Table A.3.3 Education Class * Income Group * Gender Crosstab*

Gender			Income Group		Total
			Low-income	High-income	
Female (p < 0.002)	Education Class	Illiterate	6	1	7
		0-3 years	10	2	12
		4-7 years	24	4	28
		8-10 years	9	8	17
		11 or more	12	17	29
	Total		61	32	93
Male	Education Class	Illiterate	3	4	7
		0-3 years	5	6	11
		4-7 years	13	15	28
		8-10 years	5	16	21
		11 or more	10	17	27
	Total		36	58	94
Total (p < 0.007)	Education Class	Illiterate	9	5	14
		0-3 years	15	8	23
		4-7 years	37	19	56
		8-10 years	14	24	38
		11 or more	22	34	56
	Total		97	90	187

Table A.3.4 Mean Education Class * Area * Risk Group Crosstab

Risk Group			Area		Total
			Cachopa	Laboriaux	
No risk (p < 0.022)	Mean Education Class	Illiterate	2	0	2
		0 - 3.9	3	2	5
		4 - 7.9	6	10	16
		8 - 10.9	18	3	21
		11 or more	2	3	5
	Total		31	18	49
Risk	Mean Education Class	Illiterate	1	0	1
		0 - 3.9	0	6	6
		4 - 7.9	7	13	20
		8 - 10.9	3	5	8
		11 or more	2	4	6
	Total		13	28	41
Total (p < 0.005)	Mean Education Class	Illiterate	3	0	3
		0 - 3.9	3	8	11
		4 - 7.9	13	23	36
		8 - 10.9	21	8	29
		11 or more	4	7	11
	Total		44	46	90

*Table A.3.5 HH Education Class * Degree of Impact By Past Disasters * Area Crosstab*

Area			Degree of Impact By Past Disasters			Total
			None	A little	A lot	
Cachopa (p < 0.007)	HH Education Class	Illiterate	3	1	0	4
		0-3	1	0	2	3
		4-7	11	2	1	14
		8-10	10	4	0	14
		11 or more	9	1	0	10
	Total		34	8	3	45
Laboriaux	HH Education Class	Illiterate	3	0	0	3
		0-3	10	2	0	12
		4-7	12	0	3	15
		8-10	5	1	1	7
		11 or more	9	0	1	10
	Total		39	3	5	47
Total	HH Education Class	Illiterate	6	1	0	7
		0-3	11	2	2	15
		4-7	23	2	4	29
		8-10	15	5	1	21
		11 or more	18	1	1	20
	Total		73	11	8	92

*Table A.3.6 HH Income Group * Degree of Impact By Past Disasters * Area Crosstab*

Area			Degree of Impact By Past Disasters			Total
			None	A little	A lot	
Cachopa	HH Income Group (Limit at Median 740 BRL)	Low-income	13	3	1	17
		High-income	19	4	1	24
	Total		32	7	2	41
Laboriaux (p < 0.028)	HH Income Group (Limit at Median 740 BRL)	Low-income	20	3	5	28
		High-income	21	0	0	21
	Total		41	3	5	49
Total	HH Income Group (Limit at Median 740 BRL)	Low-income	33	6	6	45
		High-income	40	4	1	45
	Total		73	10	7	90

*Table A.3.7 HH Income Group * Degree of Impact By Past Disasters * Risk Group Crosstab*

Risk Group			Degree of Impact By Past Disasters			Total
			None	A little	A lot	
No risk	HH Income Group (Limit at Median 740 BRL)	Low-income	25	2	1	28
		High-income	19	2	1	22
	Total		44	4	2	50
Risk (p < 0.004)	HH Income Group (Limit at Median 740 BRL)	Low-income	8	4	5	17
		High-income	21	2	0	23
	Total		29	6	5	40
Total	HH Income Group (Limit at Median 740 BRL)	Low-income	33	6	6	45
		High-income	40	4	1	45
	Total		73	10	7	90

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*Table A.3.8 Highest Education Class * Number of Strategies * Area Crosstab*

Area			0	1	2	3	Total
			Number of Strategies (0 = ineffective, 0.5 = half effective, 1 = effective, sum all strategies and round up to integer)				
Cachopa	Highest Education Class	Illiterate	0	0	2	0	2
		0-3	0	1	0	0	1
		4-7	2	2	2	1	7
		8-10	5	7	3	1	16
		11 or more	4	7	3	4	18
	Total		11	17	10	6	44
Laboriaux (p < 0.021)	Highest Education Class	0-3	0	2	0	0	2
		4-7	6	1	0	3	10
		8-10	2	7	1	0	10
		11 or more	6	15	5	1	27
	Total		14	25	6	4	49
Total (p < 0.022)	Highest Education Class	Illiterate	0	0	2	0	2
		0-3	0	3	0	0	3
		4-7	8	3	2	4	17
		8-10	7	14	4	1	26
		11 or more	10	22	8	5	45
	Total		25	42	16	10	93

*Table A.3.9 HH Income Group * Number of Strategies * Area Crosstab*

Area			0	1	2	3	Total
			Number of Strategies (0 = ineffective, 0.5 = half effective, 1 = effective, sum all strategies and round up to integer)				
Cachopa (p < 0.016)	HH Income Group (Limit at Median 740 BRL)	Low-income	3	10	0	4	17
		High-income	6	7	9	2	24
	Total		9	17	9	6	41
Laboriaux	HH Income Group (Limit at Median 740 BRL)	Low-income	9	14	2	3	28
		High-income	5	11	4	1	21
	Total		14	25	6	4	49
Total (p < 0.014)	HH Income Group (Limit at Median 740 BRL)	Low-income	12	24	2	7	45
		High-income	11	18	13	3	45
	Total		23	42	15	10	90

*Table A.3.10 HH Income Group * Number of Strategies * Risk Group Crosstab*

Risk Group			Number of Strategies (0 = ineffective, 0.5 = half effective, 1 = effective, sum all strategies and round up to integer)				Total
			0	1	2	3	
No risk (p < 0.019)	HH Income Group (Limit at Median 740 BRL)	Low-income	6	16	1	5	28
		High-income	4	9	8	1	22
	Total		10	25	9	6	50
Risk	HH Income Group (Limit at Median 740 BRL)	Low-income	6	8	1	2	17
		High-income	7	9	5	2	23
	Total		13	17	6	4	40
Total (p < 0.014)	HH Income Group (Limit at Median 740 BRL)	Low-income	12	24	2	7	45
		High-income	11	18	13	3	45
	Total		23	42	15	10	90

*Table A.3.11 Responder's Education Class * Number of Risks Mentioned * Area Crosstab*

Area			Number of Risks Mentioned					Total
			0	1	2	3	4	
Cachopa (p < 0.003)	Responder's Education Class	Illiterate	2	0	2	0	0	4
		0-3	1	0	1	2	0	4
		4-7	0	1	1	4	5	11
		8-10	0	2	7	6	1	16
		11 or more	0	0	0	7	3	10
	Total		3	3	11	19	9	45
Laboriaux	Responder's Education Class	Illiterate	1	0	0	1	0	2
		0-3	2	1	0	4	0	7
		4-7	2	4	5	3	1	15
		8-10	0	4	3	3	0	10
		11 or more	0	3	6	5	1	15
	Total		5	12	14	16	2	49
Total (p < 0.003)	Responder's Education Class	Illiterate	3	0	2	1	0	6
		0-3	3	1	1	6	0	11
		4-7	2	5	6	7	6	26
		8-10	0	6	10	9	1	26
		11 or more	0	3	6	12	4	25
	Total		8	15	25	35	11	94

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*Table A.3.12 Responder's Education Class * Number of Risks Mentioned * House Risk Group Crosstab*

House Risk Group (Based on the Answer to the 2 Previous Questions)			Number of Risks Mentioned					
			0	1	2	3	4	Total
No risk (p < 0.017)	Responder's Education Class	Illiterate	3	0	1	0	0	4
		0-3	3	1	1	2	0	7
		4-7	1	2	4	1	3	11
		8-10	0	3	7	6	1	17
		11 or more	0	3	3	5	2	13
	Total		7	9	16	14	6	52
Risk	Responder's Education Class	Illiterate	0	0	1	1	0	2
		0-3	0	0	0	4	0	4
		4-7	1	3	2	6	3	15
		8-10	0	3	3	3	0	9
		11 or more	0	0	3	7	2	12
	Total		1	6	9	21	5	42
Total (p < 0.003)	Responder's Education Class	Illiterate	3	0	2	1	0	6
		0-3	3	1	1	6	0	11
		4-7	2	5	6	7	6	26
		8-10	0	6	10	9	1	26
		11 or more	0	3	6	12	4	25
	Total		8	15	25	35	11	94

*Table A.3.13 Responder's Education * Ability to Mention Any Risk * Area Crosstab*

Area			Ability to Mention Any Risk		Total
			No	Yes	
Cachopa (p < 0.002)	Responder's Education Class	Illiterate	2	2	4
		0-3	1	3	4
		4-7	0	11	11
		8-10	0	16	16
		11 or more	0	10	10
	Total		3	42	45
Laboriaux	Responder's Education Class	Illiterate	1	1	2
		0-3	2	5	7
		4-7	2	13	15
		8-10	0	10	10
		11 or more	0	15	15
	Total		5	44	49
Total (p < 0.00013)	Responder's Education Class	Illiterate	3	3	6
		0-3	3	8	11
		4-7	2	24	26
		8-10	0	26	26
		11 or more	0	25	25
	Total		8	86	94

*Table A.3.14 Responder's Education * Ability to Mention Any Risk * Risk Group Crosstab*

House Risk Group			Ability to Mention Any Risk		Total
			No	Yes	
No risk (p < 0.00013)	Responder's Education Class	Illiterate	3	1	4
		0-3	3	4	7
		4-7	1	10	11
		8-10	0	17	17
		11 or more	0	13	13
	Total		7	45	52
Risk	Responder's Education Class	Illiterate	0	2	2
		0-3	0	4	4
		4-7	1	14	15
		8-10	0	9	9
		11 or more	0	12	12
	Total		1	41	42
Total (p < 0.00013)	Responder's Education Class	Illiterate	3	3	6
		0-3	3	8	11
		4-7	2	24	26
		8-10	0	26	26
		11 or more	0	25	25
	Total		8	86	94

*Table A.3.15 House in Risk? * Received Institutional Help? * Area Crosstab*

Area			Received Institutional Help?		Total
			No	Yes	
Cachopa	House in Risk?	No risk	28	4	32
		Some risk	10	2	12
		High risk	1	0	1
	Total		39	6	45
Laboriaux (p < 0.005)	House in Risk?	No risk	20	3	23
		Some risk	16	2	18
		High risk	3	5	8
	Total		39	10	49
Total (p < 0.005)	House in Risk?	No risk	48	7	55
		Some risk	26	4	30
		High risk	4	5	9
	Total		78	16	94

A.4 Original citations in Portuguese

All translations from Portuguese were made by the author of this study.

[Citation 1] Civil Defence of Rio de Janeiro, interview via e-mail, 2010-09-08

"Acredito que o ensino está diretamente ligado ao poder de percepção de risco, pois, como a pessoa pode identificar o risco e deixar não se tornar vulnerável aos desastres se ela não aprendeu a identificá-los[?]"

[Citation 2] Community worker and resident of Laboriaux, interview 2010-05-06

"[Uma pessoa com maior gráu de ensino] tem mais sensibilidade para ter conhecimentos dos fatos. Você conhece a realidade. Você sabe que o profissional que está alí está com duas funções: de te proteger e te ajudar. Você na hora aquele nervosinho... você não tem essa visão, então é porque você não tem conhecimento."

[Citation 3] Resident of Laboriaux, interview 2010-07-04

"Na verdade, ninguem faz nada [aqui]. Sei que não se deve jogar lixo nas encostas mas fica fora de controle, se perde a esperança. Fico preocupado."

[Citation 4] Resident of Laboriaux, interview 2010-06-12

"A situação que aconteceu lá... estou me sentindo pior porque afeitou muito a minha saúde, assim. Sabe, eu não sou mais aquela pessoa que eu era, sabe, eu não tenho mais aquela segurança que eu tinha... que quer dizer estou morando aqui, estou segura aqui. O meu modo de ser, meu modo de pensar e meu modo de agir... eu não me acho mais segura. Com tudo isso que aconteceu ae a gente fica pensando poxa, hoje foi ela, de repente pode ser [a minha casa desabando]..."

[Citation 5] Community leader, Residents' Association of Rocinha, interview 2010-05-24

"As pessoas que são más instruidas elas acabam tendo um crescimento familiar muito grande. Hoje praticamente... a quantidade de filhos por familia é uma média de 4. Tem familia que tem 8 filhos. (Na Rocinha toda?) Não, nessa parte que tem mais possibiliade de risco, que é a area de Macega, talvez pela falta de instrução, o pessoal não tem tido muita oportunidade de estudar, e ter conhecimento das coisas. [...] A quantidade de filhos, isso prende muito à mãe dentro de casa, ao pai. As mães tiveram que largar os estudios, que gravidaram muito cedo, muito nova, e a responsabilidade de cuidar de um filho, dois filhos, aumentou mais do que ela poder se dedicar em cima, à escola."

[Citation 6] Maria Marta, director of a school in Cidade de Deus, cited in Observatório de Favelas (Gonçalves 2010)

"Não é todo professor que quer trabalhar em favela. Não só por achar que não é seguro, mas também pela desvalorização social que tem este lugar. Se no Rio falta professor, na favela falta muito mais."

[Citation 7] Resident of Laboriaux, interview 2010-05-23

"Não se fala, não se comunica e não se une."

[Citation 8] Civil Defence of Rio de Janeiro, interview via e-mail, 2010-09-08

"Por culpa de alguns políticos do passado várias construções irregulares foram erguidas em locais de risco e anualmente centenas de pessoas morrem em desastres naturais principalmente causadas pelas chuvas. Neste cenário nós já verificamos que temos que retirar essas famílias de áreas de risco e colocá-las em um lugar seguro mesmo que sacrifique algumas coisas como a vida social."