

**Trabajo final para el VI Congreso ALAP  
NOT TO BE CITED OR QUOTED**

**Future Differential Vulnerability to Natural Disasters in  
Latin America and the Caribbean by Level of Education**

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## **Abstract**

As the specific effects of climate change in Latin America and the Caribbean or anywhere else in the world are still highly uncertain and there is no guarantee that the intended effects of specific, often costly interventions to reduce climate change impact will actually serve to the purpose, this paper stresses that education should be seen as a central factor for both increasing coping capacity with regard to particular climatic changes and improving the resilience of people to climate risks in general. The main hypothesis is that investments in universal primary and secondary education are the most effective strategy for preparing the population of Latin America and the Caribbean to cope with the still uncertain dangers associated with future climate. The empirical evidence presented in support of our hypothesis stems from multi-variate statistical analyses of cross-country time series of the factors associated with past natural disaster fatalities since 1970 in more than 150 countries. Our main data sources are the Emergency Events Database (EM-DAT) providing us with the necessary information on number of disasters and related casualty figures by country and year, as well as data on populations by age, sex and level of educational attainment from the Wittgenstein Centre. Combining the statistical evidence with the population projections underlying the latest Shared Socioeconomic Pathways (SSPs), as used by the global climate change community for IPCC-related modeling, we will be able to make predictions of the future adaptive capacity of Latin American and Caribbean societies under different assumptions regarding future challenges with respect to mitigation and adaptation to climate change.

## Introduction

This paper addresses the topic of future vulnerability to natural disasters in Latin America and the Caribbean (LAC) from a demographic perspective. Vulnerability to natural disasters is of significant interest in its own right as an important source of premature death. But it becomes even more relevant when we consider that the mechanisms by which such vulnerability is either enhanced or reduced are isomorphic to those that affect the resilience or vulnerability to likely future climate change.

To study the interactions of socioeconomic development and societies' resilience to climate change in greater detail and also to provide a scenario "thread" through the different climate research communities (van Vuuren et al. 2011), the global Integrated Assessment Modeling (IAM) community together with the Impacts, Adaptation, and Vulnerability (IAV) community has recently launched a new scenario development effort (Kriegler et al. 2012) which lead to the so called Shared Socioeconomic Pathways (SSPs). These are representative qualitative narratives of how the world might develop over the course of the 21<sup>st</sup> century following a widely negotiated and broad enough range of possible alternative futures, particularly with regard to future societies' capacity for mitigation and adaptation to climate change (O'Neill et al. under review in GEC). Following these narratives, researchers can integrate and make their knowledge comparable across a range of different fields, thus broadening the scope of our knowledge about the likely future implications of climate change. While the previous global emissions scenarios published by the Intergovernmental Panel for Climate Change (IPCC) have included socioeconomic drivers and population in particular only in very reduced form, the SSPs are supposed to form the skeleton of the IPCC 5th Assessment Report.

The original narratives underlying the SSPs have been translated into the language of demographic change by KC and Lutz (2014). Uncovering what they call "the human core of the SSPs", the authors provide comprehensive assumptions for the future of fertility, mortality, and migration for all countries of the world. As has been pointed out by Hunter and O'Neill (2014), these can be used to look at which demographic factors and relationships can be reliably projected quantitatively into the future. If we know how future population will be distributed across social groups and if we know the differential in vulnerability of these groups, we can 'translate' the SSPs into different contexts. Some examples of such translation attempts include the use of the SSPs for projecting future GDP per capita (Crespo Cuaresma under review in GEC), assessing urbanization impacts from the different scenarios (Jiang and O'Neill under review in GEC), or to the likely damage and adaptation costs due to expected future sea level rise (Hinkel et al. 2014). In this particular paper, we present a similar translation of the SSPs, namely by looking at their implications in terms of future

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vulnerability to natural extreme events. Applying earlier results by Striessnig et al. (2013) which quantified the demographic determinants of past social vulnerability on the global level, we project the SSPs for LAC, one of the world regions most heavily affected both by extreme weather events and the potential effects of climate change.

The paper will be structured as follows. Section 2 will provide a short summary of the SSPs in general, as well as the outlook they offer for LAC in particular. Section 3 will look at some of the more recent evidence on the relationship between disaster vulnerability and demography with a specific emphasis on the effect of education. In Section 4 we will present the aforementioned translation of the SSPs in terms of future predicted number of deaths in LAC before closing with a discussion.

## **The SSP Scenario Framework and what it implies for Latin America and the Caribbean**

As discussed by Arnell et al. (2011) the SSPs were designed to include both a qualitative narrative component and a quantitative one describing the development of certain socioeconomic drivers of climate change numerically. This is supposed to represent a major upgrade of the IPCC's emissions scenarios which so far have been very detailed on its assumptions with regard to energy use, technological development and implied emissions levels while being less explicit about demographic dynamics, including population only as a scaling variable and without any further disaggregation. In contrary to that, the SSPs are based on detailed population projections by age, sex, and level of education produced by the Wittgenstein Centre for Demography and Global Human Capital in Vienna (Eds.: Wolfgang Lutz, Bill Butz, Samir KC Forthcoming). While the five different SSPs presented in this paper cannot claim to depict the multitude of different futures, they nevertheless span a broad range of possible scenarios within the challenges to mitigation and adaptation space (O'Neill et al. 2013).

In the probably most optimistic scenario, SSP1, where the challenges both in terms of mitigation as well as adaptation are assumed to be small, the world makes very good progress toward sustainability. This is achieved by a high rate of technological progress and subsequent cooperation between the development leaders and followers. As a consequence, income levels rise steadily, poverty alleviation proceeds and global inequality is reduced. On the demographic side, SSP1 corresponds to a rapid demographic transition driven by rapid expansion in education systems. Low levels of fertility in today's high fertility countries eventually lead to a comparatively small overall population level.

SSP2 is referred to as the "middle of the road" scenario because it assumes intermediate challenges with respect to mitigation and adaptation to climate change. Compared to SSP1 nothing all too revolutionary is happening. Rather we experience the continuation of current trends with regard to development, democratization or shifts in the global energy mix. Educational investments are still growing but not as fast as in SSP1. As a consequence, population growth is not decelerated as much either, corresponding to medium assumptions both for fertility and mortality.

SSP3 describes a world of extreme fragmentation and polarization. While some global leaders pull ahead, large fractions of the world population, particularly in the global south, are left behind, leading to staggering inequality. The consequence is a stalled transition toward the knowledge society. Education does not increase nearly as much as in the previous scenarios, leading to high levels of fertility and unevenly distributed population growth. Also, since international cooperation is reduced to a minimum, migration between

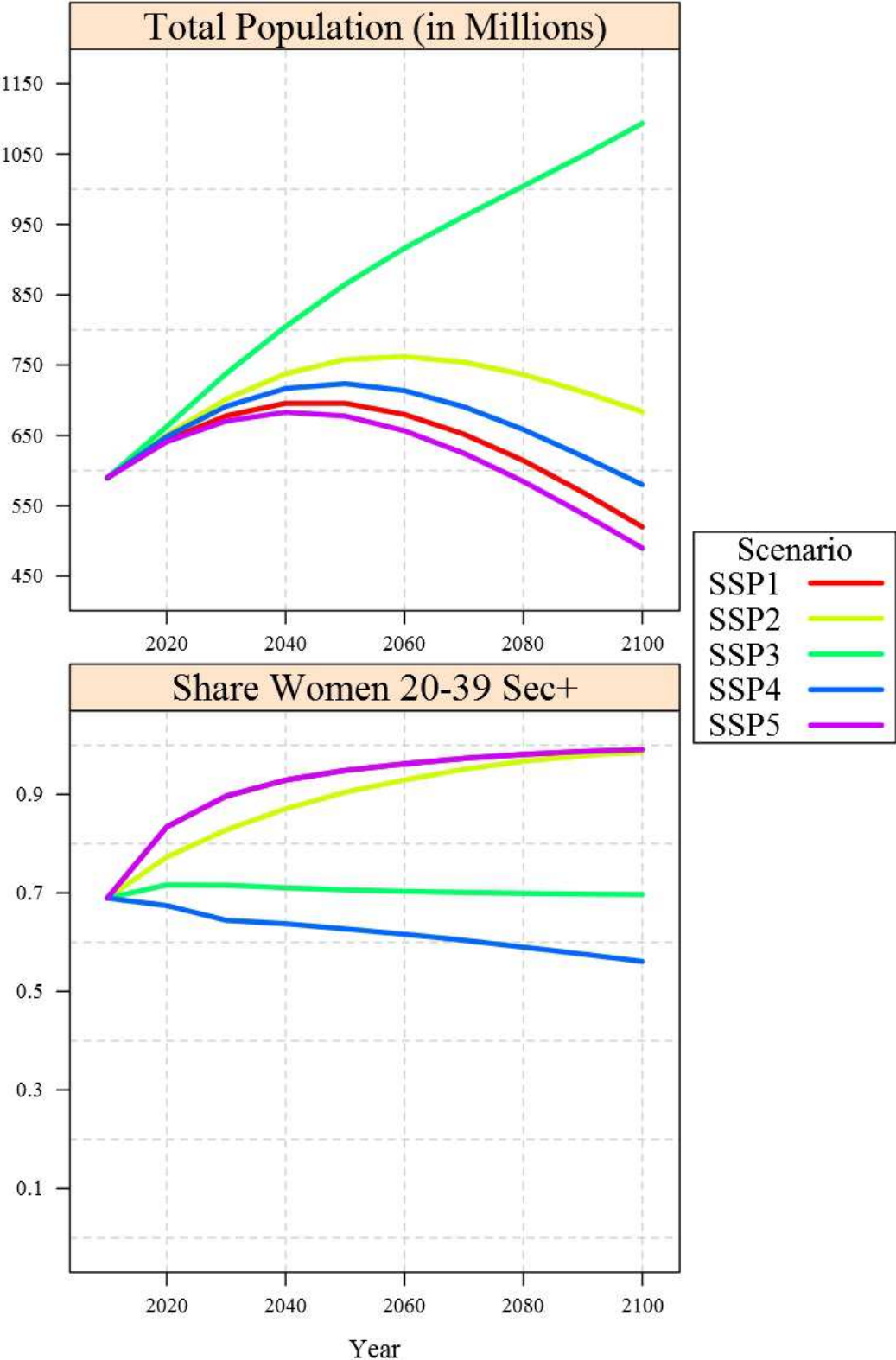
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the newly developing regional blocks of countries also does not play a strong role in this scenarios population dynamics. Not surprisingly, challenges both to mitigation and adaptation appear to be insurmountable in this scenario.

SSP4 is different from SSP3 mainly because challenges to mitigation are reduced. Yet societies' future adaptive capacities are seen to be rather limited. This is both due to large within- and between-country inequality. On the one hand, it leads to large proportions of people who do not have the financial means for making a big contribution to global climate change as they are simply not rich enough to adopt consumerist Western lifestyles. On the other hand, climate change becomes a particularly strong threat for the vast proportion of disadvantaged people who are faced with big challenges for adaptation. Demographically this scenario corresponds to high inequality in the distribution of education. Subsequently, the country average of fertility remains very high in developing countries, whereas the fertility reversal in the rich OECD countries is cancelled because the social transformations facilitating it do not reach far enough.

Finally, SSP5 corresponds to conventional development, "more of the same" in the sense that economic growth is supposed to solve all economic and social problems alike. The environmental consequences of this emphasis on growth do of course lead to large mitigation challenges, while the adaptation challenges are rather small as a consequence of robust economic growth. Education is assumed to be high throughout the world; however the picture looks more complicated with regard to fertility. While fertility is comparatively high in today's richer and low fertility countries, the combination of work and family becomes increasingly more difficult everywhere else in the world. The overall effect on world population is mixed.

Figure 1. Total Population and Share of Women Aged 20-39 with at least Secondary Education in Latin America and the Caribbean, Shared Socioeconomic Pathways (SSPs), 2010 - 2100.



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Figure 1 shows the specific demographic implications of SSP1 to SSP5 in terms of total population (top) and the projected share of women aged 20-39 with at least secondary education (bottom) for LAC. As was to be expected, both SSP1 and SSP5 lead to very high levels of education and low levels of overall population. Yet the development pathways leading to these results are very different; sustainability and low levels of emissions in SSP1, conventional GDP-focused development in SSP5. While it is beyond the scope of the present analysis, it would nevertheless be highly interesting to see what the differences in mitigation challenges between these two scenarios would mean in terms of climate hazard. Since nobody has translated the SSPs into world region specific future numbers of natural extreme events, in the following analysis we have to restrict ourselves to the study of the future adaptation challenges. It is clear however already at this point that due to the similarity of the demographic outcomes, these challenges are going to be fairly similar.

The SSPs tell a more interesting story when comparing the implications of SSP2 and SSP4. Despite higher educational attainment in general leading to smaller populations, the case is reversed when looking at LAC. The middle of the road scenario leads to a higher level of population despite of describing a far better educated continent than the scenario characterized by inequality. In addition to that, inequality (SSP4) is worse than fragmentation (SSP3) in terms of female education, however, total population is projected to be way higher in a fragmented world than in a world of strong inequality. The reason is that almost all countries in LAC today are in the low fertility category. In SSP2, where medium assumptions are assumed for all regions, fertility is still higher than in the SSP4 scenario where it remains low. In addition to that, despite the education progression being smaller in SSP4 than in SSP2, LAC countries already have progressed a lot until today. As there are not many women left in the less educated category, the inequality in education does not affect the outcome as strong as fertility.



## **Demographic determinants of Vulnerability**

Vulnerability towards natural disasters affects people at all stages of their life course although the intensity of the risk also tends to differ by age. While there is some evidence that people at the very beginning (when they are babies) and at the very end of their life cycle (when they are frail elderly) are more vulnerable because they directly depend on the help of others, for the years in between other factors tend to dominate the differentiation of risk. These factors range from household characteristics associated with economic standing (such as the construction and stability of the house) to the ecological setting of the house to individual behavioral variables. One individual characteristic that in the past has not received enough attention in risk studies is the level of educational attainment. Recently a series of studies has clearly demonstrated the decisive role of education in reducing such risks.

In general, in the field of population-environment interactions there is increasing recognition that people not only differ with respect to their contribution to climate change but also in their adaptive capacity. A recent summary states: "The evidence is clear that demographic differences fundamentally affect people's contributions to environmental burdens, their ability to participate in sustainable development, and their adaptability to a changing environment" (From the statement of an international scientific panel as published in *Science*, Lutz et al. (2012)). The future adaptive capacities of societies and the differential vulnerability of their members are one of the least studied aspects of the important question of how dangerous climate change will be for future human well-being. For example, several studies that try to assess the impact of climate change on future malaria deaths in Eastern Africa combine the projected changed climate conditions for 2080 with today's public health capabilities, population distributions, human capital, and general adaptive capacities. But such assessments can be misleading since we know that not only will the climate likely change over the coming decade, but also that demographic structures and associated socioeconomic capabilities will definitely change.

The central hypothesis to be addressed in this section is that education can play an important role in reducing the negative impacts of extreme climate events on human mortality. Education is considered as one important way individuals acquire knowledge, skills, and competencies that can directly or indirectly influence their adaptive capacity. Most directly, literacy and numerical skills obtained through formal education imply better access to relevant information, such as early warnings for tropical storms or seasonal prediction of drought (Patt, Ogallo, and Hellmuth 2007; Moser and Ekstrom 2010). Second, there is evidence that education also enhances cognitive skills and the willingness to change risky behavior while at the same time extending the personal planning horizon (Behrman and Stacey 1997; Neisser et al. 1996; Nisbett 2009). Education enhances the acquisition of

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knowledge, influencing values and priorities as well as the capacity to plan for the future and improve allocation of resources (Glewwe 1999; Thomas, Strauss, and Henriques 1991). Besides that, as described in the previous section on disability, education leads to better health and physical wellbeing (Fuchs, Pamuk, and Lutz 2010; Baker et al. 2011; KC and Lentzner 2010) and is positively related to 'life' skills (e.g. basic practical knowledge on nutrition and health practices, government institutions, and organization) as well as problem-solving skills (Moll 1994; Ishikawa and Ryan 2002; Schnell-Anzola, Rowe, and LeVine 2005). Consequently, it is reasonable to assume that when facing natural hazards or climate risks, educated individuals are more empowered and hence more adaptive in their response to, preparation for, and recovery from disasters. Furthermore, better educated societies have greater social, economic, and institutional capabilities necessary for successful adaptation to climatic change (KC and Lutz 2013).

When the effects of education are being studied, often the question of endogeneity arises. At the aggregate level, there can be either reverse causality or joint determination of the factors studied. Societies with high average level of education generally tend to be more developed and perform well in other development indicators such as health and living standards. It could therefore be possible to assume that the apparently positive effects of education on reducing vulnerability were actually the results of, for example, better infrastructure and health facilities in a country. To study this issue it is necessary to explicitly include these other factors into the analysis.

At the individual level in addition to the possibility of reverse causation there is also the possibility that the effect could be explained by selectivity (e.g. that certain stronger individuals become both better educated and more resilient to disasters). This topic of endogeneity and causality in the effects of education, both at the individual and societal level, is extensively discussed by Lutz and Skirbekk (forthcoming – Chapter 2). It should be pointed out that when assessing the effect of educational attainment, the issue of identifying the direction of the effect is made significantly easier by the fact that the time when the educational attainment was reached (through schooling) tends to be significantly earlier than the time at which vulnerability is assessed. Hence when we study the vulnerability of a 50-year old woman, her educational attainment was on average achieved more than 30 years earlier and is hence independent of the possible effects of recent disasters on the school system or her individual chance to have received an education. Hence, in the spirit of the discussion at the beginning of the paper, there are many good reasons to assume that there is indeed functional causality in the effect of more education on reducing vulnerability.

It has recently been acknowledged that the impacts of climate change are not distributed evenly across population groups and countries (Parry et al. 2007). Accordingly, extant research has investigated socio-demographic differences in impacts of, responses to, and recovery from natural disasters and extreme climate events. It has commonly been found

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that the poor, 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). Furthermore, low-income groups generally face more obstacles during the phases of response, recovery, and reconstruction (Masozera, Bailey, and Kerchner 2007). Consequently, studies on social vulnerability commonly highlight poverty/income as a main characteristic explaining inequalities in all aspects of disasters (Fothergill and Peek 2004).

At the macro level, economic inequalities in impacts from natural disasters have also been reported across communities, regions, and nations (Cavallo and Noy 2010). Fatalities in low-income countries are generally much higher than those of higher income nations (Kahn 2005) while macroeconomic recovery is slower in the former as compared to the latter (Noy 2009). However, apart from economic factors, recent studies show that social characteristics such as literacy levels, degree of openness to foreign trade, and political environment are also associated with disaster impact (Toya and Skidmore 2007; Noy 2009). This suggests that income alone does not explain differential vulnerability. Likewise, the findings that countries with higher levels of education suffer less from the impacts of natural disasters imply that investment in human capital may be a practical tool to prepare for an increasing number of extreme climate events.

### ***New Empirical Evidence***

Based on the above described rationale, the working hypothesis is that formal education could directly or indirectly reduce vulnerability and enhance adaptive capacity. Recent efforts in that direction span empirical analysis ranging from individual-and household-level analyses to village-level studies and national case studies, as well as global-level time series analysis.

An individual level study of disaster preparedness during the 2012 Indian Ocean earthquakes of 557 households located along the Andaman coast in Phang Nga province finds that formal education – measured at the individual, household, and community levels – increases the likelihood of preparedness actions being taken (Muttarak and Pothisiri 2013). Having been affected by the 2004 tsunami clearly increases emergency preparedness but for the group of persons without such disaster experience, education turned out to be a relevant factor in anticipating the risk and taking preparedness actions.

Another recent study at the individual level by Frankenberg et al. (2013) examines the extent to which education serves as a means of protection against natural disaster using longitudinal survey data collected in two provinces on the island of Sumatra, Indonesia,

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before and after the 2004 Indian Ocean tsunami. They find that education clearly plays a role in coping with the disaster over the longer term with the better educated being of better psycho-social health five years after the tsunami. They are less likely than others to live under precarious living conditions and appear to be better at compensating for loss of income following the tsunami.

Similar evidence on the association between education and vulnerability has been reported at the community level. KC (2013) finds strong effects of education using comprehensive village level data in Nepal (a microsample of the 2001 census covering 2.5 million individuals together with disaster data for 2000-2009) on damages due to floods and landslides in terms of human lives lost, animals lost, and other damage to households. Comparing the effect of education with those of income and wealth, the author concludes that education has a stronger and more consistent impact in reducing damage due to floods and landslides in Nepal.

Similarly, a study by Garbero and Muttarak (2013) investigates the impacts of floods and droughts on community welfare in Thailand. Based on the Thai government surveys of living conditions and life quality of 68,695 rural villages for 2009- 2011, the paper uses difference-in-difference methods to analyze how floods and droughts in 2010 affected consumption and income of the villages in 2011. It finds that communities with higher educational attainment did not experience a reduction in consumption, investment in agriculture, and education, nor a decline in income. A further analysis demonstrates that communities with high levels of education are more able to secure available government financial aid for areas affected by floods and droughts.

Another study by Muttarak et al. (2012) on 286 villages in Phang Nga province in Thailand, chosen for its most severe losses from the 2004 Indian Ocean tsunami, shows that preparation for extreme climate events and natural disasters are driven by past experience and anticipation of such events in the future. In addition, villages with a higher proportion of village members with at least secondary education are more likely to prepare for potential natural disasters.

Likewise, Pichler and Striessnig (2013) use data from qualitative interviews conducted in Cuba and the Dominican Republic to compare these two island states with regard to disaster vulnerability. Even though they are fairly similar in their exposure to natural extreme events, disaster outcomes vary greatly between the two islands. While effective disaster response is strongly embedded in the entire Cuban population, which is one of the most educated in the developing world, the interviews strongly confirm that lack of education and literacy in the Dominican Republic makes people more vulnerable and prevents them from even understanding warnings about upcoming danger.

Using national level time series of disaster fatalities around the world, a recent study by Striessnig et al. (2013) finds significant evidence for the role of education – particularly

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female education – in reducing disaster fatalities while there is no evidence for the widely assumed role of income per capita in reducing vulnerability after controlling for other key determinants of socio-economic development as well as exposure to risk. Table 1 shows an update of this multi-variate statistical analysis with newer data for a larger number of countries (158) and a larger number of alternative models for the period 1970 to 2010 for which data were available. The dependent variable is the log of disaster deaths. The sources of data and definitions of variables are explained in detail in Striessnig et al. (2013). Here it suffices to say that in addition to controlling for the number of disasters (as a proxy for exposure) and for population size as a scale parameter, the rate of population growth (for demographic change), and a polity score (for quality of governance), the different models have been defined to assess the relative importance of three different factors of human development: Economic growth (as measured by GDP per capita), the development of public health (as best captured by lagged infant mortality to avoid endogeneity) and the proportion of women aged 20-39 with at least secondary education (a human capital indicator that has been shown to be most sensitive in other contexts).

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TABLE 1. DETERMINANTS OF NATIONAL DEATH FROM NATURAL DISASTER. PANEL REGRESSION FOR 152 COUNTRIES OVER 10-YEAR INTERVALS BETWEEN 1980 AND 2010 USING TIME FIXED EFFECTS. THE DEPENDENT VARIABLE IS THE LOG OF DEATHS PER CAPITA. NUMBERS IN PARENTHESES ARE STANDARD ERRORS BASED ON THE HETEROSKEDASTICITY-REISTANT AND AUTOCORRELATION-RESISTANT COVARIANCE MATRIX. OTHER INDEPENDENT VARIABLES NOT REPORTED HERE ARE DUMMY VARIABLES FOR 18 WORLD REGIONS. SIGNIFICANCE CODES: 0.01 = \*\*\*; 0.05 = \*\*; 0.1 = \*.

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	
Constant	-2.252*** (0.774)	-2.983*** (0.761)	-1.227 (0.838)	-3.100*** (0.788)	-1.253 (0.841)	-1.932** (0.868)	-2.062** (0.876)	
Log (#Disasters)	1.650*** (0.119)	1.562*** (0.118)	1.569*** (0.118)	1.574*** (0.120)	1.578*** (0.120)	1.535*** (0.118)	1.555*** (0.119)	
Pop Growth Rate	1.401*** (0.517)	1.220*** (0.449)	0.987** (0.455)	1.076** (0.512)	0.873* (0.527)	1.037** (0.452)	0.745 (0.525)	
Log (Lagged Pop)	0.252*** (0.082)	0.300*** (0.081)	0.266*** (0.081)	0.296*** (0.082)	0.262*** (0.082)	0.288*** (0.081)	0.278*** (0.081)	
Polity Score	-0.376*** (0.132)	-0.233* (0.134)	-0.320** (0.130)	-0.238* (0.134)	-0.326** (0.131)	-0.226* (0.133)	-0.234* (0.134)	
GDP per Capita (1000s)	-0.005 (0.010)			0.006 (0.011)	0.005 (0.011)		0.012 (0.011)	
Lagged IMR		0.010*** (0.003)		0.011*** (0.003)		0.008*** (0.003)	0.009*** (0.003)	
Female 20-39 Sec+ Edu			-1.472*** (0.414)		-1.523*** (0.431)	-1.076** (0.434)	-1.173*** (0.443)	
Deviance	1135.210	1100.223	1104.476	1099.509	1104.081	1087.360	1084.830	
AIC	2010.264	1993.109	1995.223	1994.753	1997.027	1988.664	1989.388	
BIC	2130.839	2113.685	2115.799	2119.635	2121.909	2113.546	2118.576	
N	548	548	548	548	548	548	548	548

These results support earlier findings that human development is positively associated with reduced disaster vulnerability at the national level. However, the three dimensions of human development turn out to be of very different relative importance. GDP per capita turns out to be insignificant in all models while infant mortality and female education turn out to be highly significant in all models with the expected signs. Higher infant mortality as an indicator of weaker public health is associated with relatively more disaster fatalities and higher levels of female education are shown to be a dominant determinant of reducing disaster vulnerability. In particular, these results clearly show that at least at the aggregate level of national time series, the ubiquitous assumption that GDP was a key determinant disaster vulnerability finds no empirical support while female education as determinant is strongly confirmed.

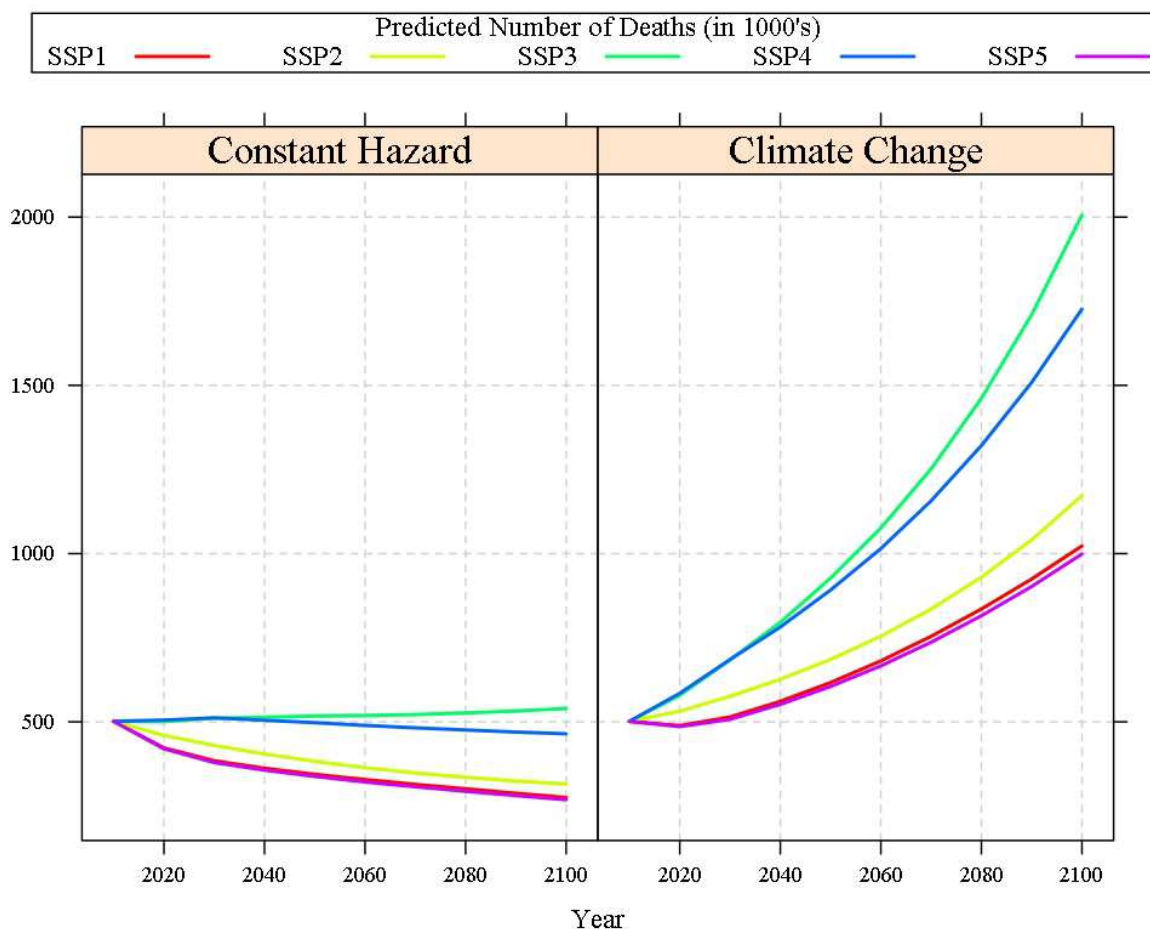


## **Translating the Human Core of the SSPs in Terms of Disaster Vulnerability**

Finally, this section converts the findings by Striessnig et al. (2013) into alternative scenarios for possible future disaster vulnerability in Latin American and the Caribbean depending on the five different SSPs (results for other world regions are available on request). Figure 2 presents two alternative assumptions about the future trends in disaster hazard combining our results from Model 7, which was chosen based on model selection criteria, with the population and education projections according to the SSPs. In the picture on the left, the assumption is that over the decades to come LAC will be exposed to “Constant Hazard”; that is, the number of registered disasters as experienced in the 2000-2010 time period will remain stable. Already in this depiction, the future of education makes a huge difference, not only in the population at risk, but also in the projected decadal number of deaths due to disasters which by the end of the prediction horizon in the fragmentation scenario (SSP3) is more than double the predicted number of deaths in the sustainability scenario (SSP1).

The potential to save lives through education becomes even more obvious under a hypothetical “Climate Change” scenario, which is operationalized by assuming a constant 10 percent increase per decade in the frequency of natural disaster events in LAC. While in SSP1 and SSP5 the increase in educational attainment is still able to prevent the future number of deaths to more than double, the effect of the assumed increase in hazard on future disaster fatalities leads to a quadrupling of disaster fatalities in SSP3.

Figure 2. Predicted Number of Deaths (in 1000s) due to Natural Extreme Events in Latin America and the Caribbean assuming “Constant Hazard” (left) and “Climate Change” (right), 2010 - 2100.



These are of course highly stylized scenario calculations. Since assessments of the future frequency of natural disasters around the world depend on myriad factors such as geography, type of disaster, or societies’ capacities to prevent them from happening in the first place, to name just a few, the IPCC is still careful in quantifying the effect of climate change on the number of natural extreme events. There seems to be a consensus, however, on an upward trend in frequency of appearance with regard to almost any type of disaster as a consequence of sea level rise or higher mean temperature. (Intergovernmental Panel on Climate Change 2012). The assumption of constant hazards is thus rather unlikely to hold and many climate change researchers may think that the assumed increase of 10 percent per decade in the “Climate Change” scenario is far too conservative for the more distant future when the negative effects of climate change may accelerate. In such a case, the calculated effects contingent on the assumed future hazard levels will be proportionately higher than in the examples shown above. In any case, even an increase of 10 percent per decade results in a dramatic rise in fatalities and highlights the potential for near term investments in education to reduce these risks. Much more context-specific analysis of differential

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vulnerabilities and the role of demographic factors including education is needed in order to arrive at robust country-specific forecasts and policy recommendations. In general, however, there can be no doubt that universal basic education of the entire population (including basic literacy and numeracy) is a key factor in enhancing the adaptive capacity and reducing the vulnerability of individuals, communities, and entire nations. Hence, when it comes to the choice of priorities for investments in adaptation, the currently favored engineering solutions should be critically compared to the long term benefits of investing in human capital formation and the general empowerment to flexibly and effectively react to partly still uncertain location specific climate change effects.

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