



Guest Editorial, part of a Special Feature on [Education and Differential Vulnerability to Natural Disasters](#)

Is Education a Key to Reducing Vulnerability to Natural Disasters and hence Unavoidable Climate Change?

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ABSTRACT. The collection of articles in this Special Feature is part of a larger project on “Forecasting Societies’ Adaptive Capacity to Climate Change” (an Advanced Grant of the European Research Council to Wolfgang Lutz). In investigating how global change will affect population vulnerability to climate variability and extremes, the project aims to help develop strategies that enable societies to better cope with the consequences of climate change. In doing so, the basic hypothesis being tested is that societies can develop the most effective long-term defense against the dangers of climate change by strengthening human capacity, primarily through education. Education can directly influence risk perception, skills and knowledge and indirectly reduce poverty, improve health and promote access to information and resources. Hence, when facing natural hazards or climate risks, educated individuals, households and societies are assumed to be more empowered and more adaptive in their response to, preparation for, and recovery from disasters. Indeed the findings from eleven original empirical studies set in diverse geographic, socioeconomic, cultural and hazard contexts provide consistent and robust evidence on the positive impact of formal education on vulnerability reduction. Highly educated individuals and societies are reported to have better preparedness and response to the disasters, suffered lower negative impacts, and are able to recover faster. This suggests that public investment in empowering people and enhancing human capacity through education can have a positive externality in reducing vulnerability and strengthening adaptive capacity amidst the challenges of a changing climate.

Key Words: *adaptive capacity; climate change; differential vulnerability; education; human capital; natural disasters*

INTRODUCTION

While there is substantial ongoing research assessing the impact of future climate change on the Earth’s physical systems, there are few systematic and comprehensive assessments on the likely impacts that change will have on future human well-being, given that not all people are equally vulnerable. It is admittedly very difficult if not impossible to try to assess how dangerous climate change will be in general for the future of humanity. But we still have to make policy choices today about what are priority investments that help to reduce the vulnerabilities of people in different parts of the world to already unavoidable climate change.

Given our ignorance about the extent of the overall threat, it makes sense to try to refer to things we think we know with high certainty. One is the fact that the social sciences have shown very clearly that to almost any kind of risk people are not equally vulnerable. Vulnerabilities vary by age, gender, education, level of income, location and many other factors. Hence it is plausible to assume that the future will also see differential vulnerability to the hazards associated with climate change. But from a policy perspective we also would like to know which of these differentials matter most? The set of papers in this collection will address this question with respect to empirical analysis of vulnerability to past natural disasters, since this is the only empirical evidence – assumed to be isomorphic to what we expect under climate change – that we have on the table. More specifically, the papers will contribute to testing the hypothesis that education is a key factor in reducing vulnerability as compared to other potentially relevant factors.

This collection of papers is one of the results of a larger project on “Forecasting Societies’ Adaptive Capacity to Climate Change” (an Advanced Grant of the European Research Council to

Wolfgang Lutz). This project is an ambitious effort to better understand what changes societies are likely to undergo over the next several decades, and determine how those changes will affect their vulnerability to a climate that is more extreme than it is today. The aim is to help develop strategies that enable societies to better cope with the consequences of climate change. The threats come most directly from increasingly intense extreme natural events, such as hurricanes, floods, forest fires and heat waves. Danger also comes from more gradual events, such as sea-level rise and changing regional temperature and humidity patterns that make agricultural production more difficult. Changing climate patterns also can increase the spread of disease.

The extent to which these events will increase human misery and death depends, in part, on the future vulnerability of the people affected. The starting assumption of the project was that a robust and resilient society will be better able to weather the storms of climate change than a society with few resources and limited coping skills. In this project those skills and capabilities are being measured and projected through the educational attainment distributions of populations by age and gender.

The basic hypothesis being tested is that societies can develop the most effective long-term defense against the dangers of climate change by strengthening human capacity, primarily through education – which helps to improve health, eradicate extreme poverty and reduce population growth. The empirical studies published in this special issue try to assess its validity under very diverse geographic, socioeconomic and cultural settings. What all the studies have in common is that they explicitly address the effects of education on disaster vulnerability and compare them to other possible relevant effects. Since the consideration of education as a possible protecting factor has so far been largely absent from the scientific literature on disaster vulnerability, this

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set of papers charts new territory. As we will see later all eleven studies confirm the important role of education for reducing different kinds of disaster vulnerabilities in very different settings and at the macro- and micro-level.

Several recent catastrophic event such as the typhoon Haiyan that hit the Philippines in 2013, the 2004 Indian Ocean tsunami, the 2005 hurricane Katrina, or the 2010 Haiti earthquake, are examples that already today more could have been done to minimize the impact of natural hazards before they occur. In fact, not all natural hazards events become a disaster and massive losses and damages are, to a certain extent, preventable. The levels of adverse impacts are determined by exposure and the vulnerability of societies and socio-ecological systems (Cardona et al. 2012). Exposure could lead to a disaster risk when the population and economic resources are exposed to potentially dangerous settings. Meanwhile, vulnerability refers to the susceptibility, sensitivity and capacities of the exposed elements to cope with and adapt to the hazard events (Schröter et al. 2005, IPCC 2007). Exposure and vulnerability are dynamic and heterogeneous depending upon various factors including demographic, economic, social, geographic, cultural, institutional, governance and environmental elements. Understanding how vulnerability is generated is crucial in disaster risk management and reduction (O'Brien et al. 2004). While there has been considerable research attention on technical aspects, biophysical vulnerability and the vulnerability of the built environment, the social aspects of vulnerability remain relatively understudied (Cutter et al. 2003).

It is recognized that successful mitigation plans need to consider differential impact of hazards as a product of social vulnerability (Morrow 2008). Individuals and communities are differentially exposed, and vulnerability based on various factors such as age, gender, education, wealth, class, race/ethnicity/religion, disability and health status, which influence both the impacts and how the actors prepare for, respond to and recover from hazards and disasters. Extant social science and disasters literature reported that those with low socio-economic status, elderly, children, women, and ethnic minorities/immigrants are the most vulnerable groups (Clark et al. 1998). The elderly, children, and women typically have less physical strength and ability to escape from danger comparing to men at prime ages (Yeh 2010). The poor and people belonging to minority groups for their part are more likely to live in poor housing conditions and disaster-prone areas. Mortality and morbidity from natural disasters are much higher among these subpopulations (Neumayer and Plümper 2007, Frankenberg et al. 2011, Doocy et al. 2013). Furthermore, low-income groups generally face more obstacles during the phases of response, recovery, and reconstruction (Masozera et al. 2007). Consequently, studies on social vulnerability commonly highlight poverty/income as the main characteristic explaining differentials in all aspects of disasters (Fothergill and Peek 2004).

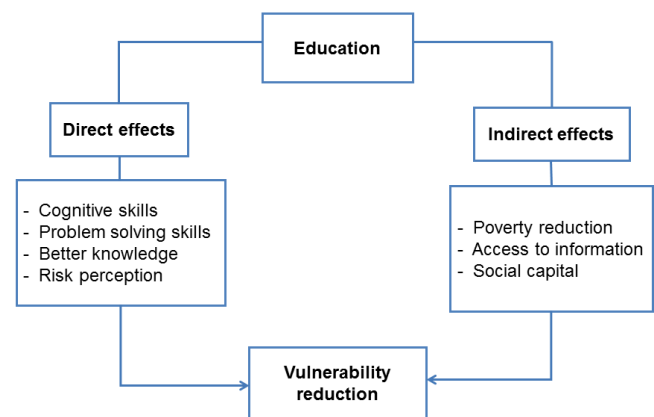
The emphasis on monetary aspect can also be seen in the measurement of loss and damage from disasters (Wrathall et al. 2013). Money values are more convenient to determine using market valuations. However, relying only on economic loss could mislead the estimation of the impacts of the disaster. While richer households and countries generally suffer greater monetary losses, they are likely to recover more quickly than their poorer counterparts (Noy 2009, Cavallo and Noy 2010). Furthermore,

fatalities in low-income countries are generally much higher than those of higher income nations (Kahn 2005). The longer-term welfare costs of a disaster thus are greater for poorer individuals or nations. The relationship between income and disaster impacts is explained through an increase in the demand for safety as income rises (Toya and Skidmore 2007). Furthermore, with higher income, individuals have more resources to employ costly disaster precautionary measures. Accordingly, development agencies and climate change communities have put effort in mainstreaming poverty reduction in climate change adaptation programs (Eriksen et al. 2007, UNDP 2007).

VULNERABILITY, ADAPTIVE CAPACITY AND EDUCATION

While poverty is well-considered as a major cause of vulnerability and poverty reduction has recently been recognized as one key tool to enhance adaptive capacity, education both in its own right and as a means for poverty alleviation, has not yet been put on the forefront for climate change adaptation efforts. There are many sound reasons to assume that education can contribute to vulnerability reduction and enhance adaptive capacity. The relationships between education and vulnerability reduction can be both direct and indirect as presented in Figure 1.

Fig. 1. Flowchart displaying the processes through which education contributes to vulnerability reduction



Education can play an important role in reducing the negative impacts of extreme climate events in direct and indirect ways. Directly formal education is considered as a primary way individuals acquire knowledge, skills, and competencies that can influence their adaptive capacity. There is a large body of literature on the effects of education on health which is summarized in Lutz and Skirbekk (2013) who conclude that there is enough evidence to assume direct functional causality. First, there is evidence that the learning experiences associated with formal education have a lasting impact on the synaptic brain structure (Kandel 2007) and enhances cognitive skills (Neisser et al. 1996, Nisbett 2009, Reynolds et al. 2010). Literacy and numerical skills as well as general skills e.g., abstract thinking obtained through formal education imply better understanding and ability to process such risk information as weather forecast or warning messages (Mileti and Sorensen 1990, Spandorfer et al. 1995). Second, education is

associated with problem-solving skills (Moll 1994, Ishikawa and Ryan 2002, Schnell-Anzola et al. 2005). Thus, in such an emergency situation like when a disaster strikes, educated individuals might be more capable to respond and act upon the event. Third, education enhances the acquisition of knowledge, values and priorities as well as the capacity to plan for the future and improve allocation of resources (Thomas et al. 1991, Glewwe 1999). It is, for example, well documented that educated individuals have better basic practical knowledge on nutrition and health practices (Nayga 2000, Burchi 2010). Similarly, education may also enhance knowledge on disaster risks and how to respond to such risks. Fourth, education can influence risk perception. If people perceive their risks to natural disasters to be real, they are more likely to react to cope with these risks. It is found that highly educated individuals are better aware of the earthquake risk (Ainuddin et al. 2013) and are more likely to undertake disaster preparedness (Paul and Bhuiyan 2010). High risk awareness associated with education thus could contribute to vulnerability reduction behaviors.

Apart from the above mentioned direct impacts, education may indirectly reduce vulnerability through many other means. Firstly, education improves socio-economic status as evident that education generally increases earnings (Psacharopoulos 1994, Psacharopoulos and Patrinos 2002). This allows individuals to have command over resources such as purchasing costly disaster insurance, living in low risk areas and quality housing, implementing disaster preparedness measures and evacuating in time of emergencies. Secondly, highly educated individuals usually have diversified communication linkages and have better access to useful information (Cotten and Gupta 2004, Wen et al. 2011, Neuenschwander et al. 2012). The level of education is highly correlated with access to weather forecasts and warnings as well as the types of technologies used to access weather information (Rodriguez et al. 2007). Access to forecast and early warnings allow individuals to respond and prepare for the hazards appropriately. Thirdly, education is associated with greater social capital and social support and wider social networks (Department for Business Innovation & Skills 2013). Social networks are particularly useful in time of emergency. For instance, individuals who are embedded in large and well-established social networks and friendship groups have higher chance to receive informal warnings and consequently more likely to confirm warnings and engage in response (Mileti and Sorensen 1990). Furthermore, social capital and social networks increase the propensity to evacuate and facilitate relocation and recovery (Airriess et al. 2008). Through increasing socio-economic resources, facilitating access to information and enhancing social capital, education can promote vulnerability reduction and adaptive capacity.

At the societal level, it is found that better educated society enjoys greater economic growth (Lutz et al. 2008, Crespo Cuaresma et al. 2013), higher life expectancy and higher degree of democracy (Lutz et al. 2010). This implies that better educated societies have greater social, economic, and institutional capabilities necessary for successful adaptation to climatic change (KC and Lutz 2014). Consequently, it is reasonable to assume that when facing natural hazards or climate risks, educated individuals, households and societies are more empowered and hence more adaptive in their response to, preparation for, and recovery from disasters.

SPECIAL ISSUE ON EDUCATION AND DIFFERENTIAL VULNERABILITY TO NATURAL DISASTERS

Based on the assumption that education can reduce vulnerability and enhance adaptive capacity to natural disasters, this Special Issue collects empirical evidence from different societies based on analyses of various data sources from individual- and household-level data, village-level studies and national case studies to global-level time series analysis. Although different types of natural disasters and disaster outcomes are explored, all eleven research articles specifically focus on investigating the role of education on vulnerability reduction. The common research question being asked in these articles is whether education can reduce negative impacts of covariate shocks resulting from natural disasters or epidemics and whether education can enhance adaptive capacity to these emergency events.

Since disaster events differ in terms of predictability, controllability, length of forewarning, magnitude and duration of impact, different types of events may affect vulnerability and response diversely. Preparing for earthquakes, a sudden-onset hazard, for instance, is not the same as preparedness actions for drought, a slow-onset event. There has not been much comparative work that considers how special characteristics of different natural disasters can influence physical and social impacts (National Research Council 2006). Likewise, the impact of natural disaster events is not distributed evenly among countries. The extent of losses relies considerably on the level of development, policies, institutional arrangements and economic conditions (Cavallo and Noy 2010). In this Special Issue, diverse types of natural disasters are being studied including both slow and rapid onset; and geophysical, meteorological, hydrological, climatological and biological disasters. The countries covered in the Special Issue include low- and middle-income countries stretching from Asia (e.g., India, Nepal, Indonesia and Thailand), Africa (e.g., Sub-Saharan African countries, Mali, Senegal and Uganda) to Central and South America (e.g., Brazil, Cuba, Dominican Republic, El Salvador and Haiti). Different types of disaster events and the diversity of countries being investigated allow us to test the robustness of the role of education on vulnerability reduction.

A variety of disaster-related outcomes are investigated in this Special Issue ranging from pre-disaster phase, during disaster events, to the disaster aftermath. Prior to a disaster event, mitigation efforts could help reduce vulnerability to disaster impacts such as injuries and loss of life and property. Avoiding building in high-hazard areas is one effective mitigation action. The case study of households in Brazil and El Salvador reports that residents of high risk areas have on the average lower levels of education than households living in low risk areas (Wamsler et al. 2012). This might be because individuals who are literate and have higher level of education have better ability to perceive and understand existing risks and are able to act on perceived threats. Correspondingly, the study of tsunami-risk areas in southern Thailand shows that individuals and households with higher education had greater disaster preparedness e.g., stockpiling emergency supplies and having family evacuation plan (Muttarak and Pothisiri 2013). Consistent findings are reported at the country-level. Comparing to neighboring countries like Haiti and Dominican Republic, Cuba, with higher average level of education among its population, has better effecting risk-

management and risk-communication system as well as disaster preparedness (Pichler and Striessnig 2013).

During the disaster event, understanding and carrying out appropriate response to warning messages are crucial in minimizing losses. Sharma and colleagues (2013) find that the clarity of cyclone warnings increases the likelihood of evacuation in coastal zones in India and the effect is the largest among the most educated group. However, there is no evidence that highly educated individuals were more likely to evacuate voluntarily to a cyclone shelter or a relief shelter. This is explained by the fact that highly educated respondents, given their higher incomes, generally live in better quality housing. Feeling safe in their home, they were less likely to evacuate.

The post-disaster phase mainly concerns disaster impacts and recovery. Disaster impacts comprise both physical and social impacts (Lindell 2013). Physical impacts include casualties (mortality, injury and morbidity) and damage to agriculture, infrastructure and the natural environment. Social impacts consist of psychological, demographic, economic and political aspects. In this Special Issue, both disaster impacts and recovery are thoroughly investigated.

With respect to physical impacts, the cross-national time series analysis of deaths from natural disasters in 125 countries as well as the study of human lives lost from floods and landslides in 75 communities in Nepal consistently show that countries with higher proportion of women with at least secondary education and communities with higher mean year of schooling respectively suffered lower mortality from disasters (KC 2013, Striessnig et al. 2013). The above mentioned comparative study of Haiti, Dominican Republic and Cuba also reports lower disaster-related mortality in Cuba, the country with the most educated population. At the individual-level, the longitudinal study of households located in Aceh and North Sumatra, Indonesia report that men who completed senior secondary school were significantly more likely to survive the 2004 Indian Ocean tsunami as compared to those with primary education (Frankenberg et al. 2013). It is explained that education maybe a proxy for height and strength, another dimension of human capital, which can be relevant in such emergency situation like running away from tsunami waves. Frankenberg and colleagues (2013) also find that women with higher education were less likely to be caught up in the water, injured or witnessed others struggling in the water. Similarly, an analysis of malaria risk in children in 8 sub-Saharan African countries by Siri (2014) reports that maternal schooling was significantly inversely associated with the odds of malaria infection. The relationship between maternal education and lower malaria parasitemia in children is found to be independent of household wealth. This finding has an important policy implication especially since there is evidence that climate variability is associated with an increase of malaria epidemics (Zhou et al. 2004). Apart from reducing mortality, injury and morbidity, it appears that education is also associated with lower damage and losses. It is found that the number of animal losses and the number of families affected by floods and landslides in Nepal were significantly lower in the villages with higher mean years of schooling (KC 2013). These findings provide strong evidence that formal schooling can reduce vulnerability in terms of life losses, injury, morbidity and damage.

Turning to social impacts, the above mentioned study of the 2004 Indian Ocean tsunami finds that post-traumatic stress reactivity (PTSR) measured 5 years after the tsunami was substantially lower among the better educated. This indicates better resilient in terms of psychosocial well-being for those with higher schooling. It is also found that the better educated were more successful in smoothing consumption, i.e., keeping their level of consumption, after the tsunami. Likewise, the study of the impacts of floods and droughts on community welfare in Thailand shows that better educated communities did not experience income loss while communities with lower education suffered a reduction in income after being hit by droughts (Garbero and Muttarak 2013). The lower psychological and economic impacts among better educated individuals and communities imply that they might cope better with disasters and spend less time to recover.

One reason why formal education can enhance coping strategies in the aftermath of a natural disaster is that highly educated individuals or households may have greater flexibility and skills to take up a new job or have better socioeconomic resources to buffer the income loss from climatic shocks. Indeed the study of villagers in rural areas in Mali and Senegal show that the respondents with a higher level of education are less vulnerable to natural hazards because they have more diversified economic activities beyond agriculture and hence are less dependent on climatic or environmental factors (van der Land and Hummel 2013). Likewise, having a wider portfolio of coping strategies, it is found that highly educated individuals and households in Uganda, Brazil and El Salvador were likely to choose mechanisms that are more sustainable and unlikely to lead to chronic poverty and undermine future prospects (Wamsler et al. 2012, Helgeson et al. 2013). For instance, households where the household head has higher educational attainment were significantly less likely to choose taking their children out of school as a coping strategy. This signifies that more educated households are less likely to opt for a strategy that can harm human capital investment.

In terms of recovery, it seems that better educated individuals or households are faster in getting back to a normal life partially because people with higher education have better social and economic resources. Accordingly, the study of the 2004 Indian Ocean tsunami aftermath previously mentioned shows that among those who got displaced after the tsunami, the better educated were less likely to stay in temporary housing, which is typically a camp. Instead, they were more likely to move to private homes, either renting or staying with family or friends. The above mentioned study on the impacts of floods and droughts in Thailand also reports that communities with higher education were more able to secure government financial assistance for drought affected areas. This might be because highly educated communities have wider social networks and better access to resources.

The eleven empirical studies discussed above provide consistent findings on the positive impact of formal education on vulnerability reduction. The results are robust across units of analysis – be it at individual, household, community or country level – and across countries being studied. Many studies in this Special Issue also show that the effect of education remains significant after accounting for wealth/income. Moreover, in

many cases, income/wealth does not have a clear tendency nor clear correlation with vulnerability reduction (KC 2013, Muttarak and Pothisiri 2013, Sharma et al. 2013, Striessnig et al. 2013, Wamsler et al. 2012). The protective effects of education – from the pre-disaster phase, during the disaster event, to the disaster aftermath – indicates that investment in public education can have a positive externality in reducing vulnerability and enhancing adaptive capacity.

POLICY IMPLICATION

Over the next several years, billions of Euros will likely be spent on adaptation programs, primarily through the Kyoto Protocol adaptation fund and national governments. Actually, the amount of 100 billion dollars has been formally pledged to be expended annually from 2020 onwards. But there is serious concern among many experts about the lack of a solid scientific basis to guide policymakers on how best to allocate the money.

The hypothesis that education is key to reducing vulnerability and strengthening adaptive capacity does indeed have massive implications for setting priorities. Should the significant funds allocated for adaptation to climate change be invested in improving existing infrastructure and agricultural practices, or should some money go instead to enhancing human empowerment through education and health? Which approach is more likely to enable people to cope with the long-term challenges posed by a climate that is becoming more violent?

Failure to wisely address these and related questions could result in ill-informed investment policies that lock countries into inflexible coping strategies that will not be effective under possible future climates. Given the significant uncertainties in place-specific climate forecasts, investments in an overall empowerment of human resources that leads to greater flexibility in reacting to the arising challenges may well be a wiser strategy.

In terms of strategies for empowerment the studies presented in this collection also show that female education is of a particular importance. Not only that there remain significant gender gaps in school enrolment and youth literacy rates, but there is also evidence that investment in female education contributes greatly to economic growth and human welfare. With respect to disaster risk reduction, the findings from this Special Issue also point to the prominent role of female education in reducing vulnerability: from increasing disaster preparedness (Muttarak and Pothisiri 2013), minimizing malaria risk (Siri 2014), lowering disaster-related mortality (Striessnig et al. 2013), to reducing disaster risk and enhancing adaptive capacity (Wamsler et al. 2012). Investing in girls' education coupling with strict enforcement on female school enrolment and completion thus should be made priority as self-evident that women educational achievements can have far-reaching effects within the family, across generations and communities.

The studies presented in this volume tried to address for the first time in a more systematic manner the important strategic question whether education should be considered a key factor in reducing disaster vulnerability and enhancing adaptive capacity to climate change. Based on the empirical evidence from many different parts of the world using very different approaches and levels of aggregation the answer turns out to be clearly on the affirmative. In particular, it is interesting to note that almost consistently

education turns out to be more important than income in reducing disaster vulnerability. This implies that policies should focus less on direct monetary transfers and income generation and more on general empowerment through education and human capital formation as the most efficient strategy toward enhancing resilience. We are realistic enough to understand that the evidence presented in this set of studies will not yet turn around the priorities in the well-entrenched vulnerability and adaptation community. But we hope that we have at least put the issue visibly on a table and hence hopefully inspire many more studies on this topic which is so important for our common future.

Responses to this article can be read online at:

<http://www.ecologyandsociety.org/issues/responses.php/6476>

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