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Climate Change, Adaptation and Formal Education: The Role of Schooling for Increasing Societies' Adaptive Capacities

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Climate Change, Adaptation and Formal Education: The Role of Schooling for Increasing Societies' Adaptive Capacities

Christine Wamsler

with contributions from Ebba Brink, Pasi Oskari Rantala, Mercedes Barillas and Carlos Umaña

Approved by

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Abstract

With a worldwide increase in disasters, the effects of climate change are already being felt, and it is the urban poor in developing countries that are most at risk. There is an urgent need to better understand the factors that determine people's capacity to cope with and adapt to adverse climate conditions. This paper examines the influence of formal education in determining the adaptive capacity of the residents of two low-income settlements: *Los Manantiales* in San Salvador (El Salvador) and *Rocinha* in Rio de Janeiro (Brazil), where climate-related disasters are recurrent. In both case study areas it was found that the average levels of education were lower for households living at high risk, as opposed to residents of lower risk areas. In this context, the influence of people's level of education was identified to be twofold due to (a) its direct effect on aspects that reduce risk, and (b) its mitigating effect on aspects that increase risk. The results further suggest that education plays a more determinant role for women than for men in relation to their capacity to adapt. In light of these results, the limited effectiveness of institutional support identified by this study might also relate to the fact that the role of formal education has so far not been sufficiently explored. Promoting (improved access to and quality of) formal education as a way to increase people's adaptive capacity is further supported in respect to the negative effects of disasters on people's level of education, which in turn reduce their adaptive capacity, resulting in a vicious circle of increasing risk.

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About the Author

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Dr. Wamsler has vast experience in the field of sustainable urban development with a focus on climate change adaptation and disaster risk reduction. Focus countries include(d) Chile, Colombia, El Salvador, Mexico, the Philippines, Sweden, Togo, United Kingdom, and Tanzania. She has authored many articles on disaster management and adaptation and recently published a book on *Urban Risk Reduction and Adaptation*. She is the coordinator of the Master of Disaster Management Program at Lund University and responsible for four different Master courses at Lund and Copenhagen Universities on (a) disaster risk reduction, (b) disaster recovery, (c) sustainable recovery and climate change adaptation; and (d) methods for climate risk management.

Climate Change, Adaptation and Formal Education: The Role of Schooling for Increasing Societies' Adaptive Capacities

Christine Wamsler
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1 Introduction

Today, climate change is on everyone's lips. With the global temperature on the rise and a worldwide increase in so-called natural 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 such events including windstorms, heat waves, heavy rains, floods and landslides (IPCC 2007). Each year, disasters trigger devastating losses in human lives and economical assets, with the poor in developing countries being most at risk (UNISDR 2002; Wisner et al. 2004).

With rapid urbanization which increasingly exposes populations and economies to climate-related hazards, the trend is for the risk to become urban (IPCC 2007). 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, on steep slopes or on flood plains, are particularly vulnerable (e.g., Bigio 2003; IPCC 2007; Wamsler 2009; Wisner et al. 2004).

While considerable research has been conducted on many aspects related to the geological and biological impacts of climate change, little is known about the specific impacts on the future wellbeing of the world's population and how it is related to our ability to adapt to changing climate conditions. In fact, knowledge about future societies' adaptive capacities is one of the most important missing links in making predictions about the effects of climate change (Lutz 2008).

Against this background, this paper's objective is to contribute to filling this gap by providing new knowledge on the aspects that shape people's capacities to adapt to changing climate conditions. More specifically, the research presented in this paper aims to examine how the risk and adaptive capacity of the residents of two low-income settlements (*Los Manantiales* in San Salvador [El Salvador] and *Rocinha* in Rio de Janeiro [Brazil]) are influenced by their level of formal education. In addition, it analyzes the complex reality of people living in disaster-prone informal settlements or so-called 'slums', thus illustrating how their precarious living conditions and social marginalization are interlinked and, in turn, related to their level of formal education. The motivation to focus on formal education is based on recent studies which hypothesize that educational attainment might enhance people's ability to cope with

disasters (e.g., Adger et al. 2004; Toya & Skidmore 2005; Blankespoor et al. 2010). Formal education refers here to studies at primary, secondary and university levels.[1]

After the description of the research methodology (second section), the third section presents the theoretical framework on which this study is based. The interrelations between the central concepts of disaster, risk, and adaptive capacity are identified and viewed from a holistic systems perspective of risk reduction and climate change adaptation. Linkages with formal education are also highlighted. The fourth section presents the research results resulting from the conducted quantitative and qualitative analyses. A comparison and interpretation of the different results is found in the fifth section, comparing the similarities, differences, and gaps between the outcomes from the two case study areas (in El Salvador and Brazil). Finally, the conclusions are presented.

2 Methodology

This paper is based on a comparative analysis of two case studies which examine the influence of formal education in determining the adaptive capacity of the residents of informal low-income settlements where climate-related disasters are recurrent. Both case studies were motivated by the project on Forecasting Societies' Adaptive Capacities to Climate Change, funded by the European Research Council and coordinated at IIASA by Wolfgang Lutz (2008).

The first case study was carried out in different phases between 2006 and 2011 and focuses on the community *Los Manantiales* in San Salvador, El Salvador, where flooding and landslides are the main hazards to life and livelihoods, followed by windstorms and earthquakes. Additional analyses were conducted in two other San Salvadorian communities: *José Cecilio del Valle* and *Divina Providencia*. The second case study was carried out between 2009 and 2011 in *Laboriaux* and *Cachopa*, two communities of *Rocinha*, an informal settlement in central Rio de Janeiro, Brazil where landslides and floods are recurrent.

In both case studies, in the following referred to as the San Salvador and the Rio case studies, data was collected through surveys, interviews, literature review and observation, and both statistical and qualitative data analyses were applied. The statistical analyses investigate how formal education influences people's level of risk, their coping strategies, and the institutional support received. The qualitative analyses focus on exploring direct and secondary effects that education may have on disaster occurrence, and vice-versa.

[1] The study's focus on formal education does not imply that other forms of education or training are discarded as factors to the capacity to cope with disasters, but is rather a pragmatic measure to delimit the research (cf. Lutz 2008). If formal education would, indeed, be identified as a key factor to people's adaptive capacity, this would support promoting formal education to sustainably assist people and 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 (Lutz 2008).

The surveys and interviews were mainly conducted during 2009–2011 and included 118 households in San Salvador and 94 households in Rio including families at high risk (i.e., the focus group of 92 and 49 households, respectively) and families at moderate risk (i.e., the control group of 26 and 44 households, respectively). In addition, around 90 interviews were held at different levels, including international and national risk management experts, organizational staff from organizations working in the case study areas, community leaders and other key informants. For the literature review, more than 200 publications were revised. In the context of the San Salvador case study, also institutional databases could be accessed and analyzed, and data of previous research collected during 2006 could be drawn from. The two case studies were finally followed up by desk work in 2011 to assess the different outcomes.

For the qualitative data analyses, a combination of literal reading, grounded theory (Glaser & Strauss 1967), systems analysis (Sterman 2000) and cultural theory (Thompson et al. 1990) was applied. For the statistical analyses of the data obtained from the two case studies, so called cross-tabulations[2] were conducted to identify potential relationships between different attributes, and their significance was tested using χ^2 (Chi square) tests.[3] Based on the research objectives, the attributes to be analyzed were chosen to be people's:

- Level of formal education;
- Level of income;
- Level of risk;
- Impact from past disasters (i.e., previous disaster experience);
- Local strategies used to cope with risk/disasters (i.e., so-called coping strategies);
- The institutional support received to reduce and adapt to disaster risk;
- Other possible key factors or attributes.

In addition, one linear regression analysis was carried out to identify any relationship between educational level and level of income, two log linear analyses[4] to examine the interaction between some independent variables, and a t-test to assess if the averages of education of the focus and control groups are significantly different from each other.

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[2] 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.

[3] 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, as opposed to, for instance, trying to appreciate the risk based on a combination of these attributes.

[4] Log-linear analysis allows the user to test the different factors that are used in the cross-tabulation (e.g., gender, etc.) and their interactions for statistical significance (StatSoft, Inc. 2011).

For the San Salvador and the Rio case studies a total of 31[5] and 80 quantitative tests, respectively, were made. First, the results which were individually statistically significant with a 5 percent confidence level were identified.[6] In the following, a Bonferroni type adjustment[7] was performed to adjust the confidence level since the error probability increases with the number of tests conducted. In the following text, probabilities (before and after Bonferroni type adjustment) are indicated behind each result where appropriate (e.g., $p<0.003$, adjusted $p<0.16$). In some cases results with lower probability are included in order to highlight findings which are considered to be crucial to follow up in future studies.

To obtain a good approximation of 'reality', and thus reliability, and to deal with threats to the validity of the conclusions, like bias in the selection of cases, focus areas and self-report bias by the interviewees, different types of triangulation were used. These include data, methodological, theoretical and investigator triangulation (cf. Harvey & MacDonald 1993; Flick 2006). Remaining limitations are mainly due to the methods chosen for statistical analysis; differences in the context and approaches used for the two case studies; lacking historical data; and the very difficult access to existing data in the precarious and insecure study areas.

3 Climate Change Adaptation and Education: A Conceptual Framework

Disasters are commonly seen as the result of an interaction between so-called natural hazards (*H*) and vulnerable conditions (*V*). In other words, it is understood that hazards such as floods, landslides and windstorms 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 hazardous events, that disasters do occur; that is: "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" (UNISDR 2009:9).

On this basis, disaster risk is conventionally expressed in the following pseudo-equation:

$$R = H \cdot V \qquad (1)$$

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

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[5] 20 tests with the dataset from 2009/10, an additional 6 tests with an existing institutional database from 2003, and an additional 5 tests with another institutional database from 2005. Only the analysis of the 2003 database was considered of relevance, showing the situation before program implementation by FUNDASAL (Fundación Salvadoreña de Desarrollo y Vivienda Mínima), El Salvador.

[6] Meaning that the probability (p) for erroneously finding a correlation is at most 5 percent.

[7] The Bonferroni type adjustment calculates for a confidence level a and a number of tests n the confidence level for the entire set of tests as a/n (Goldman 2008). The different error rates allowed in this study were $a = 0.05$, $a = 0.10$ and $a = 0.16$. The individual probability (p) of each result was compared with the adjusted error rate (A). If $p < A$, the result is significant at the corresponding level a (meaning that the probability (p) for erroneously finding a correlation is at most 5 percent, 10 percent, and/or 16 percent).

While a disaster is said to be the result of "insufficient capacity or measures to reduce or cope with potential negative consequences" (UNISDR 2009:9), the definition of disaster risk (as represented by Eq. 1) does not include such capacities and/or measures, and consequently does not link the components of risk to appropriate risk reduction measures. In addition, actions related to recovery are often not mentioned as an inherent part of risk reduction.[8] However, preparedness for recovery is crucial for risk reduction since (a) both spontaneous and planned early recovery starts the moment a hazard occurs; (b) risk areas affected by a hazard are generally still in the process of recovering from earlier hazards; and (c) the term 'hazard' includes primary and secondary hazards (e.g., landslides or cholera after earthquakes and floods), and includes not only rapid but also slow-onset events which can develop over time or are successive (e.g., aftershocks) (Wamsler 2010).

The identified limitations led to the development of the extended definition of risk and risk reduction by Wamsler (2009) which directly links the different risk components to the corresponding risk reduction measures. These include not only measures of prevention (to reduce or avoid hazards), mitigation (to reduce vulnerability), and preparedness to respond (to improve post-disaster response), but also measures of preparedness to recover (to improve post-disaster recovery). This can be expressed by:

$$R = H/P \cdot V/M \cdot L_R/PP \qquad (2)$$

where *R* stands for risk, *H* for hazard(s), *V* for vulnerability, L_R for lack of mechanisms and structures to respond and recover, *P* for prevention, *M* for mitigation, and *PP* for preparedness for response *and* recovery.

The development of the extended risk definition has both theoretical and practical implications since the way risk is defined dictates how risk reduction is addressed (Slovic 1999). Notably, the four measures included in the extended risk definition are defined in a way to highlight that, for each type of measure, there are always two different ways to assist people to cope with or to adapt to changing climate conditions.[9] These are (a) directly reducing the corresponding risk component, or (b) increasing capacities to reduce the corresponding risk component, thus enabling societies to reduce their level of risk on their own. In both cases, the active participation of institutions and people at risk and the building on local patterns of behavior and existing coping strategies proved to be crucial for achieving sustainable change (Wamsler 2007). The latter includes evaluating the local strategies for reducing risk,

[8] Only recently has it become more and more accepted by scholars and practitioners to include actions related to recovery in the notion of preparedness (cf. UNISDR 2009).

[9] The definitions are as follows: Prevention (or hazard reduction) aims (to increase the capacity) to avoid or reduce the potential intensity and frequency of existing or likely future hazards that threaten households, communities, and/or institutions. Mitigation aims (to increase the capacity) to minimize the existing or likely future vulnerability of households, communities, and/or institutions to potential hazards/disasters. Preparedness for response aims (to increase the capacity) to establish effective response mechanisms and structures for households, communities, and/or institutions so that they can react effectively during and in the immediate aftermath of potential future hazards/disasters. Preparedness for recovery aims (to increase the capacity) to ensure appropriate recovery mechanisms and structures for households, communities, and/or institutions that are accessible after a potential hazard/disaster (including risk transfer and sharing).

supporting and improving effective ones, scaling down unsustainable practices and, where necessary, offer better alternatives.

Coping capacity is defined by UNISDR (2009:8) as "[t]he ability of people, organisations and systems, using available skills and resources, to face and manage adverse conditions, emergencies or disasters". In other words, it includes already used coping capacities (i.e., existing coping strategies) as well as potential, but so far unused, coping capacities. The skills and resources mentioned in this definition of coping capacity can be translated into the four risk reduction measures of Eq. (2), which would mean that a system's or people's coping capacity is their ability to reduce their overall risk by applying these measures. While the term 'adaptive capacity' is not included in UNISDR's glossary (2009), a definition can be found in the introduction to the IPCC Fourth Assessment Report, stating that "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). On this basis, and using the extended definition of risk described above, it can be assumed that people's adaptive capacity and people's coping capacity are determined by the same attributes or factors. Adaptive capacity and coping capacity are therefore used as synonyms in this study, as well as the associated process of increasing these capacities, namely, risk reduction and climate change adaptation.

Against this background, what are the key factors to people's capacity to cope with and adapt to increasing disasters? Income is often considered as *the*—or one of the—key factor (e.g., Blankespoor et al. 2010; Cutter et al. 2003; UN-HABITAT 2010; Kahn 2005; Lindell & Perry 2004; Toya & Skidmore 2005; Wisner et al. 2004). 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. 2004). In contrast, education is generally not considered to be a key factor to people's level of risk or their capacity to cope with and adapt to disasters. In fact, higher levels of education are generally only linked to a higher socioeconomic status and more lifetime earnings (e.g., Cutter et al. 2003). In other words, it is argued that it is only through its correlation with income that education is related to risk. In the context of models such as the Pressure and Release (PAR) Model[10] and the Sustainable Livelihoods (SL) approach[11] education is mentioned as one

[10] 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 urbanization. The dynamic pressures then 'translate' the root causes into unsafe conditions where people (on local, community or household levels) 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. 2004).

[11] The SL approach is a model, promoted for instance by 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. 2004:94-95).

of many factors that people use to obtain a livelihood, thus contributing to their capacity to cope with stress and shocks (including disasters and other climate-related impacts) (Wisner et al. 2004).

In recent studies, however, the question is raised as to whether formal education might in fact play a more central role in determining people's adaptive capacity. Adger et al. (2004), Toya & Skidmore (2005) and Blankespoor et al. (2010) demonstrate, for instance, how a lower level of formal education, independent of income, is correlated with increasing numbers of deaths or other forms of loss from disasters, by combining different indicators of education with data from the OFDA/CRED International Disaster Database. 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. Toya & Skidmore (2005) use data on the total years of schooling attainment for the population aged 15 or over in *Economic Development and the Impacts 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 per GDP. The correlation is particularly strong for developing countries for which the level of formal education proves more significant to disaster losses than for income levels. In *The Economics of Adaptation 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 that invest in female education suffer less disaster-related deaths. Summarized, these studies are a strong indicator that formal education, as well as gender equality in education, seems to play a more important role in determining people's level of risk than what has been previously considered. The studies presented focus on different aspects related to education and risk, such as access to information,[12] understanding of risk,[13] decision making,[14] and the empowerment of women,[15] but lack a more

[12] As pointed out by Adger et al. (2004), literacy plays an important role in determining access to information about the urgency of adaptation to climate change and the assistance that will be offered by governments.

[13] According to Adger et al. (2004), 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. Toya & Skidmore (2005) 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 makes people generally less likely to understand or respond to warnings (Cutter et al.2003) and/or obey evacuation instructions (Lindell & Perry 2004).

[14] Education is said to be a fundamental determinant of poverty and marginalization (e.g., Adger et al. 2004; UNDP 2004). 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 the decision-making processes, including risk governance (UNDP 2004). Adger et al. (2004) 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. On a national and international level, some researchers argue that a higher educational attainment could be an important asset for finding new solutions for how to tackle the adverse effects of climate change. According to UNDP (2004), a more educated population will, for instance, be better able to partner with experts in designing ways of protecting urban neighborhoods and rural communities.

[15] 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.

comprehensive analysis of the importance of education versus the different aspects or components that form a part of people's level of risk.

4 Results: Risk to Climate-Related Disasters

The conceptual framework presented in the previous section directly links to the research objectives of this study, which analyze the role of formal education as regards (a) people's level of risk, (b) their coping strategies, and (c) the institutional support they receive. According to the extended view of risk, both the local strategies and the institutional support to cope with and adapt to climate-related disasters form part of the risk reduction measures available at the community and household level and thus belong under the denominator in the extended risk equation (see Eq. 2). In other words, the second and the third research objective are in fact part of the first research objective, since local coping strategies and institutional support are part of the factors that determine people's level of risk. The difference in the factors that influence people's level of risk can also be called differential vulnerability.

4.1 Quantitative analysis of risk factors—differential vulnerability

This section presents the results of the quantitative analyses of the factors that influence people's differential vulnerability. The following four datasets formed the basis of the analyses:

(a) Survey data from the San Salvador case study (carried out in 2009/10);
(b) Survey data from the Rio case study (carried out in 2010/11);
(c) Institutional database of the low-income settlement *Los Manantiales* in San Salvador;
(d) Institutional database of the low-income settlement *Divina Providencia* in San Salvador.[16]

4.1.1 Average levels of education in high- and low-risk areas

The analysis of all four datasets indicates lower levels of education for households living at high risk as opposed to residents of lower risk areas. In other words, a correlation was identified between people's level of education and people's level of risk. Tables 1 and 2 show the comparison of the average number of years of schooling of the focus and control groups, considering both the average level of education of the heads of households and the average level of all (adult and working) household members.[17, 18]

2010). For instance, educated women tend to have less children (e.g., Busso 2002), and a smaller number of dependents can in turn make families less vulnerable to hazardous impact (Cutter et al. 2003).

[16] *Divina Providencia* forms part of the San Salvador case study and was included in the survey from 2009/10 (cf. Section 2).

[17] The average levels of education of the family member with the highest level of education could also be compared. In San Salvador, the results were an average of 9.4 years of schooling for the low risk areas and 9.0 years of schooling for the high risk areas, while in the Rio case study an average of 9 years was identified for both the focus and the control group.

Table 1. Average education and income levels in focus and control groups (i.e., people living in high-risk and lower-risk areas) based on recent surveys.

		Average education of head of household (years)	Average education of household members (years)	Average income of head of household (US$ / BRL)*	Total income of household (US$ / BRL)*	Household income per person (US$ / BRL)*
San Salvador case study	**High risk**	5.0	** 6.2	111	243	57
	Low risk	5.7	*** 7.0	71	259	59
Rio case study	**High risk**	5.6	6.5	818 (≈US$ 485)	1258 (≈US$ 746)	442 (≈US$ 262)
	Low risk	7.0	7.1	801 (≈US$ 475)	1478 (≈US$ 876)	568 (≈US$ 278)

* US$ for San Salvador (local currency); BRL for Rio.

** If only those who receive income are included, the average is 6.5.

*** If only those who receive income are included, the average is 7.3.

Table 2. Average education and income levels in focus and control groups (i.e., people living in high-risk and lower-risk areas) based on analyses of institutional databases.

		Average education of head of household (years)	Average education of household members (years)	Average income of head of household (US$)	Total income of household (US$)	Household income per person (US$)
San Salvador Manantiales (2003)	**High risk**	5.0	5.8	181	269	60
	Low risk	5.8	6.3	171	288	74
San Salvador Divina Providencia	**High risk**	2.1	3.0	64	143	39
	Low risk	4.4	5.0	86	92	49

[18] Allowing a 10 percent error rate, in the case of *Rocinha* only the difference between the (lower) average levels of education of the heads of households in the high risk area *Laboriaux* versus the (higher) averages in the low-risk area *Cachopa* proved to be significant ($p<0.082$). T-tests were conducted to analyze if the differences in averages are statistically significant. The fact that none of the differences was statistically significant at the 5 percent level can be explained by the fact that a larger number of people would be needed in each group to prove that the identified differences did not happen by chance.

4.1.2 Relationship between education and income

Based on the results presented in the previous section, it was considered of interest to determine whether there is a direct relationship between education and income in the study areas. Thus, the average levels of income of the focus and control groups were analyzed. In addition, a series of cross-tabulations, $\chi 2$ tests and a linear regression analysis were conducted.[19]

As opposed to the analyses of the average levels of education, the analysis of the average levels of income of the four datasets does not show a clear tendency and, thus, no clear correlation could be identified between people's levels of income and people's level of risk. In fact, Tables 1 and 2 show higher average incomes of the heads of households living in high risk areas (as opposed to those living in low risk areas) for three out of the four datasets. Looking at the average income per household member, the analysis of all four databases indicates a slightly higher income of those family members at lower risk. However, in the case of the San Salvador survey (Table 1), the difference of only US$ 2 is negligible. This result is confirmed with the linear regression analysis of the San Salvador survey which shows no relationship between income and education. However, the 2003 database of *Los Manantiales* shows a significant[20] correlation between (a) the average educational level of those over 18 years of age and the total household income ($p<0.001$; adjusted $p<0.05$), and (b) the total household income and the educational level of the head of the household ($p<0.002$; adjusted $p<0.10$). The database of *Divina Providencia* did not allow similar analyses.

In the Rio case study area, the cross-tabulation and $\chi 2$ tests did not show any significant correlation between education and income at the household level. However, for the female residents a significant correlation was identified between their level of education and income ($p<0.003$; adjusted $p<0.16$). No such correlation could be found for men. In other words, in the study area and only for women, it is very likely that a higher educational level leads to a higher income. While a similar analysis was not possible in the context of the San Salvador case study, the data analysis shows that the two most educated women (13 grades or higher) have a higher average income (i.e., US$ 325) than the men at the same educational level (i.e., US$ 207). In addition, the least educated women earn on average considerably less than the least educated men. Finally, allowing an error rate of 10 percent, in the Rio case study none of the differences in income proved to be significant.[21]

4.1.3 Disaster impacts and education

To investigate the factors that influence people's level of risk, different analyses were conducted to identify possible correlations between education and:

- Impacts from past disasters;

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[19] For the linear regression, average household monthly income was used as the response variable, and average household education in years as the independent variable.

[20] Based on $\chi 2$ tests and Bonferroni type adjustments.

[21] In the Rio case study, only by allowing a 32 percent error rate, a significant correlation could also be identified between the educational level of the highest educated person in the household and the total household income ($p < 0.004$; adjusted $p < 0.32$).

- Living in a (declared) risk area;
- Knowledge of existing risk factors;
- The use (and number) of coping strategies;
- Institutional support received.

Analyses were made in order to analyze correlations between (a) the impact levels of past disasters; (b) past disaster impacts and the use of coping strategies; and (c) people's own risk evaluation and assistance received to reduce risk. Related results are presented below.

Factors influencing past disaster impacts

A series of cross-tabulations was conducted to identify a possible correlation between people's level of education and the way they were affected by past disasters. In the context of the San Salvador case study, additional cross-tabulations were conducted to assess whether previous disaster experience has an effect on households' level of disaster risk (comparing the impact levels of Hurricane Mitch and the impact levels of Hurricane Stan).

Importantly, the analysis of the 2003 database of *Los Manantiales* shows a correlation between the educational level of the heads of household and disaster risk ($p<0.0015$; adjusted $p<0.10$),[22] while no correlation could be found between income levels and disaster risk. Even by allowing a 16 percent error rate, the analyses of the other databases of the San Salvador and the Rio case studies did not indicate any correlation between income or education and past disaster impacts. However, in the San Salvador case study, a clear correlation could be found between the way in which households were affected by Hurricane Mitch in 1998 and the way in which the same households were affected by Hurricane Stan in 2005 ($p<0.001$; adjusted $p<0.05$).[23] No such analysis could be made for the Rio case study. Here, data pointed toward a possible correlation between a lower mean educational level of households and living in a high-risk area (i.e., in *Laboriaux*) ($p<0.005$, adjusted $p<0.4$).

Factors influencing people's way of coping

To assess if people's use of coping strategies is influenced by their level of education, income, and/or past disaster impacts, cross-tabulations were performed using these variables.

The San Salvador case study did not show any significant correlation between education or income and (conscious) strategies taken to cope and adapt to (increasing) disaster risk. However, the analyses indicate a significant correlation between past disaster impacts and the use of coping strategies ($p<0.001$; adjusted $p<0.05$). In other words, those households who in the past were affected the most were also most likely to

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[22] Only significant at 10 percent after Bonferroni type adjustments using six as total number of analyses made.

[23] 68.8 percent of those households which were not affected by Hurricane Mitch in 1998 were also not affected by Hurricane Stan in 2005; 82.6 percent of those households which were affected only a little by Hurricane Mitch in 1998 were also affected a little by Hurricane Stan in 2005; and 83.3 percent of households affected a lot by Hurricane Mitch in 1998 were also affected a lot by Hurricane Stan in 2005.

take risk reduction measures into their own hands (76.9 percent for Mitch; 88.2 percent for Stan).[24] To further explore this relationship, another cross-tabulation was applied using three variables: household level of income, coping strategies taken, and past disaster impact. As a result, a significant correlation was found indicating that those in the high-income group (US$ 201 or more) were found to be more likely to take coping strategies to lessen their disaster risk than those in the low-income group (0–200 US$) ($p<0.0023$; adjusted $p<0.10$ for Mitch / $p<0.0001$; adjusted $p<0.005$ for Stan).

In the Rio case study, the level of education could be tested against (a) whether or not households had (consciously) taken coping strategies to reduce their level of risk, and (b) the number of reported coping strategies. The result was the identification of a significant correlation between the educational level of the interviewee and his or her ability to mention any types of risks in the settlement ($p<0.00013$, adjusted $p<0.0104$). This was the most significant result of the Rio case study, meaning that interviewees with lower education were more likely to see their surroundings as risk-free, while those with higher education were more aware of existing risks. It was also found that interviewees with a higher level of education were able to point out a higher number of risks in the settlement ($p<0.003$, adjusted $p<0.16$). In the San Salvador case study, the survey data did not allow a similar comparison.[25]

Factors influencing institutional support

In order to assess if education, income, and/or past disaster impacts influence the institutional support households receive to cope with and adapt to disasters, a series of cross-tabulations was carried out. No significant correlations could be found. However, the data shows that in both case study areas the families living at high risk have received more institutional help than those at lower risk. Despite the institutional support received, out of these families 36 percent in the San Salvador case study and 63.3 percent in the Rio case study state that their current level of risk is similar or even worse than before. Additional analyses suggest that there might be a correlation between households being able to express being at risk and having received institutional support. Allowing a 40 percent error rate, in *Rocinha* a significant correlation could be found between reporting to be at risk and having received institutional help ($p<0.005$, adjusted $p<0.4$).

4.2 Qualitative analysis of risk factors—differential vulnerability

This section presents the qualitative analyses of the factors that influence people's differential vulnerability. The results show how disasters affect people living in informal settlements such as *Los Manantiales* and *Rocinha,* and how this is related to their level of formal education. In contrast to the quantitative analyses presented in the previous section, the qualitative analyses do not investigate the relative importance of

[24] The next most likely were those households that were affected a little (71.4 percent for Mitch; 67.4 percent for Stan). Households that were not affected were the least likely to take disaster risk reduction measures (41.2 percent for Mitch; 8.3 percent for Stan).

[25] Here, interviewees only had to state if their level of risk is low, moderate, or high. On this basis, no correlation could be found between education and the answers.

education (as opposed to other factors such as income), but aim at providing illustrative examples of the kind of influence education can have on people's level of disaster risk. It thus provides an understanding of *how* education is linked to the conceptual framework presented in Section 2.

4.2.1 Education: Direct effect on aspects that reduce risk

In both the San Salvador and the Rio case studies it was found that education can have a direct influence on people's level of risk and associated risk reduction. Based on the comparison of data obtained from interviews, observation and relevant literature, formal education is considered to have a positive effect on people's:

- Awareness and understanding of existing risk;
- Access to (and provision of) information on risk reduction;
- Acceptance and adequate use of institutional support;
- Way of coping (by improving their own risk reduction strategies).

As regards the latter, two issues that are related to formal education were identified to be of special relevance for efficient local coping. These are a) having a formal job, and b) people's possibilities for (or interest in) moving to a lower risk area within or outside their settlement. The following sections describe these outcomes in more detail.

Awareness and understanding of existing risk

The statistical analyses of the Rio case study show a correlation between people's level of education and their ability to perceive existing risks (see Section 4.1.3). The interviews with key informants and residents confirm this result. A representative of the Civil Defense of Rio de Janeiro states, for instance, that their work in *Rocinha* clearly shows that formal education is directly linked to people's ability to perceive risks. With risk awareness being a necessary condition to engage in disaster risk reduction (UNISDR 2002), this demonstrates the vital role of education for people's adaptive capacity.

In contrast, in the San Salvador case study—upon probing virtually all interviewees at high risk (i.e., 97 percent)—named either flooding or landslides as an imminent risk to their lives, and the majority (i.e., 83 percent of the focus group) could mention at least one factor that makes them more vulnerable (as compared to other residents living at lower risk) (Wamsler 2007). However, the qualitative analysis of the 2006 interviews shows that it was the illiterate interviewees at high risk who could not mention any additional risk factors.

Access to (and provision of) information on risk reduction

In both the Rio and the San Salvador case studies, observation and interviews with residents suggest that a higher level of education has a direct effect on people's access to information. This includes information on existing:

- Hazards and other threats;
- Safer places to live;
- Measures to reduce risk;

- Knowledge on potential institutional support;
- Laws and people's own rights.

As an example, Ana, a highly educated female resident from *Rocinha,* mentions searching for risk information on the web as one of her main coping strategies (see Box 1). The improved access to information and the associated knowledge gained allows people to create new ideas and to chase after opportunities to improve their situation. Residents from *Rocinha* also suggested that better educated people have better means to express themselves, which is crucial for informing others (including authorities) about their own risk situation. In line with this, key informants state that people with higher levels of education are more likely to be successful in their contacts with authorities and emergency officials. A local community worker from *Laboriaux* states, for instance, that formal education often proves valuable for people at risk in their contact with emergency officials. This was also confirmed in the San Salvador case study, where those residents with the lowest levels of education were the ones who frequently mentioned that (a) they do not have any idea of how they could improve their situation, and (b) that they do not know of any institutions which could assist them.

Box 1. Access to information on risk reduction.

Ana, single mother, 40 years old, 11 years of education, is currently taking tests to enter university to study journalism. She lives in *Cachopa*. She has not received any institutional support to improve her situation, but she managed to get a stipend from the renowned and private language school Cultura Inglesa for her son to study English. When asked about the ways she copes with existing disaster risk, she mentions a range of different strategies including:

- Looking for risk information on the internet;
- Investing in the structure of the house;
- Improving the electricity (distribution and outlets);
- Not throwing trash on the streets;
- Sending her son to study outside the *favela* (slum).

When asked about her interest in moving to another and more secure area, Ana states that there is a difference between *living in* a *favela* and *being* the *favela* (thus referring to the associated stigma of its residents), and then highlights that she *only* lives here because she does not have the possibility to live anywhere else.

At an individual level, increased awareness and understanding of existing risk, together with better access to and provision of information on risk reduction, are important preconditions to reduce existing risk by (a) accepting and/or adequately using institutional support, and (b) improving people's own way of coping (see the following sections). At the community level, an unequal distribution of information on risk reduction was shown to create tension among residents, which negatively affects community-based risk reduction (Wamsler 2007).

Acceptance and adequate use of institutional support

The qualitative analyses of both case studies suggest that people with higher levels of education are more likely to be responsive to disaster warning and alerts (cf. Cutter et al. 2003; Lindell & Perry 2004). The Civil Defense of Rio de Janeiro informs that the negligence of their warnings and alerts is one of the principal reasons for the differential vulnerability of people living in the same community. A community worker residing in *Laboriaux* supports this, stating that education makes residents less suspicious towards the authorities and more likely to accept institutional support, if considered adequate. In the San Salvador case study, no such clear correlation could be found. Here, people from all educational levels were mentioning both the importance and the uselessness of emergency organizations such as emergency committees, fire fighters and the police. However, observation suggests that people's level of education influences people's adequate use of institutional assistance (see Box 2). This refers to people's active participation, maintenance of physical risk reduction measures, regular contributions to local emergency funds, and the adequate use of credits received. The latter is confirmed by a community leader who states that it is not the quantity, but the inadequate use of money which is a determinant for residents' high level of risk.

Box 2. Acceptance and use of institutional support.

Francisca lives with her husband and her baby in the high-risk area *Laboriaux*. She is 26 years old and has 8 years of education. When asked how she copes with the imminent risk of landslides, she mentions a range of different strategies including staying at home in order to not miss any information from the Civil Defense Service.

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Maria, a female resident from *Los Manantiales,* 6 years of education, takes an active part in the community-based work offered by the institution FUNDASAL to reduce existing risk. While several interviewees expressed their reluctance to actively participate, she says: "It is true that we [meaning the poor] have to work [in order to reduce our risk], but this is how it is, we have to work hard if we really want to make a change here and have a better life."[26]

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A technical staff member working in *Rocinha* for the governmental program, Programa de Aceleração do Crescimento, describes the importance of education: "Facing a disaster, the affected families have a lot of issues to solve and to deal with. Those who have a better education can generally cope better with the post-disaster situation than those who have less education, […] because education helps them to make better decisions, for instance, when they have to decide where to go to an

[26] Original citation: "Es cierto que a nosotros nos toco trabajar, pero así tiene que ser algo que le cueste a uno, para vivir mejor."

[27] Original citation: "Visto a haver um desastre, as familias involvidas têm uma dificuldade a enfrentar. Então os que têm melhor educação podem enfrentar melhor dos que têm menos, […] porque a educação possibilita tomar decisões mais acertadas. Num caso de recorrer um abrigo, de acionar um poder público, ou acionar um outro poder, uma outra ajuda; a educação vai contribuir. Então com certeza a educacão é determinate."

emergency shelter, when they have to deal with authorities or other institutions which offer different types of assistance, etc. These are cases where better education will be of help. Hence, people's education is certainly a determinant [for people's level of risk]."[27]

Improvement of own coping strategies

In both study areas, it was only after probing that around 65 percent of the interviewees could mention any kind of strategies or improvements made to reduce their risk. However, observation and interviews with key informants show that virtually all the residents in *Los Manantiales* and *Rocinha* are actively adapting to their risk situation, which is a common feature in many southern low-income settlements (cf. Jabeen et al. 2009; Wisner et al. 2004, 2007). The strategies the residents are aware of, and thus are consciously applying, are mainly of a structural or economic nature (such as improvements in their houses and the surrounding areas, saving money, taking credits). After probing, it is mainly those interviewees with a higher level of education who mention, and actively use other types of strategies. These include strategies that are directly related to education, such as:

- Sending children to study outside their own settlement (see Box 3);
- Temporarily sending children to study outside their own settlement (only after disaster occurrence) (see Box 3);
- Improving physical access to school (e.g., cementing streets so that children do not sink into the mud, or building small wooden bridges where landslides washed away parts of the street);
- Encouraging dependents to study;
- Taking a job outside their own settlement;
- Being able to change one's employer (e.g., depending on changing demands which can also be influenced by climate variability and extremes);
- Staying constantly informed about existing risk (by using different sources).

Box 3. Improved coping through education—education as a conscious strategy.

Ana, single mother, 11 years of education, lives in *Cachopa*. When asked how she deals with existing risks, she mentions sending her son to study outside the *favela* so that his education is not affected by the problems within the *favela,* including natural hazards, shootings, power cuts, striking teachers, etc. In contrast, Francisca, single mother, 8 years of education, living in *Laboriaux,* was sending her two eldest sons to the local school. However, after the devastating landslides in 2010 and the resultant closure of the local school, she decided to send them to her mother. Francisca mentions this as an active strategy to cope with the recent disaster. She highlights that she does not want her boys to miss any classes and that she is afraid she will not be able to run out of her house with her two boys *and* her baby in case of another landslide.

Data suggests that it is not necessarily the number of strategies, but the use of different types of strategies that differs between people of different educational levels. This increases the likelihood of tackling not only one, but several different risk components (i.e., existing hazards, vulnerabilities, response mechanisms and recovery mechanisms). In contrast to education, the qualitative analysis shows that increased income often leads to an increased number of, or focus on, physical improvements, which does not necessarily lead to reduced risk (Wamsler 2007). Lost efforts due to destroyed contention walls and embankments were frequently mentioned. In addition, better-off households are more likely to opt out of community engagement, which can have a negative effect not only on social cohesion but on the disaster resilience of the entire community (Wamsler 2007).

Finally, two education-related issues were identified to be of special relevance for efficient local coping: having a formal job and people's interest in moving to a lower risk area (within or outside the settlement). The following sub-sections explain their potential to reduce risk and how they are related to people's level of education.

Possibilities of attaining a formal job

Neither the qualitative analysis of the San Salvador study nor the Rio case study indicates a strong correlation between formal education and income. However, both studies show the importance of having a formal job for coping with disasters. In fact, supporting dependents to obtain a formal job is part of people's coping strategies (Wamsler 2007). Interviewees state that a formal job allows them an easier and/or cheaper access to:

- Post-disaster credits (directly from employers or from banks, etc.);
- Life insurance (for family dependents left behind);
- Pension after retirement or in case of the inability to work;
- Secure income (e.g., job not vulnerable to climate variables and extremes);
- Health insurance (allowing better and cheaper treatment) (see Box 6);
- Possibility to take (paid) sick leave (e.g., after disasters);
- Other workers' benefits (such as a 13th salary, regulated hourly rates, staff security regulations/equipment);
- Direct post-disaster assistance from employers (such as construction materials);
- An official address (of the employer) required to register children at school.

The importance of these issues is shown in the case of an informal worker living in *Divina Providencia* who pays into the social security system through deals with entrepreneurs who certify his employment, thus getting (illegal) access to formal insurance mechanisms.[28] In addition, people working in the informal sector often need to work at several jobs and, thus, have little time left over for community-based efforts to reduce risk (Wamsler 2007). Finally, interviewees suggested that the level of formal education is a determinant for people obtaining a job in the formal sector (see Box 4),

[28] Note that in the San Salvador case study only 26 out of the 331 residents included in the study had access to the Salvadoran social security system. The low number not only reflects the low number of residents having a formal job, but also the fact that employers take advantage of low-income people by offering formal jobs without any formal benefits.

and that the correlation between formal education and income is less likely for male residents. The latter relates to the fact that there are more well-paid jobs for men (than for women) that do not require any formal education (such as motorcycle taxi driver and bartender).

Box 4. Importance of having a formal job to cope with disaster risk (and link to education).

"When I was living in the *favela*s in the 1960s, parents commonly warned their children: 'If you drop out of [elementary] school, you won't be able to get a job and you'll end up collecting garbage.' Several years ago when I was in Rio, 200 vacancies opened up for garbage collectors. Over 4,000 people applied and a high school diploma was mandatory" (Perlman 2010:231).

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According to the Director of *Rocinha's* Residents' Association, the residents' level of education influences their level of disaster risk in two ways. 1) lower education generally influences a higher number of children per family and, 2) it restricts people's access to the formal working sector. Regarding the latter, he states: "These [less-educated] residents may not be able to get a [formal] job, since many formal jobs require a certain level of education, degree. And we know that not having a [formal] job, or only having an [informal] job with low wages, makes people incapable of moving out [of the risk zone] and to a better place."[29]

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In *Cecilio del Valle*, Mercedes reports on her uncle who recently died, leaving behind four children. Since her uncle had a formal employment, she is now getting his life insurance: "This allows us to take care of his house and the children. He left behind four small children, the oldest one will soon be 14."[30]

Moving out of a risk area

Although the quality of the education available to people in low-income settlements in San Salvador and Rio is often sub-standard, the study found indications that education may be the key to moving to a more secure area. This includes low-risk areas within the same settlement, and (to a lesser extent) moving to a formal part of the city where risk and risk reduction is less shaped by informal processes. More interviewees with higher education mentioned moving somewhere else as a potential option and had some ideas of how this could be realized. In *Los Manantiales,* an illiterate resident living at high

[29] Original citation: "Talvez pela pessoa não poder ter aquela oportunidade de emprego, como muitos empregos exigem um grau de escolaridade, instrução. E a gente sabe que afeta muito o pessoal não tem condições de sair dalí para um lugar melhor, devido a não ter emprego, ou ter emprego com salário muito baixo ... só da para sustenar a família." Note that when using the word emprego (employment) people refer to a formal employment (with carteira assinada). This is also confirmed by Janet Perlman (2010). For a more causal job people use the term trabalho (work).

[30] Original citation: "Ya lo que nosotros podemos hacer es cuidar la casa y por los niños. Ha dejado 4 niños chiquitos, la mayor va a cumplir 14 años, verdad."

risk clearly stated his wish to move away, but without any specific idea or plans. In accordance, several community leaders mentioned a direct correlation between a resident's level of education and having a long-term vision and life plan.

In a longitudinal study about Rio de Janeiro's informal settlements, Perlman (2010) found three factors that increased the likelihood of a person moving from the *favela* (slum) to a *bairro* (formal settlement). In the study, the people who moved tended to be the ones who (a) had fathers with relatively more education; (b) had more education themselves; and (c) were more knowledgeable about Brazilian politics. In contrast, no correlations were found between moving out from a *favela* and people's income level. In the same study, staying in an informal settlement was found to be correlated with other indicators of wellbeing, such as having a formal job, being a homeowner, and/or being active in a community organization (Perlman 2010). Interestingly, while this is confirmed in the San Salvador case study, it also indicates that people with a formal job often express interest in moving to a low-risk area *within the same* settlement. In fact, all the interviewees who had an exceptionally high level of education and a formal job (at a governmental agency) had been moving to a lower risk area within their respective settlement (namely, *Los Manantiales* and *Cecilio del Valle*). Finally, both the San Salvador and the Rio case studies demonstrate the importance of women as *the* pushing factor for families to move out, mainly motivated by their strong wish to protect their children (see Box 5).

Box 5. Education and interest in moving to lower risk areas.

> During an interview in *Los Manantiales*, Esperanza expressed that she has always wanted to move somewhere else in order to protect her children. However, her husband has never been willing to move, creating a lot of stress and tension, which finally led to their separation: "I can tell you that in the past, until recently, it was nearly impossible to live here [due to all the disasters occurring], and I was close to moving somewhere else, and I even escaped with my children and got separated from my husband, because he never wanted to leave this place."[31] Esperanza finally did not move out of *Los Manantiales* since her risk level reduced considerably with the help of FUNDASAL's upgrading program.

4.2.2 Education: Mitigating effects on aspects that increase risk

Both the San Salvador and the Rio case studies found that a higher level of education has an influence on risk due to its potential to reduce underlying risk factors. These risk factors were identified to include:

- Poor health;
- Organized crime and corruption;
- Teenage pregnancy and single motherhood;

[31] Original citation: "Yo le puedo contar que más antes, quizás daba hasta decepción vivir aquí, yo por poco me iba de aquí, hasta nos escapamos de separar con mi esposo, porque nunca se iba de aquí."

- Informal settlement growth, including the residents' stigmatization, exclusion from formal decision-making processes, insecure tenure, and inadequate housing and infrastructure.

The related analyses and outcomes presented below describe: (a) the appearance or relevance of the issue in the context of the case study areas; (b) its relation to education; and (c) its influence on disaster risk. It is thus illustrated how education can have a mitigating effect on underlying risk factors, how this is linked to the conceptual framework presented in Section 2, and how the different factors are mutually reinforcing.

Poor health

Context. In *Los Manantiales* and *Rocinha*, people's physical and mental health status is very low when compared to the surrounding formal settlements. Lacking waste and waste water facilities, contaminated spring wells, overcrowding, violence and poorly ventilated houses are part of the causes for the high number of illnesses. *Rocinha* has, for instance, a disproportionately high concentration of tuberculosis cases, which is similar to the tuberculosis concentration in some African countries which lack basic healthcare (Verly 2009). Informal and physically demanding work is another reason why people repeatedly report having physical and mental health problems in both case study areas.

Education→poor health. People's level of education is an important determinant of health. In fact, the number of years of schooling has been identified as the second most relevant variable to the health status of adult Brazilians (after age) (Fonseca et al. 2000). The progression of diseases, such as tuberculosis, is exacerbated by frequent abandonment of treatment which is directly related to low levels of education (e.g., Ferreira et al. 2005). Interviews further revealed that many of the less-educated residents of *Los Manantiales* and *Rocinha* are forced to take on informal jobs which are often physically demanding, with unregulated working hours, few safety restrictions, and no health insurance, leading to an accentuated number of injuries, physical wear, and mental stress.

Poor health→disaster risk. While good health is said to be a key resource to disaster survival (e.g., Enarson 2000; Wisner et al. 2004), health deficiencies make people more vulnerable. As illustrated in Box 6, poor health (including injuries and debilitating illnesses) reduces people's possibilities to earn a living and might force other family members to leave school early to support their family. Interviews suggested 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 low-income area. Furthermore, health is a determinant to people's capacity to respond to disasters. For example, interviews and observations showed that a timely evacuation in the steep stairways and winding alleyways may be very difficult for a person with a reduced physical capacity. In this context, Box 6 describes the situation of a handicapped man who lost his wheel chair during the floods after Hurricane Stan. People's health is also likely to affect their capacity to recover. For example, an already weakened immune system decreases the chances to withstand the infectious diseases that are often spread in the aftermath of disasters (cf. Wisner et al. 2004). Another example is illustrated by a woman living in the high-risk area *Laboriaux*, who did not suffer any direct disaster

impact after the 2010 landslides. However, due to already having a history of psychological illness, the landslide affected her strongly and she had great difficulties to return to the way she had lived before.

Box 6. Poor health: An education-related underlying risk factor.

Claudia, a less-educated female resident of *Los Manantiales* suffers from kidney malfunctioning. Before falling sick, Claudia was earning money by informally cleaning in different households outside the settlement. During an interview she illustrated how not having health insurance and the resulting difficult access to adequate health services has caused her health to deteriorate and, thus, increased her level of disaster risk: "No, it would just be fantastic if I would have any [health] insurance. The insurance makes a big difference. Without it, I have to go to the Hospital Rosales and wait there for around 3 days in the emergency room until I can get a bed. In theory, I would have to do this every week, but [because of this situation] I do not go any more […] and therefore my health has been getting worse."[32] Claudia's son just finished his third year at school. Due to his mother's health and resulting financially difficult situation, he is now forced to leave school in order to earn money for her and his family. His mother is not happy about this, but she is proud that her son is taking responsibility: "You know, this boy is very smart. He would like to continue studying at the University, but now this is not possible. No, because he has to work. 'Since I am helping you mom', he tells me."[33]

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Ernesto is an illiterate resident of *Los Manantiales*. He has lived all his life next to the river, but now his situation makes him worry because he lost his leg in a work accident, lost his wheel chair (which had been given to him by a church) during the floods in the aftermath of Hurricane Stan, and is now responsible for taking care of his two grandchildren: "I have always been living on the river banks, but when I could still walk this did not worry or afflict me. But now it does […] And imagine, my daughter leaves me here with her 2 children."[34] Since not only Ernesto's wheel chair, but also his house and his land were washed away during Stan, he is currently living on his neighbor's land. His son had to leave school and is unable to work, because he has to take care of his handicapped father.

[32] Original citation: "No, a que galán que tuviera seguro yo. El seguro es más distinto, en el Hospital Rosales para irme hacer estas diálisis tengo que irme a estar 3 días en emergencias para ver si hay camillas, para entrar para adentro. Cada 8 días tendría que irma, pero yo ya no estoy hiendo, […] y por eso es que me he puesto más mal."

[33] Original citation: "Fíjese que es inteligente ese muchacho. La idea es de él de seguir estudiando en la universidad, pero como ahorita no. No pues si tiene que trabajar. Como le estoy ayudando mamá, me dice."

[34] Original citation: "Vivía siempre a la orilla del río, pero antes no me afligía porque podía caminar, pero ahora […] Fijese, que aquí me deja mi hija con los dos niños".

Organized crime (and corruption)

Context. Like many other informal settlements in Latin America, *Los Manantiales* and *Rocinha* are controlled by violent and rival gangs and associated drug trafficking movements. In the San Salvador case study, flooding and landslides were generally seen as the main risk to lives and livelihoods. Earthquakes and windstorms ranked next in importance, together with the lack of job opportunities and the insecurity due to *maras* (gangs). There are daily reports of residents of *Los Manantiales* being killed, harassed, violated and robbed (FUNDASAL 2010). In the Rio case study, the most frequently mentioned risk after landslides was to be caught in the crossfire during one of the police's sporadic raids in their effort to control violent gangs or search for drugs, contraband, firearms and stolen goods. Abandoned by regular law enforcement, the residents of *Los Manantiales* and, to a greater extent in *Rocinha*, must rely on the gangs to keep order, allowing the residents to go about their daily lives.

Education→organized crime. In San Salvador, community leaders explicitly mention that they can see a direct relation between level of education and violent behavior shown in the form of organized crime and intra-family violence. In both contexts, it was found that children who drop out of school are more easily recruited by criminal gangs (Dowdney 2003; FUNDASAL 2010).[35] The glamorization of 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, status items (like sneakers and IPods), attractive women, and perhaps most importantly; respect and inclusion (Dowdney 2003). 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). The difficult access to the employment market for youngsters coming from informal settlements is another contributing factor to the steady inflow of new recruits to criminal gangs (Perlman 2010; FUNDASAL 2010). This creates a vicious circle where the violent gangs and associated turf wars add to the stigmatization and employers' discrimination of people with a *tugurio* or *favela* address.[36] The direct link between education and organized crime is confirmed by Dowdney (2003) who argues that primary and secondary education is one of the most important measures to sustainably reduce the enrolment to the drug industry.

Organized crime→disaster risk. Because of the violent conflicts between different gangs and the police, male life expectancy is low,[37] and many residents fear the police and see them as corrupt and brutal. This creates widespread mistrust, not only in police officers, but in any kind of authorities, including emergency and development planning officials. In the San Salvador case study, national and municipal governments were often seen as unhelpful and even a hindrance to people's risk reduction efforts. This has direct consequences for institutional support for prevention, mitigation, response and recovery. In addition, organized crime, corruption and political

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[35] 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).

[36] In El Salvador, informal settlements or slums are called *tugurio*, in Rio they are called *favela*.

[37] In the interviews it was said that the young men involved with the *tráfico* (the drug trafficking movement) often do not live to age 25.

factionalism have an eroding effect on trust and social capital *within* the informal settlements, affecting local community cohesion and community-based coping mechanisms (Wamsler 2007). It also dilutes the information flow about jobs and other opportunities that is spread through informal community networks (Perlman 2010), including information on potential risk reduction and available institutional support. In Rio, 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 organizations has drastically decreased (Perlman 2010). Observations and interviews show that in both case study areas, the affected people are highly dependent on mutual help. Loss of social capital due to organized crime can thus be assumed to have serious effects on people's level of risk. In addition, organized drug trafficking can be seen as a direct factor to the availability and abuse of illegal substances, which can lead to increased risk. Alcohol or drug abuse may affect people's vulnerability in several ways, for example by causing economic hardship, difficulties in managing a job, or lead to social disintegration (Uchtenhagen 2004; NIDA 2010), thus increasing the impact of a potential disaster. Interviews disclosed that 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, not making sure that they go to school). Interviewees described the trafficking movement and the associated drug abuse and violence as a threat to health and wellbeing, for example through increased mortality and psychological stress for the residents (cf. Uchtenhagen 2004; Box 7).

Box 7. Organized crime and corruption: An education-related underlying risk factor.

Several interviewees report how rivalries between different groups (of different political parties or different violent gangs), in combination with corruption, negatively influence adequate assistance. Luis, living in *Cecilio del Valle,* states: "The contention walls were probably built in the least affected areas, and people in the areas most at risk were left with nothing. The local board helped in the sense that they were trying to access help from different organizations. But then, well, this is what one can often see here: After the earthquake, most people, including the local board, knew which families were most in need; however, in practice, things turned out differently. They hardly took them into account, those that were most in need."[38] Another resident states that not only the assistance from the local board, but also the assistance from the municipality is politically influenced: "Well, this is how the political parties work […]: it is only some few people who really get some help […], they give corrugated iron sheets, scantlings, cement or bricks […], but they only give to some."[39]

[38] Original citation: "Los muros se dieron quizás en las partes menos afectadas, y en las partes más afectadas se quedaron sin. Pues si ayudan en el aspecto de ellos de andar viendo si consiguen con instituciones ayuda. Pero realmente eso es lo que aquí se ve a veces, como le digo. Cuando el terremoto mucha gente sabia, como la gente directiva aquí sabía quienes necesitaban realmente de muros de retención, pero no fue así. No tomaron casi en cuenta a las personas que mas lo necesitaban."

[39] Original citation: "Así los partidos políticos […] son contadas las gente que les dan [...] dan laminas, cuartones, cemento o ladrillos, […] pero es rara la gente que ellos les dan."

Teenage pregnancy (and single motherhood)

Context. A female interviewee from *Cecilio del Valle* said: "Many of us are single mothers and the only financial resources we have go into the nutrition of our children."[40] Interviews and observations also indicate a high frequency of teenage and pre-teenage pregnancies. When discussing risks 'off the record' in *Rocinha*, early and unwanted pregnancies are almost as frequently mentioned as the risks related to drug trafficking.

Education→teenage pregnancy. Teenage pregnancy is known to be more common among girls with low levels of education (Busso 2002; Observatório da Educação 2006; Stern 2002). The educational level can be a direct determinant in teenage girls' knowledge with respect to fertility and contraceptives,[41] as well as in the total number of children that a woman is expected to have during her life (Busso 2002). A Brazilian study indicates that the risk of becoming pregnant is higher for teenage girls who are currently not attending school (Observatório da Educação 2006). Others suggest that the lack of opportunities for poor and less-educated young women often leaves them with fewer options than to be wives and mothers in order to gain social inclusion and to secure their livelihoods (by linking their life to that of a man) (Stern 2002; Observatório da Educação 2006).

Teenage pregnancy→disaster risk. Interviews revealed that single and teenage mothers in *Los Manantiales* and *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 pregnancy (including mental health problems) and possible rejection from their family (or partner). Several of the female 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 early and unplanned pregnancies often lead to vulnerable family constellations such as single-headed households, and add to the responsibilities of the parents of the young (or single) mother. According to disaster literature, mothers (and even more single mothers) are especially at risk in disaster situations (Enarson 2000). High birth rates and large numbers of dependants increase the wear and workload of women and make them more vulnerable (Enarson 2000; Cutter et al. 2003). Being responsible for a small child (or several) is likely to affect a woman's ability to respond to disasters. Conflicting work, family responsibilities, dependency on childcare and reduced mobility might delay the recovery of mothers. For instance, a young mother of three children, living close to the houses that collapsed in *Laboriaux* in 2010, sent her 6 and 7 year old sons to stay with her mother in another state, fearing that (in case of another landslide) she would not be able to run out of the house with all three children (see Box 8). In addition, having to evacuate to a temporary shelter makes it more difficult for women to resume their income-earning activities and take care of their children at the same time (Enarson 2000).

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[40] Original citation: "Muchas de nosotros somos madres solteras, no tenemos más fondos de sacar los alimentos de nuestros hijos."

[41] Although interviews indicated that sexual education is not often provided in Brazilian schools, the possibility to access such information may increase with a higher level of education.

Box 8. Teenage pregnancy: Education-related underlying risk factor.

A woman living in *Cecilio del Valle* states: "You just have the money to pay bills but not to eat. I bought a pair of shoes for my son so that he can go to school, and then I could not pay the electricity bill. The next [electricity] bill will be double to be paid next month."[42]

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A community leader from *Rocinha's* Residents' Association links teenage pregnancy to disaster risk and education: "People with little education often end up having very large families, particularly in this part where the risk is highest, which is the area of *Macega*. It is perhaps due to people's lack of formal education that the people there haven't had many opportunities to study and gain knowledge about things [...]. The number of children tie the mother to their home, and also the father. Many mothers have to quit their studies because they become pregnant at a very early age, too young; and the responsibility of caring for a child, or for two children, becomes too much burden, so that they cannot continue going to school."[43]

Informal settlement growth

Context. Alongside all the difficulties in *Los Manantiales* and *Rocinha*, there exists a great ingenuity. Interviews and observation disclose how materials and objects are constantly sold and recycled to fill new functions for housing, micro enterprises, and risk reduction measures. Old car tires are converted into retaining walls or embankments, plastic sheets and corrugated iron into water gutters. Problems like insufficient living space are solved by constructing another floor or filling up river banks, missing electricity outlets by simply drawing another cable, and many residents work informally in different fields. However, there is a downside to the fast-paced informal development. In fact, issues such as overcrowding, unsafe constructions, the absence of waste and waste water management, permanent fear of being evicted, deforestation, and excavated slopes are part of daily life.

Education→informal settlement growth. 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 (cf. Section 4.2.1). In addition, the poor quality of public education in El Salvador and Brazil particularly affects children in informal settlements (see Section 4.2.3), leading to a continued separation and an amplification

[42] Original citation: "Uno tiene para pagar recibos uno, pero no tiene para comer. Compré unos zapatos a mi hijo para ir a la escuela, y ya no pagué la luz, ya me va a venir doble el otro mes".

[43] Original citation: "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."

of the differences and inequalities between people living under 'formal' and 'informal' conditions.

Informal settlement growth→disaster risk. The impact of informal settlement growth on people's level of disaster risk is related to a range of different aspects, including residents' stigmatization, exclusion from formal decision-making processes, insecure tenure, and inadequate housing and infrastructure. The interviews in both study areas clearly show how living in an informal settlement strongly constrains people's life opportunities, such as obtaining a job (see Box 9).[44] The stigmatization of *tugurios* or *favelas* further restricts the residents' access to institutional assistance. As illustrated in Box 9, the change of names of some communities in *Los Manantiales* (from Riveras del Río [River Banks] to Nueva Esperanza [New Hope]) immediately improved the residents' access to institutional assistance. Living under informal conditions, without having an officially recognized address, also restricts people's access to education (where an address is required to register children at school) and their ability to take part in decision-making processes, such as political elections (cf. Perlman 2010; UN-HABITAT 2010). A majority of residents in *Rocinha* do not receive mail at their homes (Censo Domiciliar 2010), and some of the interviewees claimed that their address had been changed so many times that they did not know it anymore. Informality can be equalized to residents' constant fear of being evicted, which can negatively affect people's motivation to improve their risk situation (Wamsler 2007). Informal building processes result in inadequate housing and infrastructure. With growing families, more stories are added to houses that were originally not meant to be multi-storey constructions, and slopes are excavated leaving neighbors up the hill 'in the air'. Informally drawn electric cables increase the risk of fires and electricity-related accidents in the aftermath of disasters. Narrow and steep streets with difficult access make an efficient evacuation and emergency assistance impossible. Analogously, the access to structures and mechanisms for recovery might be problematic for informal workers who lack associated rights (see Section 4.2.1) and people who do not have tenure (see Box 10). Formal infrastructure (such as waste water tubes) that pass though the settlement are not maintained by the authorities resulting in increasing hazards and risk. The lack of adequate infrastructure for waste management is also linked to extensive littering, which could be observed as a major risk factor in both study areas, increasing both people's vulnerability and their exposure to hazards. An official from the Civil Defense in Rio says that it is people's level of education (and not their income) that positively influences their understanding of how littering can cause disasters.

[44] One community leader in *Los Manantiales* highlights that while residents' level of education has increased over the last decades, most are still without work. In this context, having good contacts was frequently mentioned as the most important aspect for getting an informal job.

Box 9. Informal settlement growth and stigmatization: An education-related underlying risk factor.

Eugenio from *Rocinha* says that the *favela's* reputation as a violent and lawless area creates mistrust in its residents, even though the majority of them are the victims rather than the perpetrators. The stigmatization made it difficult for him to find formal work, and during shoot-outs between traffickers and the police, he cannot make it to his job without risking his life, adding further weight to his employers' discrimination.

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In the study area in San Salvador, interviewees from *Cecilio del Valle* describe how governmental staff is completely ignorant about their situation and does not even want to step foot in their settlement: "The government has never had the kindness to visit these remote [meaning informal] places […]."[45] Consequently, governmental assistance is scarce: "No, they have not given us anything. We only see them passing by. Since we are 'private' [meaning informal], as they say it. […] They do not care about us, only for the ones that have formally accessed their land."[46]

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How people are stigmatized due to their address (i.e., the name of the settlement they live in), is illustrated by Alejandro, resident of *Los Manantiales*: "Before, this community wasn't called New Hope; it was called River Banks. This was its name. […] Absolutely nobody wanted to provide any assistance for River Banks, no single organization wanted to help us saying that River Banks means that it is located next to the river, and this is true. But we came here because it was actually the Municipality who offered here land for housing, and if we would build construction walls, we were told that we would get legal tenure."[47] However, it was only after many years of fearing eviction, and only after the FUNDASAL upgrading project providing assistance for legalization and physical improvements for risk reduction that they were given legal tenure.

[45] Original citation: "El gobierno nunca tuvo la amabilidad de venir a ver éstos lugares que están remotos, por decirles así […]."

[46] Original citation: "No, a nosotros no nos dieron nada, solo veíamos pasar. Como somos privados dicen. […] No se preocuparon por la gente, solo por los de la alcaldía o por los que están."

[47] Original citation: "Antes la comunidad no se llamaba Nueva Esperanza, se llamaba Riveras del Río, ese era el nombre que tenía. […] En Riveras del Río todo el mundo no quería ayudar, en varias instituciones benéficas no querían ayudar, porque dijeron que Rivera del Río quiere decir que esta a la orilla del río, y es cierto. Pero como habían lugares proporcionados del Granjero con los muros de protección nos dio el lugar para que hiciéramos las casas y que después nos iba a dar una escritura pública."

Box 10. Informal settlement growth and insecure tenure: An education-related underlying risk factor.

The examples of Maria, living in *Laboriaux* (Rio), and Eugenia living in *Cecilio del Valle* (San Salvador), demonstrate the importance of having legal tenure for residents' level of risk. Eugenia does not own the land she is living on and says: "But imagine, not only does one not have a secure entrance to one's own house, if in addition I would spend a lot of money on [improving] this, and perhaps the next day they come and say 'leave, go away from here' […]."[48] Maria lives with her husband and children, 44 years old, 10 years of education. Her children got a scholarship from the church to study. When asked about the ways she is coping with existing risks, she mentions being a homeowner (as opposed to renting) as a strategy, as well as investing to improve her house and plot to become less vulnerable to disaster impacts. Since she earns her living informally through a local catering business, she does not want to move elsewhere. In fact, she calls *Rocinha* the perfect place to live and run a catering business, because its central location makes it easy to attend to clients in the wealthier areas São Conrado and Ipanema. She says that her living place offers her the possibility of having a big kitchen, natural springs with fresh water, and a marvelous view. The only problem for her is that local disasters can negatively affect her business. After the disaster-related deaths in 2010 in *Laboriuax,* people were not in a *clima de festa* (party mood). Some people were moving away from *Laboriaux* and the local demand for her birthday cakes and party catering was low.

4.2.3 Disaster impacts on people's education

Both the San Salvador and the Rio case studies show that disasters strongly affect residents' lives and livelihoods, including short-lived and long-lasting impacts on their level and quality of education. In the aftermath of disasters, children are often obliged to temporarily, or even permanently, leave school. Reasons are:

- Children have to work to economically support their family;
- Children have to take care of injured family members (see Box 6);
- No money for paying school fees (due to increased post-disaster expenses or burglaries in damaged and thus easily accessible houses);
- Loss of belongings required to attend (or change) school, including school uniforms, books, ID documents, etc.;
- Destruction of local school;
- Permanent closing of local school due to being in a high risk zone.

In other cases, children do not have to leave school. However, temporarily or permanently they have to travel to another school far away from home. This results in:

- Additional expenses for bus fares;
- Reduced time available for homework, other responsibilities and sleep;

[48] Original citation: "Pero imagínese que uno, tras que no tiene una entrada suficiente y va uno a gastar para que el día de mañana le vengan a decir vayanse de aquí […]."

- Children going to school only every other day (since the early mornings become too stressful over time).

Interviewees report on families which after disasters had to move to other areas where their children could not attend the local school. This can be due to the fact that:

- The new school cannot take more pupils;
- The parents do not (yet) have a recognized address to register their children at the new school.

Many of the female residents highlight that there are many factors in the aftermath of a disaster which make it difficult for children to concentrate on their studies. Such factors are:

- Reduced or lacking space for studying (with houses being partly damaged or destroyed);
- Electricity failures or outage making it impossible to study early mornings or after sunset;
- Difficult and dangerous way to school (with pathways being washed away);
- Community distress (due to increased differences, unequal post-disaster assistance, etc.);
- Psychological distress of families (due to increased fear of disasters, illnesses, loss of family members, threat of being resettled, etc.);
- Pupils having increased responsibilities, having to take care of sick family members, the reconstruction of houses, part-time jobs, etc;
- Living in temporary shelter or in houses with little security or no privacy (i.e., lacking doors, walls, etc.);
- Family disruptions due to a permanent move of (some of the) children to other family members in more secure areas.

The increase of heath problems in the aftermath of disasters often affects young school children disproportionally, making them "vulnerable to whatever illness, infections, allergies …"[49] as mentioned by Esperanza, *Los Manantiales*. Such illnesses and injuries are, for instance, caused by:

- Waste water and solid waste entering houses (after floods or landslides);
- Contaminated spring wells;
- Wet mattresses;
- Non-functioning or loss of pit latrines;
- Mosquitoes due to standing water.

Depending on people's capacity to recover, for some families the mentioned impacts are short-lived, for others long-lasting. Influencing factors are, for instance, if they have resources to quickly replace lost belongings, are able to borrow money, have family members living nearby in more secure areas, have contacts to easily get new ID documents, etc. Assuming that education is crucial for people's adaptive capacity (which is confirmed by this study), disasters and associated impacts on people's education are likely to result in a vicious circle of increasing risk and deteriorating education. Making matters worse, in both case study areas the number and frequency of

[49] Original citation: "… propenso a cualquier enfermedad, granos, picazón …".

disasters is increasing. However, it is important to highlight that the education in low-income settlements is inadequate, even without disaster occurrence. Classes are often cancelled due to power cuts, shootings, and absent or striking teachers. Perlman (2010) and Gonçalves (2010) report how teachers in *favelas* are afraid to come to class and typically only show up a few times a week. Maria Marta, director of a school in *Cidade de Deus,* Rio states: "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" (Gonçalves 2010:1).[50] Nevertheless, although the quality of the education in both case study areas is of obvious low quality (and has even decreased in some parts), several interviewees[51] mention the better access to education for their children as one of the reasons why they feel less at risk today.[52]

5 Discussion: Towards Sustainable Adaptation

This section discusses the potential role and influence of formal education in determining societies' adaptive capacity. First, a summary of the different key results is presented, followed by a comparative analysis of the quantitative and qualitative results of the San Salvador and the Rio case studies. Finally, the outcomes are discussed in the light of the conceptual framework presented in Section 2.

5.1 The role of education for people's adaptive capacities: Summary of key results

At the beginning of the two case studies, virtually all information gathered seemed to indicate that education does not play a major role for people's level of disaster risk. Without exception, the international risk management experts interviewed suggested that education plays a minor role, with the only risk-reducing influence being its positive influence on people's level of income. In addition, none of the consulted international *and* national experts was aware of any specific research analyzing the inter-linkages between people's level of education and disaster risk, nor of any specific databases which would allow such analyses. Nevertheless, more in-depth studies comparing quantitative and qualitative data gathered through surveys, interviews, literature review, and observation showed a different picture. In fact, the qualitative results of both the San Salvador and Rio case studies indicate that formal education has a positive and direct effect on:

- People's awareness and understanding of existing risk;
- Their access to, and provision of, information on risk reduction;

[50] Original citation: "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."

[51] For instance, 5.6 percent in the high risk area of *Rocinha*.

[52] Importantly, the question about the factors which make them less at risk today was an open question without pre-determined answers.

- Acceptance and adequate use of institutional support;
- The improvement of people's own coping strategies.

As regards the latter, two issues related to formal education were identified to be of special relevance for efficient local coping: Having a formal job, and people's interest (and efforts) in moving to a lower-risk area within or outside their own settlement. In addition, the qualitative results suggest that a higher level of education can influence disaster risk due to its potential to mitigate underlying risk factors. These factors were identified to include:

- Poor health;
- Organized crime and corruption;
- Teenage pregnancy and single motherhood;
- Informal settlement growth, including associated stigmatization of slum dwellers, exclusion from formal decision-making processes, insecure tenure, and inadequate housing and infrastructure.

Moreover, the quantitative analyses conducted support some of the qualitative results, for instance, by indicating a significant correlation between:

- Interviewees' education and ability to point out any risks in their settlement (Rio);
- Interviewees' education and the number of risks they were able to point out (Rio);
- People's (lower/higher) average levels of education and living in a (high/low) risk area (San Salvador and Rio).

Other important results from the surveys in 2009–2011 are the identified correlations between:

- Households affected by Mitch in 1998 and households affected by Stan in 2005 (San Salvador);
- Impact from past disasters and local coping strategies (San Salvador);
- Total household income, impact from past disasters, and local coping strategies (San Salvador);
- Education and income of women (Rio).

Finally, in the San Salvador case study the quantitative analysis of the institutional database from FUNDASAL from 2003 indicates correlations between:

- Education of head of households and total household income;
- Education (of working adult) household members and total household income;
- Education of head of households and disaster risk.

Although the latter was only statistically significant before the Bonferroni type adjustment, the comparison of the different results shows its validity (see following section).

5.2 Comparative analysis: The climate and education nexus

The summary of the key results presented in Section 5.1 shows that education has indeed an important role to play in determining people's level of disaster risk. This section highlights some of the results by discussing the differences between the two case studies.

5.2.1 Education and disaster risk

In the Rio case study, through statistical analysis, a clear correlation was found between the educational level of the interviewee and his or her ability to point out any risks in the settlement. This result was independently confirmed in interviews with key informants. Accordingly, lower educated people seem to be more likely to downplay their own risk. If this were the case, the outcome of the 2003 database from San Salvador, which identifies a negative correlation between education and disaster risk, becomes more significant. The definition of high and low risk in this database is based on people's own risk perceptions, as opposed to more objective risk evaluations used in the surveys. In addition, the database shows the situation in the settlement before the FUNDASAL upgrading program and associated risk awareness campaigns were carried out. The identified correlation could thus actually be stronger than what the numbers show.[53] Interestingly, further analyses of the same database not only show a correlation between education and disaster risk, but also indicate a significant correlation between education and income, but *not* between income and risk. This gives rise to the high importance of education as opposed to income. Pointing towards the same issue, the Rio case study showed no significant correlation between education and income, neither for households nor for men – only for women (see Section 5.2.3).

Comparing the qualitative and quantitative results of the San Salvador case study, it is possible to argue that there is an important link between people's level of education and their efforts to reduce risk through different coping strategies. That this correlation did not prove to be significant in the quantitative analysis is probably due to the fact that this analysis was only based on the coping strategies that the interviewees mentioned (and are aware of). People's conscious coping strategies are, however, mainly related to structural or economic improvement, leaving out residents' numerous other strategies which were identified in the qualitative analysis.

5.2.2 Institutional support for risk reduction and adaptation

From the case studies it can be concluded that the current institutional assistance provided to reduce and adapt to current risk is not sufficient. In fact, while in San Salvador those households at high risk have received more assistance (if compared to those at moderate risk), they were hit quite strongly and in a similar way by both Hurricane Mitch in 1998 and, seven years later, by Hurricane Stan in 2005. In the Rio case study, similar analyses could not be made. However, while in the Rio case study area the households at risk have received more institutional help, 63.3 percent of these state that their current level of risk is similar or even worse than before. The qualitative

[53] Note that the Rio case study first found a similar correlation between household's education and past disaster impact, but it was not significant after the Bonferroni type adjustment (56 percent error rate).

analyses of both case studies suggest that the persistent levels of risk are, among other things, related to the fact that:

- There is still too much focus on emergency assistance as opposed to longer-term adaptation;
- There is a gap between what households and organizations undertake to deal with risk, with people's strategies for coping being heterogeneous, continuous, and based mainly on individualistic behavior while institutions focus more on providing uniform, short-term, and community-based measures (cf. Wamsler 2007);
- The strategies taken for mainstreaming risk reduction in the sectoral program are not sustainable (cf. Wamsler 2009);
- Little consideration is given to climate variability and change, resulting in only short-lived improvements.

On this basis, the common understanding (of most of the interviewed risk management experts and institutional staff) that informal education on risk reduction is more influential than formal education becomes questionable. Independently, virtually all interviewees agreed that the current measures are not sufficient in a context of increased numbers and frequency of disasters, casting current institutional approaches into doubt.

5.2.3 Results with a 'gender twist'

One of the results of this study is that formal education seems to be of special importance for determining women's level of risk. This was confirmed by statistical analyses of the Rio case study and the qualitative results of both case studies. The statistical analyses show that for women, more education is likely to lead to a higher income.[54] No such correlation was found for the male participants. The qualitative analyses suggest that this may be due to the fact that there are many male-dominated jobs that are relatively well-paid, but do not require formal education (such as taxi driver and bartender), while this is not the case for female-dominated jobs. It seems that it is easier for men (as opposed to women) to get a formal job without a certain level of formal education. Knowing the importance of formal employment for people's adaptive capacity (as demonstrated in Section 4.2.1), formal education is especially crucial for determining women's level of risk.

The importance of formal education in determining women's level of risk also becomes obvious when analyzing the other qualitative outcomes. In fact, the results show an obvious 'gender twist' in that the correlations identified between education and the factors that (directly or indirectly) influence risk are more (or only) relevant for women. Obvious examples include teenage pregnancy and single motherhood (cf. Section 4.2.2). In addition, both case studies show how many children, instead of serving as a sort of retirement security, stay dependent on their parents or single mothers. Perlman (2010) describes of how whole families live on the retirement payment of a grandfather. Other sources confirm that in urban areas, young people often

[54] Note that the San Salvador case study did not include tests on the individual level; therefore a similar analysis could not be made.

stay dependent on, and live in the house of, their parents or single mothers, even after having a family of their own (e.g., *The Economist* 2010).

Health is another factor where the relevance of women's level of education is especially determinant (cf. Section 4.2.2). The correlation between education and HIV/AIDS in Brazil is one of many examples illustrating this. The disease began among the higher educated and progressed to infect people of all levels of education. In Southeast Brazil (including Rio) where the disease has existed for the longest time, it is now starting to dominate the less educated. In this context, a clear correlation between less education and having the disease was found only for females (Fonseca et al. 2000). Furthermore, Busso (2002) states that women's level of formal education positively influences their children's nutritional levels. With regard to organized crime and substance abuse, again there is a 'gender twist'. While it is mainly the men who are directly involved, it is the women who have most of the risk-reducing consequences (cf. Section 4.2.2).

Finally, it is important to highlight the woman's role in (actively) reducing risk. Based on the interviews, women are often motivated by their strong desire to protect their children (cf. Section 2.1.6) or to provide them with better life opportunities, including improved education (cf. Section 4.2.1).

5.3 From current risk reduction to sustainable adaptation

Based on the results presented in the previous sections, the strong influence of formal education on risk and risk reduction can be shown by linking them to the extended risk definition presented in Section 2. Associated conceptual and practical implications are presented in the following.

5.3.1 Conceptual implications of results

For this study, the conceptual framework (presented in Section 2) has proved to be an adequate analytical tool for analyzing the role of formal education. As opposed to the conventional view of risk, it allows a comprehensive analysis of the interactions between education, disaster risk, risk reduction, and adaptive capacity. People's level of risk is here determined by four different risk factors: the existing and area-specific hazard(s), vulnerabilities, response mechanisms, and recovery mechanisms. The associated measures or adaptive capacities (which aim at reducing each of the four risk factors) are: prevention, mitigation, preparedness for response, and preparedness for recovery. On this basis, the results of this study show that education influences *all* the different risk factors and corresponding adaptive capacities. See Tables 3 and 4 for some illustrative examples.

Table 3. Influence of education on existing area-specific risk.

Factors influencing people's level of risk	Influence of (lower) education *Illustrative examples of how lower levels of education might increase risk*
Hazard(s)	▪ Increased exposure to existing hazards due to: - High and increasing numbers of people in the same disaster-prone settlement with no option or little interest to move to lower risk areas; resulting in - Increased proximity of housing and infrastructure to hazards; - Expansion of informal settlements into high-risk areas. ▪ Intensified hazards and creation of new ones, such as: - Floods related to extensive littering and inadequate infrastructure; - Landslides due to excavation, deforestation, intensive littering and inadequate constructions; - Fire due to inadequate electricity connections.
Vulnerability	▪ Concentration of highly defenseless population groups weakened by diseases, conflict, work-related injuries, family disruptions, etc.; ▪ Organized crime and corruption affecting community cohesion and information flow on risk and risk reduction; ▪ High numbers of teenage pregnancies and vulnerable households with single mothers, numerous children or other dependents, etc.; ▪ High numbers of people working in informal and physically demanding jobs with no or little social protection; ▪ Limited access to formal assistance and low influence on decision-making processes (for risk management); ▪ Inadequate house constructions and infrastructure; ▪ Mistrust in authorities, including planning authorities and emergency organizations.
Response mechanisms and structures	▪ Reduced mobility of people with poor health, single mothers, and families with many children; ▪ Reduced mobility due to low income (e.g., no personal vehicle and lack of money for paying public transportation); ▪ Reduced mobility due to organized crime (resulting in high levels of insecurity and increased expenses for 'protection' offered by criminal groups); ▪ Lack of emergency access and evacuation roads (due to informal living conditions); ▪ Limited access to formal response mechanisms (due to informal living conditions); ▪ Mistrust in authorities and thus ignorance of disaster warnings, alerts, evacuations, offered emergency shelter, etc.; ▪ Difficulties in communication and contact with emergency organizations.

Recovery mechanism and structures	▪ Difficulties to recover quickly due to poor health conditions; ▪ No access to formal recovery credits (due to informal work, no legal tenure, no permission to use assisted housing as collateral, no official address, etc.); ▪ Mistrust in authorities (which might lead to refusal or inadequate use of recovery assistance offered).

Table 4. Influence of education on people's adaptive capacity.

Factors influencing people's level of risk	**Influence of (high level of) education** *Illustrative examples of how higher levels of education might reduce risk*
Precondition for adequate selection of adaptation measures	▪ Increased risk awareness; ▪ Better access to information on risk, risk reduction, offered institutional assistance, etc.; ▪ Better ability to assess, and provide authorities information on, own risk situation; ▪ Increased acceptance of (adequate) institutional assistance; ▪ A certain level of community cohesion, good health, time availability and financial resources.
Prevention	▪ Moving out of a risk area (within own settlement or outside own settlement).
Mitigation	▪ Use of an increased number of risk reduction measures, including non-structural measures; ▪ More active use of education-related coping strategies, such as sending children to study outside their own settlement; ▪ Better use of institutional assistance (e.g., through the adequate use and maintenance of constructive measures); ▪ Better selection of adequate risk reduction measures.
Preparedness for response	▪ Acceptance and adequate use of institutional support such as warnings, evacuation, emergency shelter; ▪ Active use of education-related coping strategies, such as temporarily sending children to study outside their own settlement; ▪ Increased mobility.
Preparedness for recovery	▪ Improved access to post-disaster credits, life insurance, paid sick leave, pension, etc. (due to formal jobs); ▪ Better use of institutional support such as recovery credits.

5.3.2 Practical implications of results

The results of this study question the adequacy of current local and institutional strategies for risk reduction, especially in the context of climate change which confronts societies with increasing, intensified, unpredictable and new hazards. The current risk reduction measures by different institutions seem to offer only limited flexibility and many local capacities are not tapped into (cf. Section 5.2.2). In addition, a huge variety of crucial but somewhat weak coping strategies were identified in both study areas. Residents report that it can take them several years to recover from single events and that many are dependent on outside help. Backsliding is also frequent and a barrier to achieving sustainable risk reduction.

What should be done in terms of specific activities? The research results suggest that increased investments in improving both the access to, and quality of, education can increase people's adaptive capacity and further empower women. The strength of this approach lies in the fact that formal education was shown to influence *all* the different risk components and associated capacities without pre-determining concrete or inflexible risk reduction measures with limited effect for sustainable adaptation. In this context, the qualitative analyses also suggest that education is especially crucial for people's ability to recover (from non-fatal damage), allowing them to bounce back from disaster impacts by either quickly establishing new livelihoods or quickly re-establishing earlier ones. One of the reasons is the identified link between formal education and access to formal employment which is crucial for people's ability to recover.

This study also implies some conditional factors for improving people's access to, and quality of, education. Such factors include the elimination (or reduction of) school fees; free school lunches; support for study material and school uniforms; counseling to reduce drop-outs, career development and re-integration of former gang members; increased incentives for teachers to work in low-income settlements; more flexible rules for school enrolment; improved disaster-resistance of schools and access roads; and the provision of basic health services for pupils and their mothers. Important preconditions to achieve this and reduce dependencies are better cooperation between authorities, NGOs and donors and improved trust relations between authorities and people at risk.

6 Conclusions

With a worldwide increase in the number and intensity of 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 so-called 'slums'. In order to reduce associated risks, there is an urgent need to better understand the factors that determine people's capacity to cope with and adapt to adverse climate conditions.

This paper examines the influence of formal education as opposed to income in determining the adaptive capacity of the residents of two low-income settlements: *Los Manantiales* in San Salvador (El Salvador) and *Rocinha* in Rio de Janeiro (Brazil), where climate-related disasters are recurrent. The research explores the potential of promoting formal education as a way to increase people's adaptive capacity. Data was

collected through surveys, interviews, literature review and observation, and both statistical and qualitative data analyses were applied. The statistical analyses investigate how formal education influences people's level of risk, their coping strategies, and the institutional support received. The qualitative analyses explore (direct and secondary) effects that education may have on disaster risk, and vice-versa.

The results indicate that formal education might have a more significant role in determining people's level of risk and their adaptive capacity than what has hitherto been acknowledged. In fact, in both case study areas, the average level of education was found to be lower for households living at high risk (as opposed to residents of lower risk areas). This positive influence of people's level of education was identified to be twofold due to (a) its direct effect on aspects that reduce risk, and (b) its mitigating effect on aspects that increase risk. On the one hand, formal education was seen to have a positive effect on issues such as people's level of awareness and understanding of existing risks; their access to information on (the adequate use of) potential risk reduction measures; possibilities of attaining a formal job; and their interest in moving out of a risk area. On the other hand, formal education has the potential to reduce underlying risk factors such as poor health, organized crime, corruption, teenage pregnancy, single motherhood, and informal settlement growth (including the stigmatization of slum dwellers, exclusion from formal decision-making processes, insecure tenure, and inadequate housing and infrastructure). The results suggest that education plays a more determinant role for women than for men in relation to their capacity to adapt. In light of these results, the identified limited effectiveness of institutional support for risk reduction might also relate to the fact that the role of formal education has not been explored sufficiently thus far.

Although further research is needed to test the validations of the findings in different contexts, it can be concluded that promoting (improved access to and quality of) formal education as a way to increase people's adaptive capacity is justified, not only due to its potential influence on increasing people's level of income. This is also supported with respect to the negative effects of disasters on people's level of education, which in turn reduce their adaptive capacity, resulting in a vicious circle of increasing risk. Finally, the conceptual framework used in this study proved to be an adequate analytical and practical tool which could help to strengthen current planning strategies for investments in climate change adaptation.

7 References

Adger, W.N., N. Brooks, G. Bentham, M. Agnew, and S. Eriksen. 2004. New Indicators of Vulnerability and Adaptive Capacity. Technical Report 7. Norwich, UK: Tyndall Centre for Climate Change Research, University of East Anglia.

Bigio, A.G. 2003. Cities and climate change. Pages 91-100 in A. Kreimer, M. Arnold, and A. Carlin (eds.), *Building Safer Cities – The Future of Disaster Risk*. Washington, D.C.: The World Bank, Disaster Management Facility.

Blankespoor, B., S. Dasgupta, B. Laplante, and D. Wheeler. 2010. The Economics of Adaptation to Extreme Weather Events in Developing Countries. Working Paper 199. Washington, D.C.: Center for Global Development.

Busso, G. 2002. *Vulnerabilidad sociodemográfica en Nicaragua: un desafío para el crecimiento económico y la reducción de la pobreza*. Santiago de Chile: CELADE-FNUAP.

Censo Domiciliar. 2010. *Complexo da Rocinha, Rio de Janeiro*. Downloaded on March 31, 2010 at: http://urutau.proderj.rj.gov.br/egprio_imagens/Uploads/RD.pdf

Cutter, S.L., B.J. Boruff, and W.L. Shirley. 2003. Social vulnerability to environmental hazards. *Social Science Quarterly* 84(2): 242-261.

Dowdney, L. 2003. *Crianças do tráfico – Um estudo de caso de crianças em violência armada organizada no Rio de Janeiro*. Rio de Janeiro: Viveiros de Castro Editora Ltda.

Enarson, E. 2000. Gender and Natural Disasters. InFocus Programme on Crisis Response and Reconstruction, Working Paper 1. Geneva: International Labour Organization.

Ferreira, S.B, A.B. da Silva, and C. Botelho. 2005. Abandono do tratamento da tuberculose pulmonar em Cuiabá – MT – Brasil. *Jornal Brasilieiro de Pneumologia* 31(5): 427-435.

Flick, U., Ed. 2006. *Qualitative Evaluationsforschung: Konzepte, Methoden, Umsetzung* [Qualitative evaluation research. Concepts, methods and realisation]. Reinbek, Germany: Rowohlt Verlag GmbH.

Fonseca, M.G., F.I. Bastos, M. Derrico, C.L. Tavares, C. Travassos, and C.L. Szwarcwald. 2000. AIDS e gráu de escolaridade no Brasil: evolução temporal de 1986 a 1996. *Cad. Saúde Pública* 16 (Sup. 1): 77-87. Accessible online at http://www.scielo.br/pdf/csp/v16s1/2214.pdf

FUNDASAL. 2010. *El mejoramiento barrial: un campo de la producción social del hábitat; La experiencia de FUNDASAL y las comunidades en el proyecto Los Manantiales.* San Salvador: Fundación Salvadoreña de Desarrollo y Vivienda Mínima.

Glaser, B.G. and A.L. Strauss. 1967. *The Discovery of Grounded Theory: Strategies for Qualitative Research.* New York: Aldine de Gruyter.

Goldman, M. 2008. *The Bonferroni Correction*. Berkeley, CA: University of California at Berkeley, Department of Statistics.

Gonçalves, M. 2010. *As escolas e a UPP*. Rio de Janeiro: Observatório de Favelas, August 11, 2010.

Harvey, L. and M. MacDonald. 1993. *Doing Sociology: A Practical Introduction.* London: Macmillan.

IPCC. 2007. *Climate Change 2007: Impacts, Adaptation and Vulnerability.* Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change **(**M.L. Parry, O.F. Canziani, J.P. Palutikof, P.J. van der Linden and C.E. Hanson, eds.). Cambridge, UK: Cambridge University Press. Available at: http://www.ipcc.ch/publications_and_data/ar4/wg2/en/contents.html

Jabeen, H., A. Allen, and C. Johnson. 2009. Built-in Resilience: Learning from Grassroots Coping Strategies to Climate Variability. Paper presented at the World Bank Urban Research Symposium, Marseille, France, June 28-30, 2009.

Kahn, M.E. 2005. The death toll from natural disasters: The role of income, geography, and institutions. *The Review of Economics and Statistics* 87(2): 271-284.

Lindell, M.K. and R.W. Perry. 2004. *Communicating Environmental Risk in Multiethnic Communities.* Thousand Oaks, CA: Sage.

Lutz, W. 2008. Forecasting Societies' Adaptive Capacities to Climate Change (FutureSoc). Annex I – Description of Work. Funded Research Proposal, European Research Council, Advanced Investigator Grant. Unpublished document. Laxenburg, Austria: International Institute for Applied Systems Analysis.

Michael, R.S. 2001. Crosstabulation and Chi Square. Bloomington, IN: Indiana University. Available at: www.*indiana*.edu/~educy520/sec5982/week_12/chi_sq_summary011020.pdf

MidiaNews. 2009. Mais de 15,6 menores de idade servem o tráfico. *MidiaNews*, December 18, 2009.

NIDA. 2010. *NIDA InfoFacts: Marijuana*. Washington, D.C.: National Institute on Drug Abuse, National Institute of Health, U.S. Department of Health and Human Services (www.drugabuse.gov).

Observatório da Educação. 2006. *Relação entre escola e gravidez na adolescência é evidenciada em pequisa nacional.* São Paulo: Observatório da Educação, Ação Educativa, December 17, 2006.

Perlman, J.E. 2010. *Favela – Four Decades of Living on the Edge in Rio de Janeiro*. New York: Oxford University Press.

Slovic, P. 1999. Trust, emotion, sex, politics, and science: surveying the risk-assessment battlefield. *Risk Analysis* 19(4): 689-701.

StatSoft, Inc. 2011. *Electronic Statistics Textbook*. Tulsa, OK: StatSoft. Available at: www.statsoft.com/textbook/

Sterman, J.D. 2000. *Business Dynamics: Systems Thinking and Modelling for a Complex World.* Boston, MA: Irwin McGraw-Hill.

Stern, C. 2002. Poverty, Social Vulnerability and Adolescent Pregnancy in Mexico: A Qualitative Analysis. Paper presented at the CICRED Seminar on Reproductive Health, Unmet Needs and Poverty: Issues of Access and Quality of Service, Bangkok, Thailand, November 2002.

The Economist. 2010. Brazil's Bolsa Familia: How to get children out of jobs and into school. *The Economist*, July 29, 2010.

Thompson, M., R. Ellis, and A. Wildavsky. 1990. *Cultural Theory.* Oxford: Westview Press.

Toya, H. and M. Skidmore. 2005. Economic Development and the Impacts of Natural Disasters. Working Paper 05-04. Whitewater, WI: University of Wisconsin.

Uchtenhagen, A. 2004. Editorial: Substance use problems in developing countries. *Bulletin of the World Health Organization* 82 (9): 641.

UN. 2009. *World Urbanization Prospects: The 2009 Revision*. New York: United Nations, Department of Economic and Social Affairs, Population Division.

UNDP. 2004. *A Global Report: Reducing Disaster Risk – A Challenge for Development.* New York: United Nations Development Programme, Bureau for Crisis Prevention and Recovery.

UN-HABITAT. 2010. *São Paulo – A Tale of Two Cities*. Nairobi: United Nations Human Settlement Programme.

UNISDR. 2002. *Living with Risk: A Global Review of Disaster Reduction Initiatives.* Preliminary version. Geneva: United Nation Publications.

UNISDR. 2009. *Terminology on Disaster Risk Reduction*. Geneva: United Nations International Strategy for Disaster Reduction (UNISDR).

Verly, A.P. 2009. Brasil: Tubeculose na favela da Rocinha. *Jornal do Brasil,* February 13, 2009.

Wamsler, C. 2007. Bridging the gaps: stakeholder-based strategies for risk reduction and financing for the urban poor. *Environment and Urbanization* 19(1): 115-142. Special issue on Reducing Risks to Cities from Climate Change and Disasters.

Wamsler, C. 2009. *Urban Risk Reduction and Adaptation: How to Promote Resilient Communities and Adapt to Increasing Disasters and Changing Climatic Conditions?* Saarbrücken, Germany: VDM Publishing.

Wamsler, C. 2010. Course material elaborated for the Master of Disaster Management at Lund and Copenhagen Universities. Course on disaster recovery at Lund University. Unpublished.

Wisner, B., P. Blaikie, T. Cannon, and I. Davis, I. 2004. *At Risk: Natural Hazards, People's Vulnerability and Disasters.* London: Routledge. Second edition.

Wisner, B., A. Mascarenhas, C. Wamsler, M. Arnold, and B. Haghebaert. 2007. Community and Civil Society Perspectives, Local Knowledge and Coping Strategies. Workshop Concept Note for the ProVention Consortium Forum 2007 Making Disaster Risk Reduction Work, Dar es Salaam, February 13-15, 2007. Retrieved December 8, 2008, from: www.proventionconsortium.org/themes/default/pdfs/Forum07/ws4_local_perspectives.doc