International Institute for
Applied Systems Analysis
Schlossplatz 1
A-2361 Laxenburg, Austria

Tel: +43 2236 807 342
Fax: +43 2236 71313
E-mail: publications@iiasa.ac.at
Web: www.iiasa.ac.at

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Reducing Vulnerability in Critical Life Course Phases through Enhancing Human Capital

Samir KC (kc@iiasa.ac.at)
Wolfgang Lutz (lutz@iiasa.ac.at)
Elke Loichinger (loiching@iiasa.ac.at)
Raya Muttarak (muttarak@iiasa.ac.at)
Erich Strießnig (striess@iiasa.ac.at)

Approved by

Pavel Kabat
Director General and Chief Executive Officer, IIASA

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Contents

Abstract

In this paper we examine selected types of vulnerability over the human life course with a specific focus on differentials not only by age and gender – as is conventionally done in demography – but also by level of education and with a focus on health.

Starting with the newborn and vulnerability in terms of infant and child mortality, we refer to the level of education of the mother. In reference to young people's susceptibility to unemployment after leaving school, we take into account the education of the women and men themselves. Proceeding further in the life course, we next consider vulnerability to becoming disabled in the age group 30-74 according to the education level of the studied persons themselves. Finally, the last section studies differential vulnerability at the national level using the time series of deaths from disasters where the aggregate levels of education at a national level are being taken into account.

We conclude that over the entire life cycle of individuals, the changes in behavior that tend to be associated with more education (of mothers or the persons themselves) can be viewed as a potent factor in reducing child mortality, reducing the risk for unemployment at young age, reducing the vulnerability to natural disasters, and finally reducing the risk of falling into disability. These general long-term benefits of near-term investments in education hold for individuals as well as for entire societies.

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About the Authors

Samir KC is Project Leader of "Modelling Human Capital Formation" at the Wittgenstein Centre (IIASA, VID/ÖAW, WU), International Institute for Applied Systems Analysis.

Wolfgang Lutz is the Founding Director of the Wittgenstein Centre for Demography and Global Human Capital (IIASA, VID/ÖAW, WU); Leader of the World Population Program at IIASA; Director of the Vienna Institute of Demography of the Austrian Academy of Sciences; and full Professor of Applied Statistics (part time) at the Vienna University of Economics and Business.

Elke Loichinger is a Research Scholar with the World Population (POP) Program at the Wittgenstein Centre (IIASA, VID/ÖAW, WU), International Institute for Applied Systems Analysis. Elke is also a project assistant at the Research Institute for Demography and Global Human Capital at the Vienna University of Economics and Business.

Raya Muttarak is a Research Scholar with the World Population (POP) Program at the Wittgenstein Centre (IIASA, VID/ÖAW, WU), International Institute for Applied Systems Analysis. Raya is also a research scientist at the Vienna Institute of Demography.

Erich Strießnig is a Research Assistant at the Wittgenstein Centre for Demography and Global Human Capital (IIASA, VID/ÖAW, WU), International Institute for Applied Systems Analysis (IIASA), and a Teaching and Research Associate at the Institute for Social Politics at the Vienna University of Economics and Business.

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Samir KC
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Erich Striessnig

1 Introduction

In this paper we will examine vulnerability over the life course with a specific focus on differentials not only by age and gender – as is conventionally done in demography – but also by level of education and with a focus on health. Indeed, there is a significant body of scientific literature showing that the changes in mental functioning, cognitive capacity, and behavior that typically result from education all lead to reduced vulnerability to virtually all threats to human life and wellbeing at all stages of the life course. Hence, reducing vulnerability through educational attainment should be a key strategy for international policies formulated with the goal of not only empowering people but also providing the manifold positive consequences of education at an individual as well as a societal level.

There are certainly many other factors in addition to education that influence vulnerability to the hazards discussed in this paper. Conventionally, economists and other social scientists have seen income as the primary determinant of vulnerability and many studies on differential vulnerability have examined variations with respect to economic standing often without testing empirically whether other observable individual or household characteristics might be more important. Place of residence, age, gender, size of household and social capital are among several other factors that have been studied in this context and have been shown to have some independent effects. A review the vast literature on these different factors is beyond the scope of this paper. However, recently at the Wittgenstein Centre for Demography and Global Human Capital, a series of studies have been carried out to systematically assess the relative importance of education compared to income and the other above mentioned characteristics in reducing vulnerability and enhancing resilience. In cases ranging from infant mortality to disability in old age and from being affected by Malaria to falling victim to natural disasters, education has turned out to be the key characteristic in reducing such vulnerability. These and other relevant studies will be discussed below in the sections dealing with specific vulnerabilities.

In a recent review, a significant amount evidence has been brought together demonstrating that the effects of education on better health and survival and several other desirable goals are indeed functionally causal (Lutz and Skirbekk in Lutz et al. 2014, Chapter 2). In this review, findings from so-called natural experiments are

summarized. While such evidence clearly strengthens the case for assuming a general functional causal relationship through the illustration that the mechanisms work in the expected direction under many different conditions, they fall short of establishing a strong causal relationship for all societies at all points in time. When such experiments demonstrate causality for one specific population group in one country at one point in time, it is far from clear that this proven relationship also holds in very different cultures at different stages of social and economic development. Hence, in order to use such relationships as a basis for projections of the future effects of education in all countries in the world, we should not aim at demonstrating strong causality but rather focus on establishing functional causality through assessing the following three criteria as specified by Lutz and Skirbekk (2014):

(a) There must be **strong empirically observed associations** between the two factors studied and these associations should hold across different societies and for different sub-groups of the population as well as for different points in time (considering the appropriate lag structures). The case for the assumption of a causal relationship is significantly strengthened if this association is observed both at the individual level (across people and households) and the aggregate level (across societies), in particular when it can be found in longitudinal cohort studies.

(b) There must be a **plausible narrative about the mechanisms** by which one force influences the other. This explanation must also give specific attention to the sequence and timing of events according to the general principle that the cause must always transpire before the consequence. In the social sciences it is important to consider that the expectation of a coming event also qualifies as a cause of behavior and not only the event itself. Along these lines, there is support from neurology that education changes the physiology of our brains and hence our perception of the world, our processing of that information, and in consequence, our behavior.

(c) **Other obvious competing explanations** for the observed associations should be explicitly and systematically studied and ruled out as explaining the overall pattern of the observed associations. This does not rule out that such other forces play a minor and non-dominant role. The two main alternative explanations of observed associations are self-selection and reverse causality.

Lutz and Skirbekk (Forthcoming) demonstrate that these three criteria are being met in the case of education effects on health, mortality, and fertility. The foundations of the effects of education on human behavior are derived from modern cognitive neuroscience where it has shown that every learning experience and in particular repeated experiences physiologically change our brains by building new synapses that not only store the information content but also become an integral part of what forms our sense of personality (Kandel 2007). While neuroscience still lacks a comprehensive understanding of the process of learning, neurological studies have confirmed beyond a doubt that brain volumes, cortical thickness, and neurological structures can be affected by more education. Hence, it seems reasonable to assume that the cognitive functions that relate to our perception of the environment around us, our view of the future, and our degree of rationality are also affected by our previous education experiences. In particular, empirical studies show that better educated individuals tend to have a longer investment horizon and be more risk adverse (van der Pol 2011).

It should also therefore be plausible to extend this reasoning to education, as a driver of the other outcome variables studied in this paper, namely the probability of finding a job and general resilience to natural disasters. In all cases, education is associated with a higher degree of abstraction and counterfactual thinking that is necessary to prepare for risks that the person has not yet experienced but that can be reasonably assumed to pose a potential danger. When it comes to education and the possibility of finding a job, in addition to the cognitive effect and the additional skills that are being acquired through education, there is also a so-called signaling effect. This effect implies that employers prefer to recruit people with a prestigious degree even though there is no evidence that their skill levels are actually higher.

In this paper vulnerability refers to being susceptible to or unable to cope with the adverse effects of hostile environment such as natural hazards, economic crisis, or persistent poverty. Specifically, we address vulnerability across four different life domains: infant mortality, youth unemployment, adult disability, and disaster deaths. While vulnerability may be specific to some types of hazards, people of certain socio-demographic characteristics are generally more vulnerable than others. For instance, young people are more susceptible to unemployment during the economic downturn whereas older adults, especially women, have a higher risk of disability. In all four cases we present evidence from different parts of the world and different stages of development examining how vulnerability varies by level of education. For three of the topics we also combine the assessments of the effects of education with alternative educational attainment scenarios to demonstrate quantitatively how investments in education can lead to fewer avoidable deaths and disabilities in the future.

For assessing the impact of alternative possible future education trends, we refer to the education scenarios as they were designated in the IIASA paper for the Human Development Report 2013 as well as a forthcoming book at Oxford University Press (Lutz et al. 2014). These scenarios are now also being utilized for the new set of global SSPs (Shared Socioeconomic Pathways) as they have recently been developed for the global climate change modeling community (Lutz 2012). Because these scenarios are being employed in three of the following four sections, we summarize them briefly here in the introduction:

The Global Education Trend (GET) scenario is based on a Bayesian model that estimates the most likely future trajectory in education-specific progression rates to higher levels from the cumulative experience of all countries over the past 40 years. The resulting education trajectories for each country are not only considered to be the "medium", but are also used as the standard against which all future education-specific fertility and mortality trajectories are being derived.

In addition to GET, there are two other benchmark scenarios with respect to future education trends. The Constant Enrollment Rates (CER) simply assumes that in each country the most recently observed levels of school enrollment, and hence educational progression, are frozen at their current levels. Since in many countries the younger age groups are much better educated than the older ones, even this scenario can lead to some improvements in adult education levels over the coming decades, but in the longer run implies stagnation.

On the other extreme, there is the Fast Track (FT) scenario which assumes that the country will shift gears and follow the most rapid education expansion experienced

in recent history, namely that of South Korea. In addition to the three benchmark scenarios, a fourth scenario, namely Constant Enrollment Number (CEN), is the worst-case scenario in that it assumes zero expansion of schooling. In the context of population growth, this implies that the proportion of children enrolled in school is actually declining over time.

In the following four sections of this paper we will follow the individual life course as we examine education specific vulnerabilities. Starting with the newborn and the vulnerability to infant and child mortality, we refer to the level of education of the mother and of the child. In reference to young people's susceptibility to unemployment after leaving school, we take into account the education of the women and men themselves. Proceeding further in the life course, we next consider vulnerability to becoming disabled in the age group 30-74 according to the education level of the studied persons themselves. Finally, the last section studies differential vulnerability at the level of national time series of deaths from disasters where the aggregate levels of education at a national level are being taken into account. Most of the studies presented are updated and further enriched versions of earlier published analyses on these topics by the authors.

2 Differential Infant and Child Mortality by Maternal Education

When new citizens of the world are born, the first months of their life are also the most dangerous months of their entire life. In most populations of the world, peri-natal mortality is higher than mortality in any of the subsequent periods of life. But even if these new citizens can survive these dangerous first months, their mortality risks are still elevated until around the age of five years, particularly in developing countries. The reason for this high risk lies primarily in a higher vulnerability to diarrheal diseases and other infectious diseases often transmitted by unclean water as well as resulting from nutritional deficits. Since these young children are entirely dependent on the care of adults – in most cases their mothers – the educational level of the mother has been shown to be a key determinant of the vulnerability of children during their first period of life.

The strong negative association between the level of female education and fertility as well as child mortality rates is well established in the literature and described in full detail in the forthcoming book by Lutz et al. (2014). Here, a case is made for assuming a direct causal effect from the empowerment of women through basic education to changes in attitudes, behavior, and the relative standing of women in their partnership, extended family, and society that result in the observed lower levels of fertility and child mortality rates.

Given this clear relationship between female education and demographic outcomes, we should expect that alternative scenarios about future education trends of women will result in different levels of fertility and mortality. In the following tables and graphs we will quantify these effects which – with regard to population growth – go in opposite directions. Higher female education reduces birth rates and at the same time improves the chances of survival for children already born. Yet the calculation below shows that the relationship between education and fertility is far more important than that between education and improved child survival, and as a result, better education is associated with a clear reduction in population growth.

This relationship is shown in Table 1 for a number of least-developed countries by comparing different demographic outcomes across different education scenarios. Under the most likely GET scenario, for Ethiopia the table shows that population will increase from 83 million in 2010 to 172 million by 2060, which is more than a doubling of the population due to current high fertility rates and a very young age structure. Under the FT scenario, the population in 2060 would only be 151 million, i.e. more than 20 million less even when assuming identical education-specific fertility rates. Under the most pessimistic CEN scenario, however, the population would increase to 194 million. This implies that by 2060 the difference between the highest and the lowest education scenarios would be 43 million people, which is more than half of the current population of Ethiopia.

Table 1 also lists the absolute number of births under the different education scenarios, which illustrates the reasons for these major differences in the population growth trajectories. By about 2060, the number of births would be more than twice as high under the CEN scenario (1.77 million) than under the FT scenario (0.88 million). As discussed above, the effect of different numbers of births on total population growth is moderated by the differences in mortality that result from different levels of education. The last columns of the table show that the number of child deaths under the age of five would be 120,000 under the FT scenario as compared to 363,000 under CER, and 403,000 under CEN.

Table 1. Different Demographic Outcomes as a Consequence of Different Education Scenarios for a Number of Least-Developed Countries (Medium Fertility Assumptions)

		Population (in million)				Births (in'00,000)*				Under 5 mortality (in '000)*			
	Year	GET	CER	FT	CEN	GET	CER	FT	CEN	GET	CER	FT	CEN
Benin	2010	9	9	9	9	18	18	17	18	114	116	112	115
Benin	2030	14	14	14	14	19	20	17	20	83	95	67	97
Benin	2060	21	22	19	22	17	19	13	20	38	52	23	55
Burkina Faso	2010	16	16	16	16	36	37	35	36	270	275	262	272
Burkina Faso	2030	27	28	26	28	43	48	35	48	220	252	160	251
Burkina Faso	2060	43	47	37	47	40	49	28	49	98	142	54	143
Burundi	2010	8	8	8	8	15	15	15	15	123	122	120	122
Burundi	2030	13	13	13	13	15	16	13	16	96	105	77	105
Burundi	2060	19	19	17	19	14	15	10	15	46	58	27	60
Chad	2010	11	11	11	11	26	26	26	26	261	263	257	262
Chad	2030	18	18	18	18	30	32	27	32	230	249	187	250
Chad	2060	27	29	25	29	26	30	20	30	112	151	71	153
DR Congo	2010	66	66	66	66	151	154	148	154	1444	1473	1396	1469
DR Congo	2030	107	109	104	109	170	186	151	191	1301	1561	1007	1642
DR Congo	2060	160	169	149	171	145	174	118	181	671	1000	444	1113
Ethiopia	2010	83	83	83	83	140	142	139	143	722	727	710	731
Ethiopia	2030	124	127	120	128	149	166	121	172	526	608	391	633
Ethiopia	2060	172	188	151	194	129	166	88	177	234	363	120	403
Guinea	2010	10	10	10	10	19	19	18	19	137	139	129	137
Guinea	2030	13	14	13	14	17	19	15	18	86	102	64	98
Guinea	2060	16	17	15	17	12	14	9	14	34	49	21	47
Haiti	2010	10	10	10	10	13	13	12	13	52	53	50	53

		Population (in million)				Births (in'00,000)*				Under 5 mortality (in '000)*			
	Year	GET	CER	FT	CEN	GET	CER	FT	CEN	GET	CER	FT	CEN
Haiti	2030	12	12	12	12	11	12	10	12	26	33	21	32
Haiti	2060	13	14	13	14	8	10	7	9	8	13	6	13
Madagascar	2010	21	21	21	21	36	36	35	36	93	91	89	92
Madagascar	2030	33	33	32	34	40	42	35	44	66	70	49	75
Madagascar	2060	50	51	44	53	37	40	26	43	34	40	17	45
Malawi	2010	15	15	15	15	34	34	33	35	204	207	200	209
Malawi	2030	26	27	25	27	48	52	40	56	204	238	152	268
Malawi	2060	48	53	42	57	52	67	38	77	141	223	86	285
Mali	2010	15	15	15	15	36	37	35	37	321	326	309	323
Mali	2030	26	26	25	26	42	45	34	45	259	294	186	292
Mali	2060	40	43	35	43	36	43	26	43	120	171	64	171
Mozambique	2010	23	23	23	23	43	44	41	43	290	292	277	290
Mozambique	2030	34	35	33	35	44	49	38	49	186	217	136	218
Mozambique	2060	46	49	41	49	38	46	27	46	84	124	47	127
Niger	2010	16	16	16	16	40	40	39	40	284	286	278	285
Niger	2030	30	30	29	30	63	67	54	67	330	360	266	362
Niger	2060	62	67	54	67	78	92	58	93	250	331	150	340
Rwanda	2010	11	11	11	11	22	22	21	22	138	141	131	139
Rwanda	2030	17	17	16	17	24	27	20	27	113	133	80	135
Rwanda	2060	26	28	23	28	23	28	17	29	58	86	32	91
Senegal	2010	12	12	12	12	23	24	22	24	107	110	100	107
Senegal	2030	19	20	18	20	25	29	20	28	81	99	52	96
Senegal	2060	27	31	23	30	22	29	15	29	31	50	15	49
Sierra Leone	2010	6	6	6	6	11	11	11	11	93	94	89	93
Sierra Leone	2030	9	9	8	9	12	12	10	13	68	78	50	79
Sierra Leone	2060	12	13	11	13	10	12	7	12	33	46	19	48
Somalia	2010	9	9	9	9	20	20	19	20	174	177	170	176
Somalia	2030	13	14	13	14	21	23	17	24	146	175	107	181
Somalia	2060	17	19	15	19	15	20	11	20	64	107	37	113
Sudan	2010	44	44	44	44	71	71	70	71	331	329	322	330
Sudan	2030	65	65	64	65	74	78	68	80	267	309	212	325
Sudan	2060	88	91	84	92	63	75	53	78	148	233	103	256
Uganda	2010	33	33	33	33	80	83	76	81	480	495	456	486
Uganda	2030	60	62	57	62	111	125	93	127	488	582	349	600
Uganda	2060	109	122	93	123	120	154	88	160	278	419	162	459
Tanzania	2010	45	45	45	45	91	94	88	93	396	407	382	402
Tanzania	2030	73	75	70	75	107	117	91	120	273	314	207	330
Tanzania	2060	114	122	99	124	100	117	71	123	145	190	82	209
Zambia	2010	13	13	13	13	30	31	28	31	207	217	194	213
Zambia	2030	21	22	20	22	37	43	29	44	187	234	120	250
Zambia	2060	33	38	28	39	34	46	24	50	96	157	52	185
Bangladesh	2010	149	149	149	149	154	154	152	154	406	408	390	406
Bangladesh	2030	179	179	177	179	128	133	119	132	164	187	128	182
Bangladesh	2060	189	194	182	193	88	102	75	100	49	70	34	65
Cambodia	2010	14	14	14	14	16	16	16	16	58	58	57	58

		Population (in million)				Births (in'00,000)*				Under 5 mortality (in '000)*			
	Year	GET	CER	FT	CEN	GET	CER	FT	CEN	GET	CER	FT	CEN
Cambodia	2030	17	17	17	17	14	14	13	14	22	24	18	24
Cambodia	2060	19	19	18	19	10	11	8	12	7	10	4	10
Laos	2010	6	6	6	6	7	7	7	7	21	21	20	21
Laos	2030	8	8	8	8	7	7	6	7	13	14	9	14
Laos	2060	9	9	8	9	5	6	4	6	5	6	3	6
Myanmar	2010	48	48	48	48	40	40	38	40	147	147	139	146
Myanmar	2030	52	52	51	52	32	34	27	33	77	86	51	80
Myanmar	2060	47	49	44	48	23	27	18	25	24	34	14	28
Nepal	2010	30	30	30	30	38	40	37	39	64	69	60	66
Nepal	2030	42	43	41	43	37	43	34	42	24	35	20	33
Nepal	2060	55	61	52	60	31	43	27	41	9	19	7	18

*for period measures, “Year” is the end of the five year period (e.g. 2060 refers to 2055-2060)

Hence, even under the CER scenario that assumes that school expansion can keep pace with population growth, the absolute number of child deaths is estimated to be three times higher compared to the fastest case of education expansion. In this sense, the expansion of female education does not only have significant consequences on population growth and development in general, it also has massive direct effects on child mortality.

So far, all discussions of the impact of alternative education scenarios have been combined with medium (the most likely) education-specific fertility and mortality assumptions. But the positive effects of education can be expected to be even stronger because future education-specific fertility rates would follow a higher trajectory (defined as gradual increases to a point of 20 percent higher than the “medium” by 2030, and 25 percent different by 2050 and thereafter) due to the higher absolute differences between the birth rates of the different education categories.

In Table 2 below, we briefly discuss the consequences of this case with an in-depth examination of two countries from the above table. In Ethiopia under the most pessimistic education scenario, CEN combined with high fertility, not only would population grow to the extremely high level of 238 million by 2060, but as the table shows child mortality would be catastrophically high with 638,000 child deaths in 2060-65 as compared to the much lower number if 186,000 child deaths under the optimistic FT scenario. In other words these two different education scenarios result in projected child deaths that differ by a factor of 3.4 even when assuming identical trajectories of education-specific child mortality rates. The result is not so different for Nepal where under the CER and CEN scenarios, almost three times as many children will be dying in 2060-65 than under the most optimistic FT scenario. This illustrates clearly that mothers’ education can indeed be a key factor in reducing child mortality in the future in the context of least developed countries.

Table 2. Different Child Mortality Outcomes as a Consequence of Different Education Scenarios for Ethiopia and Nepal (High Fertility Assumptions)

		Under 5 mortality (in '000)*			
	Year	GET	CER	FT	CEN
Ethiopia	2010	747	754	737	758
Ethiopia	2030	641	742	476	774
Ethiopia	2060	361	562	186	638
Nepal	2010	67	72	63	69
Nepal	2030	30	43	24	41
Nepal	2060	15	30	12	31

These results dramatically illustrate how important progress in female education is for avoiding a significantly higher number of child deaths. It can even be argued that these figures represent an underestimation of the effects of education on child mortality because they only consider the individual level effects and not the community-level impacts of education. The literature has shown (Fuchs et al. 2010; Pamuk et al. 2011) that there are typically spillover effects – normative change in favor of family limitation and better availability of reproductive health services in communities with better educated women. Particularly in countries that have experienced the most rapid voluntary fertility declines—such as Iran, Mauritius, and South Korea—these community-level effects were highly relevant. A multilevel analysis of 22 countries in sub-Sahara Africa shows that an additional fertility decline of up to one child per woman is attributable to the aggregate-level effect of female education in addition to the individual-level effects (Fuchs et al. 2010; Pamuk et al. 2011) .

Finally, it needs to be pointed out that the interaction between education and population growth goes both ways. Under the CEN scenario of high population growth due to high birth rates, the increase in the school age population is such that even maintaining current school enrollment rates can be an uphill battle. In several African countries during the 1980s, the proportions of young cohorts in school actually declined, presumably because of the combination of cuts in education efforts due to economic and political problems and very rapid population growth, resulting in an increase in the younger out of school population (Lutz & KC 2013). The stall of the fertility decline observed in some African countries around 2000 was associated with this stall in education of the relevant female cohorts. Although female education is an important force in lowering fertility, rapid growth in the number of children in a society in which resources do not grow at the same pace is an obstacle to the expansion of education. For this reason, it is most effective from a policy perspective to try to increase female education while at the same time improving access to family planning programs.

In conclusion, this section has clearly demonstrated that improving maternal education is a key strategy in reducing future child vulnerability to (by definition) premature mortality. The scenarios presented here up to 2060 under alternative education assumptions – but identical education-specific mortality rates – show that under the pessimistic education scenarios there will be 3-4 times more child deaths in many of the least developed countries than under the scenarios assuming rapid improvements in education among young women.

3 Youth Unemployment by Level of Education

Another critical and vulnerable period in the life course of young people is the transition from the years of education (assuming that they are in countries that offer basic education) into the labor market. In many countries of the world this transition is made quite difficult by high levels of youth unemployment. This situation has been dramatically worsened as a consequence of the recent economic crisis even in some of the richest industrialized countries. Unfortunately, it is quite difficult to get reliable statistical information on the levels of unemployment by age, gender, and level of education for many developing countries. While in Europe there are regular and comparable labor force and employment surveys, virtually no such data sources exist for developing countries. Initial efforts by the authors of this paper to extract relevant information from the public use samples of selected censuses in developing countries turned out to unfeasible for an education-specific analysis of unemployment. For this reason the following analysis will only focus on European countries for which Eurostat provides consistent time-series data of unemployment by level of education as well as the USA.

3.1 Background: Youth Unemployment and Education

Youth unemployment is an indicator of young people experiencing difficulties in the transition from education to employment. When the economic conditions are not favorable for job creation, young people in particular experience difficulties in finding and keeping jobs.

The OECD report entitled *Education at a glance* (2013, p.13) emphasizes the importance of education in reducing the vulnerability of young people: "The distribution of unemployment within the younger generation sheds light on some of the factors that may increase the risk of joblessness, which, in turn, offers insights for policy responses. Most notably, educational attainment has a huge impact on employability, and the crisis has strengthened this impact even further. On average across OECD countries, 4.8% of individuals with a tertiary degree were unemployed in 2011, while 12.6% of those lacking a secondary education were. Between 2008 and 2011 the unemployment gap between those with low levels of education and those with high levels of education widened: across all age groups, the unemployment rate for low-educated individuals increased by almost 3.8 percentage points, while it increased by only 1.5 percentage points for highly educated individuals. Without the foundation skills provided by a minimum level of education, people find themselves particularly vulnerable in an insecure labor market."

There are several mechanisms that result in this pattern of generally lower unemployment for more highly educated younger people. First, structural change in the economies of many countries leads to new job creation in sectors such as ICT that typically require higher skills. Secondly, when employers have a choice between a better and lower skilled person for any given job it is a rational decision to offer the job to the better skilled person in the expectation that he/she will be more productive for a given salary level. But on top of this effect of higher skills, it has also be argued that there is a "signaling effect" which leads to the recruitment of people with better education on paper even when the actual skills have not been tested. This can also lead to a crowding out effect in which under conditions of a tight labor market more jobs are

given to people with better education thus resulting in relatively higher unemployment for those with lower levels of formal education. All these factors are contributing to the described education differentials in unemployment.

But the pattern can also differ by the stage of economic development of a country. While there is ample evidence that higher education increases the chances of employment in advanced economies, for developing countries several studies suggest that "the nature of educational enrollment, attainment, and employment may be very different in rapidly changing societies, and these relationships are likely to change across historical time" (Yabiku & Schlabach 2009, p.537). In transitioning societies, meaning those that are moving out of being predominantly agrarian, education systems often produce graduates faster than the economy can adjust, leading to a shortage of job opportunities in the formal sector for individuals with higher education. Two factors that contribute to this phenomenon in a number of developing countries are the high aspirations for finding a prestigious job that are often associated with higher formal education and a situation where the chosen field of study does not match the demand by the labor market. It is not unusual that graduates in one field have serious difficulties finding an appropriate job while in other fields there is a lack of qualified graduates.

3.2 Empirical Evidence from Europe

As discussed above, the empirical data on trends in youth unemployment by level of education is very unevenly distributed. While for Europe consistent data exist for a large number of countries (as provided by Eurostat[1]), for developing countries it is very hard to find any such data as all.

Table 3. Youth (Ages 15 To 24) and Adult (Ages 25 To 64) Unemployment Rate, 2008 and 2012 (Source: EUROSTAT Database; Based on Labor Force Survey Data)

Country	2008			2012		
	15 to 24 years old	**25 to 64 years old**	**difference between youth and adult unemployment rate (in percentage points)**	**15 to 24 years old**	**25 to 64 years old**	**difference between youth and adult unemployment rate (in percentage points)**
Austria	8	3.2	4.8	8.7	3.7	5
Belgium	18	5.9	12.1	19.8	6.5	13.3
Bulgaria	12.7	5	7.7	28.1	11.1	17
Croatia	21.9	7	14.9	43	13.6	29.4
Cyprus	9	3.2	5.8	27.8	10.4	17.4
Czech Republic	9.9	4	5.9	19.5	6.1	13.4
Denmark	8	2.6	5.4	14.1	6.5	7.6
Estonia	12	4.7	7.3	20.9	9.1	11.8
EU 27	15.6	6	9.6	22.8	9.2	13.6
Finland	16.5	5	11.5	19	6.2	12.8

[1] „EUROSTAT database, data retrieved June 25, 2013, from http://epp.eurostat.ec.europa.eu/portal/page/portal/statistics/search_database"

Country	2008			2012		
	15 to 24 years old	25 to 64 years old	difference between youth and adult unemployment rate (in percentage points)	15 to 24 years old	25 to 64 years old	difference between youth and adult unemployment rate (in percentage points)
The Former Yugoslav Republic of Macedonia	56.4	30.7	25.7	53.9	28.4	25.5
France	18.6	6.1	12.5	23.8	8.4	15.4
Germany	10.6	7.2	3.4	8.1	5.2	2.9
Greece	22.1	6.7	15.4	55.3	22.4	32.9
Hungary	19.9	6.9	13	28.1	9.7	18.4
Iceland	8.2	1.9	6.3	13.5	4.5	9
Ireland	12.7	5	7.7	30.4	13.1	17.3
Italy	21.3	5.6	15.7	35.3	9	26.3
Latvia	13.1	6.9	6.2	28.4	13.8	14.6
Lithuania	13.4	5	8.4	26.4	12.3	14.1
Luxembourg	17.9	4	13.9	18.8	4.2	14.6
Malta	12.2	4.7	7.5	14.2	5	9.2
Netherlands	5.3	2.2	3.1	9.5	4.5	5
Norway	7.5	1.8	5.7	8.5	2.3	6.2
Poland	17.3	6	11.3	26.5	8.6	17.9
Portugal	16.4	7.2	9.2	37.7	14.5	23.2
Romania	18.6	4.7	13.9	22.7	5.8	16.9
Slovakia	19	8.5	10.5	34	12.2	21.8
Slovenia	10.4	3.7	6.7	20.6	8	12.6
Spain	24.6	9.8	14.8	53.2	22.8	30.4
Sweden	20.2	4.2	16	23.6	5.8	17.8
Switzerland	7	2.8	4.2	8.4	3.6	4.8
Turkey	18.5	8	10.5	15.7	6.9	8.8
United Kingdom	15	4	11	21	5.8	15.2

Table 3 shows that adult unemployment is significantly lower than youth unemployment in all European countries for which data are available. This clearly shows that the period of transition from education to entering the labor market is a particularly critical phase in the life cycle of all people. The burden of finding a job is usually placed entirely upon the young people themselves; concurrently, older people in existing employment contracts are typically well-protected by labor laws and hence the first reaction in times of economic difficulties for companies is to stop recruiting young people before considering sacking people that are already employed. Furthermore, when it comes to terminating employment contracts in times of crises, younger employees are frequently the ones that are more likely to lose their jobs, because they are often less protected by labor laws and cheaper to lay off than older workers.

Figure 1 shows the development of youth unemployment in the European Union since the year 2000. The education differentials in unemployment vary over time, but at any point between 2000 and 2012, higher levels of education are associated with lower

levels of unemployment. The figure also clearly shows the effect of the economic crisis after the boom years until 2008. While youth unemployment rates increased for all education groups from 2009 onwards the sharp differences by level of education remain unaffected by the crisis, actually the differentials still widened a bit as a consequence of the crisis. At the level of the EU-27 the unemployment rate of young men and women in 2012 was 30 percent for the lowest education groups, 20-23 percent for the intermediate education groups and only 18 percent for the highest education categories. In the following Table 4 and Figure 2 this pattern will be studied at the national level.

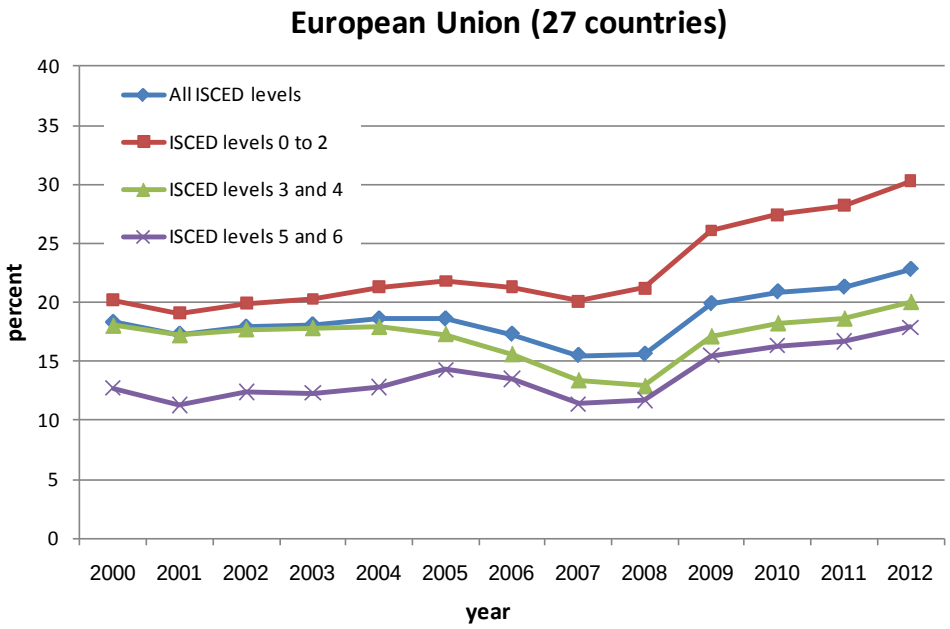


Figure 1. Youth Unemployment Rate (Ages 15 To 24) for All EU27 Countries Combined and Selected Individual Countries, by Highest Level of Educational Attainment, 2000 to 2012 (Source: EUROSTAT Database) ISCED Levels 0 to 2 = Pre-Primary, Primary and Lower Secondary Education; ISCED Levels 3 and 4 = Upper Secondary and Post-Secondary Non-Tertiary Education; ISCED Levels 5 and 6 = First and Second Stage of Tertiary Education

Table 4. Youth Unemployment Rate (Ages 15 to 24), by Highest Level of Educational Attainment, 2012 (Source: EUROSTAT Database; Based on Labor Force Survey Data)

Country	All ISCED levels	Pre-primary, primary and lower secondary education (ISCED levels 0 to 2)	Upper secondary and post-secondary non-tertiary education (ISCED levels 3 and 4)	First and second stage of tertiary education (ISCED levels 5 and 6)
		Total		
Austria	8.7	12.4	6.9	:
Belgium	19.8	32.8	16.2	14
Bulgaria	28.1	46.5	26.5	:
Croatia	43	61.5 (u)	42.1	45 (u)
Cyprus	27.8	30.1	25.1	30.5

Country	All ISCED levels	Pre-primary, primary and lower secondary education (ISCED levels 0 to 2)	Upper secondary and post-secondary non-tertiary education (ISCED levels 3 and 4)	First and second stage of tertiary education (ISCED levels 5 and 6)
Czech Republic	19.5	48.9	16.1	12.6
Denmark	14.1	16.6	11.2	13.7 (u)
Estonia	20.9	32.6	18.7	:
EU 27	22.8	30.3	20	17.9
Finland	19	29.7	14.3	:
The Former Yugoslav Republic of Macedonia	53.9	63.1	49.3	61.8
France	23.8	37.8	21.4	14.7
Germany	8.1	12.2	5.7	4.4
Greece	55.3	50.7	58	52.3
Hungary	28.1	44.7	25.5	18.9
Iceland	13.5	16.6	8.2	:
Ireland	30.4	50.4	29.9	17.9
Italy	35.3	40.2	33	33.3
Latvia	28.4	44.1	26.5	13.7 (u)
Lithuania	26.4	36.3 (u)	26.2	21.6 (u)
Luxembourg	18.8	22.6	16.6	:
Malta	14.2	22.8	9.9	:
Netherlands	9.5	13.3	6.8	5.1
Norway	8.5	10.4	5.8	7.2
Poland	26.5	33.2	26	22.5
Portugal	37.7	39.4	35.5	39.1
Romania	22.7	16.3	25.1	29.1
Slovakia	34	66	31	29.1
Slovenia	20.6	29.6 (u)	18.6	21.3 (u)
Spain	53.2	59.9	49.7	39.8
Sweden	23.6	38.6	18.1	14.1
Switzerland	8.4	7.4	9.3	7.9 (u)
Turkey	15.7	12.6	17.2	25.7
United Kingdom	21	37.2	18.8	12.6
		Males		
Austria	8.8	11.1	7.5	:
Belgium	20.4	33.7	15.5	14.1
Bulgaria	29.5	49.9	27	:
Croatia	42.3	57.3 (u)	42.1	:
Cyprus	28.8	33.9	27.2	27.2 (u)
Czech Republic	19.9	50.8	15.3	17.6 (u)
Denmark	14.8	17.1	11.6	:
Estonia	23.4	32.1	20.5	:
EU 27	23.4	30.5	20.1	17.9

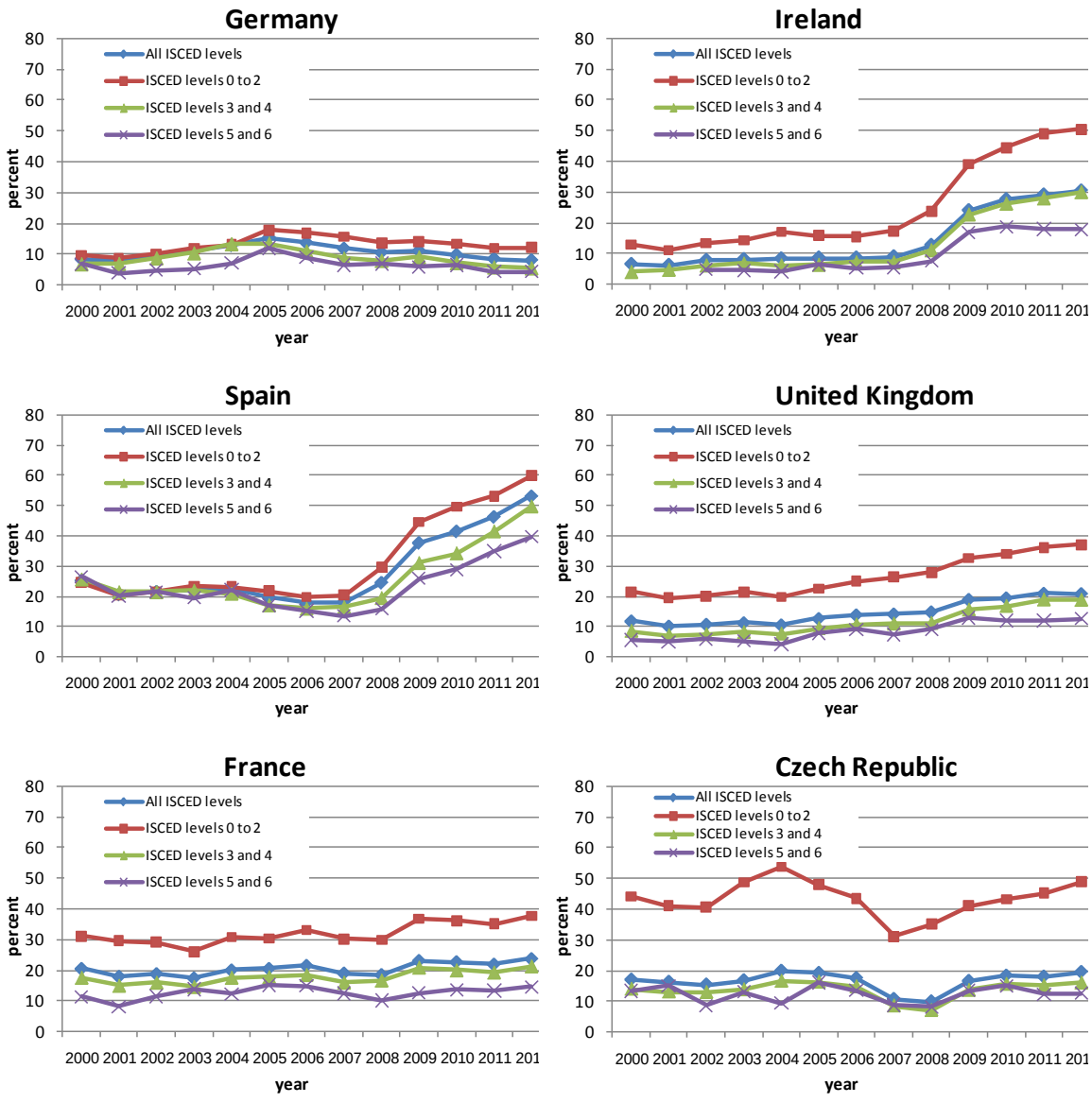
Country	All ISCED levels	Pre-primary, primary and lower secondary education (ISCED levels 0 to 2)	Upper secondary and post-secondary non-tertiary education (ISCED levels 3 and 4)	First and second stage of tertiary education (ISCED levels 5 and 6)
Finland	19.9	30.4	15.5	:
The Former Yugoslav Republic of Macedonia	55.2	64.8	51.6	59.7
France	23.9	37	20.3	15
Germany	8.8	12.6	6	:
Greece	48.4	47.2	50.9	34.8
Hungary	28.8	43.9	25.8	:
Iceland	14.7	18.9	:	:
Ireland	36.4	56.1	34.3	22.1
Italy	33.7	38.5	31.2	26.1
Latvia	27.6	39	24.4	:
Lithuania	29.9	:	28.4	:
Luxembourg	18.9	22.5 (u)	16.8 (u)	:
Malta	13.9	19.3	10.1 (u)	:
Netherlands	8.9	11.7	6.7	5.4
Norway	9.9	11.4	6.9	14.8 (u)
Poland	24.1	31.4	23	19 (u)
Portugal	36.4	37.8	34.2	38.1
Romania	22.3	18.7	24.2	23.8 (u)
Slovakia	35	64.9	31.5	30.8 (u)
Slovenia	20.3	29.5 (u)	18.1	:
Spain	54.4	58.9	52.6	38
Sweden	25	40.5	19.3	16.5
Switzerland	8.8	7.9	9.3	9.8 (u)
Turkey	14.6	13.6	14.6	20.3
United Kingdom	23.6	37.3	21	16.1
Females				
Austria	8.7	14.5	6.3	:
Belgium	18.9	31.1	17.2	14
Bulgaria	26	40.4 (u)	25.7	:
Croatia	44.3	67.8 (u)	42.1	52.4 (u)
Cyprus	26.7	:	21.8	31.6
Czech Republic	19	45	17.4	10.6 (u)
Denmark	13.5	16	10.9	:
Estonia	18	33.7 (u)	16.5	:
European Union (27 countries)	22	30	19.8	17.9
Finland	18	29	13	:
Former Yugoslav Republic of Macedonia, the	51.8	58.6	44.7	62.9

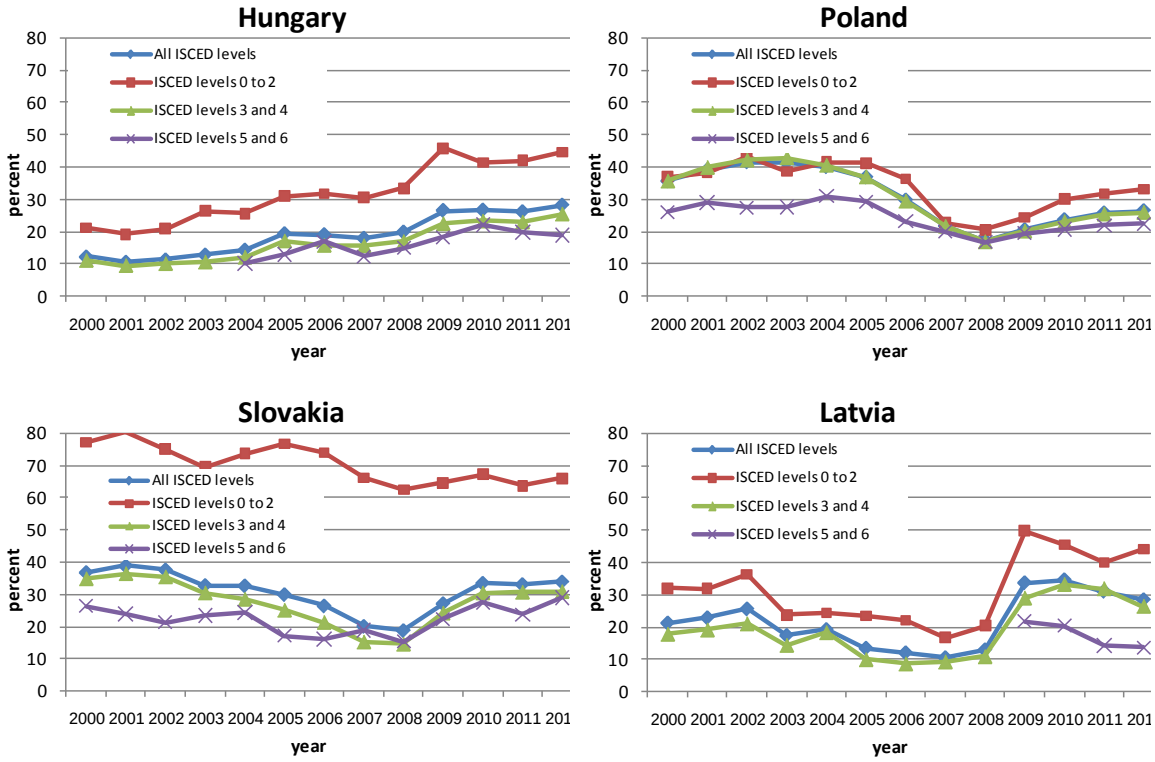
Country	All ISCED levels	Pre-primary, primary and lower secondary education (ISCED levels 0 to 2)	Upper secondary and post-secondary non-tertiary education (ISCED levels 3 and 4)	First and second stage of tertiary education (ISCED levels 5 and 6)
France	23.7	39.3	22.8	14.4
Germany	7.3	11.6	5.3	4
Greece	63.2	58.5	66.3	59.1
Hungary	27.3	46.5	25.2	21.8
Iceland	12.3	14.1	9.9	:
Ireland	24	41.2	24.7	15.3
Italy	37.5	43.9	35.3	36.6
Latvia	29.3	56	29.3	:
Lithuania	21.9	:	22.9 (u)	:
Luxembourg	18.6	23 (u)	16.3 (u)	:
Malta	14.6	29.5	9.8 (u)	:
Netherlands	10	15.1	7	4.9
Norway	6.9	9.3	4.5	4.6 (u)
Poland	30	39.5	30.8	24.3
Portugal	39.2	42.4	36.7	39.5
Romania	23.2	12.2	26.5	32.4
Slovakia	32.5	68.6	30	27.9
Slovenia	21	29.8 (u)	19.3	23.5 (u)
Spain	51.8	61.6	47	40.8
Sweden	22.2	36.9	16.8	12.5
Switzerland	8.1	6.8	9.3	6.6 (u)
Turkey	17.8	10.2	22.1	30.8
United Kingdom	18	37	16.6	9.4

note: (:) data not available, (u) data with low reliability.

While Table 3 clearly shows that young people are more vulnerable to unemployment than older ones, the above table and figure show that within the younger demographic less educated individuals are even more vulnerable. In the great majority of countries where reliable data is available (14 out of 21) young people with any kind of tertiary education have lower levels of unemployment than those who have at most a lower secondary education. But there are interesting country-specific deviations from the general pattern that can be explained by specificities of the education systems as well as rigidities in the labor markets. Figure 2 shows that in every single country included the lowest education groups have significantly higher risks of unemployment that the higher education groups. With respect to the economic crisis it is interesting to see that the times series for German and France show hardly any effect of the crisis on youth unemployment whereas in Ireland and Spain the effects were most dramatic. Youth unemployment in Ireland among the lowest education group is currently 50 percent and even 60 percent in Spain. Compared to this the unemployment rate among young adults with post-secondary education is 18 percent in Ireland and “only” 40 percent in Spain. This interesting difference in the extent of the educational unemployment differential may have to do with rigidity of the labor market in Spain as

compared to that in Ireland unemployment rates of the more highly educated have actually declined over the past five years. But even in Spain the reports about massive increase of unemployment among university graduates have to be put into perspective. The data show that even under the dramatic conditions where overall young unemployment is at more than 50 percent those with university education have a 50 percent better chance of finding a job than those with only basis education. Hence even under these extreme conditions a better education still reduces the vulnerability to the risk of remaining unemployed.





note: data points with low reliability for ISCED levels 5 and 6: Ireland (2002-04), Czech Republic (2000-11), Hungary (2004-07), Poland (2000), Slovakia (2000-06) and Latvia (2011/2012)

Figure 2. Youth Unemployment Rate (Ages 15 to 24) for Selected EU Countries, by Highest Level of Educational Attainment, 2000 to 2012 (Source: EUROSTAT Database) ISCED Levels 0 to 2 = Pre-Primary, Primary and Lower Secondary Education; ISCED Levels 3 and 4 = Upper Secondary and Post-Secondary Non-Tertiary Education; ISCED Levels 5 and 6 = First and Second Stage of Tertiary Education

Table 5 below shows comparable data for the United States of America where the pattern of youth unemployment fully confirms to the expected general pattern described for Europe above. Actually the differentials are even greater than in Europe showing that young adults with only high school graduation are about three times more likely to be unemployed that young people with a completed Bachelor's degree. For high school dropouts the situation is even much worse with more than 30 percent of them being without a job. This is four times the vulnerability as compared to young adults with a bachelor degree.

Table 5. Unemployment Rate of 16- to 24-year-olds, by Educational Attainment, USA, 2010 (Source: http://nces.ed.gov/pubs2012/2012026/tables/table_27.asp, accessed June 24, 2013)

Total	Less than high school completion	High school completion only	Some college or associate's degree	Bachelor's or higher degree
18.8	**30.2**	**23.0**	**12.2**	**7.3**

In conclusion, this section has demonstrated that with respect to the risk of unemployment, young people aged 15-24 tend to be significantly more vulnerable than their older peers. But this higher vulnerability does not apply equally to all younger people. For all countries for which reliable and comparable statistics could be found – unfortunately only for Europe and the USA – by far the highest risk of unemployment exists for young men and women with low levels of education. The data also indicates that, almost universally, the risk of unemployment monotonically decreases with higher levels of education. Hence, particularly in the context of technological advance and further automation of production processes, promulgating high quality education which also enhances the increasingly sophisticated skills that are demanded in the labor market is a key strategy for reducing the vulnerability of young adults to the risk of unemployment.

4 Disability of Adults Aged 30-74 by Level of Education

As we proceed further through the life course of an individual into adult and mature adult age, his or her health status becomes an increasing concern. Both with respect to individual life satisfaction and happiness as well as regarding contribution to societal productivity, health status and its inverse – the disability status of a person – play an increasing pertinent role as one ages. Particularly in the context of population ageing, there is increasing concern that the fact that disabilities clearly increase with age will lead to a worsening problem of disability in the future.

There are many factors influencing the health/disability status of a person. They range from genetic factors to factors associated with individual lifestyle to quality of preventive health care and the curative health care systems of a country. But when it comes to observable individual characteristics of people there is overwhelming empirical evidence from virtually all countries for which data exist that this risk varies greatly by level of education for both men and women (KC & Lentzner 2010). This difference is best documented for the case of mortality where in terms of male life expectancies, the gap between the highest and lowest educational groups in various countries range from as high as 12 years (in Eastern Europe) to 3-4 years (in Mediterranean countries). What is less well known and documented is that the prevalence of disabilities also tends to vary greatly with the level of education. And since falling into disability at the mid-adult age is a much more prevalent risk among populations around the world than outright mortality, in this section we will try to summarize the evidence with respect to disability rates of adults in the age span 30-74 for which fairly good data has become available.

Data for this analysis comes from the World Health Survey (WHS)[2], a collection of sample surveys of the adult population of 18 years of age and older in 70 countries across the globe as shown in appendix Table I. Data was collected in 2002/2003 with personal interviews conducted in the local language using standardized survey instruments. Respondents provided information on demographic characteristics, health status, risk factors, access and utilization of health services and health care expenditure. In this analysis, two health status indicators measuring disability (presence or absence) were defined based on responses on activity of daily living (ADL) and self-reported health (SRH).

[2] WHO (2000). The World Health Surveys (WHS). W. H. Organization. Geneva, WHO.

As Table 6 shows fourteen per cent of the sample population in Eastern Europe was ADL disabled. In the other four regions the proportion of disabled ranged from nine per cent in Africa to five per cent in Latin America. These differences are greatly influenced by the fact that the population of Europe is on average much older than that of Africa. However, in addition to age there are also important differentials with respect to level of education. Table 6 shows the percentage of ADL disability in each education group in each region for the sample before standardizing by age. As for regional differences, Eastern Europe appears to have the highest level of disability followed by Africa and Asia, with Latin America and Western Europe showing the lowest levels. Eastern Europe also has the highest levels of disability across all levels of education. Regional and country differences in levels of disability must be viewed with caution due to the subjective nature of the questions and the degree to which cultural and socio-economic factors may systematically impact reporting.

Table 6. Proportion of Disabled in Population by Education Level for World Regions (Men and Women Aged 30-74)

Education	Africa	Asia	Western Europe	Latin America	Eastern Europe
None	0.12	0.16	0.20	0.13	0.37
Primary	0.07	0.08	0.10	0.07	0.29
Secondary	0.04	0.04	0.05	0.04	0.12
Tertiary	0.04	0.03	0.03	0.02	0.09
Total	0.09	0.08	0.06	0.05	0.14

Table 7 shows the odds ratios resulting from a regression of ADL disability on age and education, separately for females and males. All values are significant at the 0.05 level or higher except for those identified by "*ns*" (not significant). The odds of reporting severe or extreme difficulty in mobility or self-care clearly increases by age; for eastern European females the odds increase rapidly with age, almost nine times as likely at age 60-69 compared with women at age 30-39 and almost three times as likely for Asian and Latin American females. For men, as age increases the odds at age 60-69 increase by as much as six times in Western and Eastern Europe compared with the odds at age 30-39.

For both sexes and in all five regions (except for Eastern European males with at least a secondary education), the prevalence of disability declined significantly with increasing education. The odds of reporting ADL disability for a woman with no education compared with a woman with primary education is the highest (more than double) in Latin America (2.43 times) and least in Africa (1.19 times); for women with at least secondary education, the odds ratio is the least (less than half) in Asia (0.46) and the highest in eastern Europe (0.82). These odds ratios can be used to calculate odds (or proportion) of reporting ADL disability for any combination of age and education groups for the different world regions. For example, the odds for a woman aged 50-59 reporting ADL disability with at least secondary education in Africa is 1.29 (2.08 times 0.62 as given in Table 7). This implies that these women have on average a 29 percent higher probability of disability than the reference category which is women aged 30-39 with only primary education.

Table 7. Regression of ADL on Age and Education: Odds Ratio by World Region

		Africa	Asia	Western Europe	Latin America	Eastern Europe
Female						
	Age					
	30-39	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**
	40-49	1.39	1.27	1.62	1.55	2.58
	50-59	2.08	1.82	3.39	1.91	3.82
	60-69	3.49	2.92	4.07	2.92	8.77
	70-74	5.74	6.37	11.07	4.81	21.3
Education						
	None	1.19	1.74	1.93	2.43	1.73
	Primary	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**
	At Least Secondary	0.62	0.46	0.53	0.52	0.82
Male						
	Age					
	30-39	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**
	40-49	1.09	1.58	1.39	0.93	2.87
	50-59	1.8[ns]	2.80	3.93[ns]	1.85[ns]	3.89
	60-69	3.26	4.50	6.02	3.16	6.19
	70-74	5.65	6.41	7.89	6.46	14.45
Education						
	None	1.38	1.21	2.00	2.35	2.56
	Primary	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**
	At Least Secondary	0.75	0.65	0.88	0.61	0.64[ns]

Note: All values are significant at the 0.05 level or higher except for those identified by *ns*.

Table 8 shows our analysis extended to include results for ten individual countries in different world regions. In general, the pattern of odds ratios above 1 for individuals with no education and below 1 for those with at least a secondary education persists across these countries. Five of the countries—Brazil, Philippines, Russia, South Africa and Turkey—all displayed these relationships for both men and women, although the values were not always statistically significantly different. In Vietnam, a similar pattern was evident, although none of the odds ratios were statistically significant. In a few countries including Pakistan some of the differences turn out to be insignificant which is likely to be due to small number of cases in those education categories. For example, in Pakistan there were only three women aged 60+ with at least a secondary education in the sample and none of them reported ADL disability.

Table 8. Regression ADL Disability on Age and Education for 10 Selected Developing Countries: Odds Ratio for Men and Women Aged 30-74

	Females			Males		
	No education	Primary	At least secondary	No education	Primary	At least secondary
Brazil	2.36	1.00	0.45	2.23	1.00	0.55
China	3.24	1.00	2.22[ns]	3.97	1.00	0.61[ns]
Ethiopia	0.86[ns]	1.00	0.70[ns]	2.18	1.00	1.19[ns]
India	0.90[ns]	1.00	0.50	0.91[ns]	1.00	0.65
Pakistan	3.42[ns]	1.00	2.37[ns]	0.73[ns]	1.00	0.36
Philippines	1.93	1.00	0.47	1.26[ns]	1.00	0.50
Russia	3.25	1.00	0.94[ns]	8.96[ns]	1.00	0.64[ns]
South Africa	1.16[ns]	1.00	0.34	2.50	1.00	0.66[ns]
Turkey	2.13	1.00	0.40	1.61	1.00	0.38
Vietnam	1.49[ns]	1.00	0.34[ns]	1.51[ns]	1.00	0.64[ns]

Note: All values are significant at the 0.05 level or higher except for those identified by *ns*.

In the introduction we stressed that there is a strong case for assuming functional causality for the effects of education on health. For this reason it makes sense to assume that these differentials also hold for the future. One may argue that the differentials may change as over time increasingly large segments of the population receive more education. But at least with respect to educational mortality differentials – where time series data exist – rapid expansions in overall education have not led to a narrowing of the differentials. In some cases the differentials actually seem to have widened over time. Hence, as a simple benchmark in the following simulation exercise we assume a constant pattern of age- and education-specific disability rates.

4.1 Projecting the Level of Adult Disability

In this section we look at the potential impact of the growth of formal education on adult health across broad geographical regions. We do so by contrasting the conventional approach that only differentiates by age and sex with an education-specific approach that explicitly includes education differentials as a source of population heterogeneity in addition to age and sex. As will be seen, the future looks very different under these two approaches.

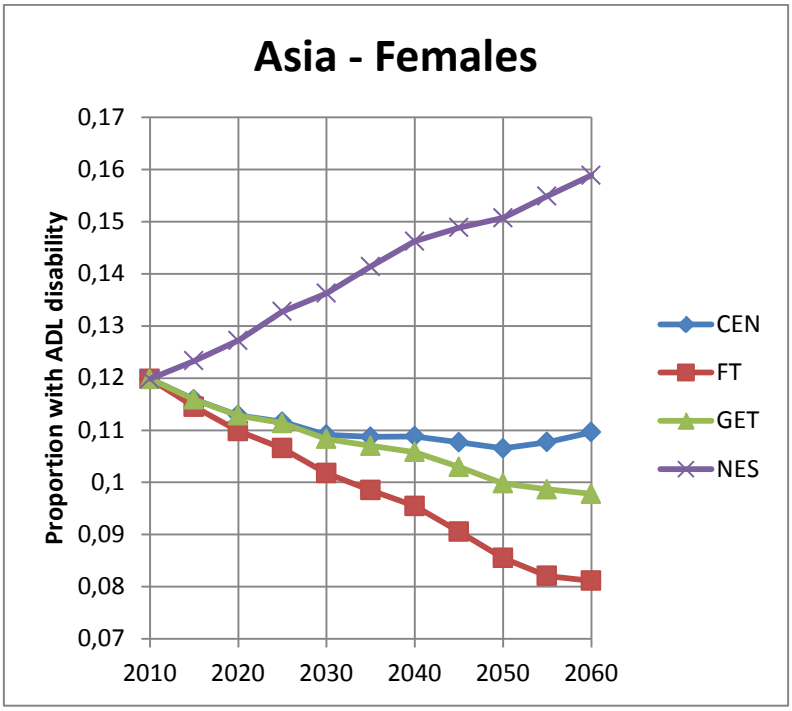
For both projections we used the Wittgenstein Centre's world population projections by age, sex, and education for the period 2010-2100 (KC et al. 2010) as the numerical basis. We first applied a constant age/sex profile of ADL disability without considering our observed educational differentials and then applied this to the projection of the future age and sex structure of the population. In a second set of calculations we factored in the education/disability relationships obtained from the WHS analysis above. We did so for the three different education scenarios as described below. More

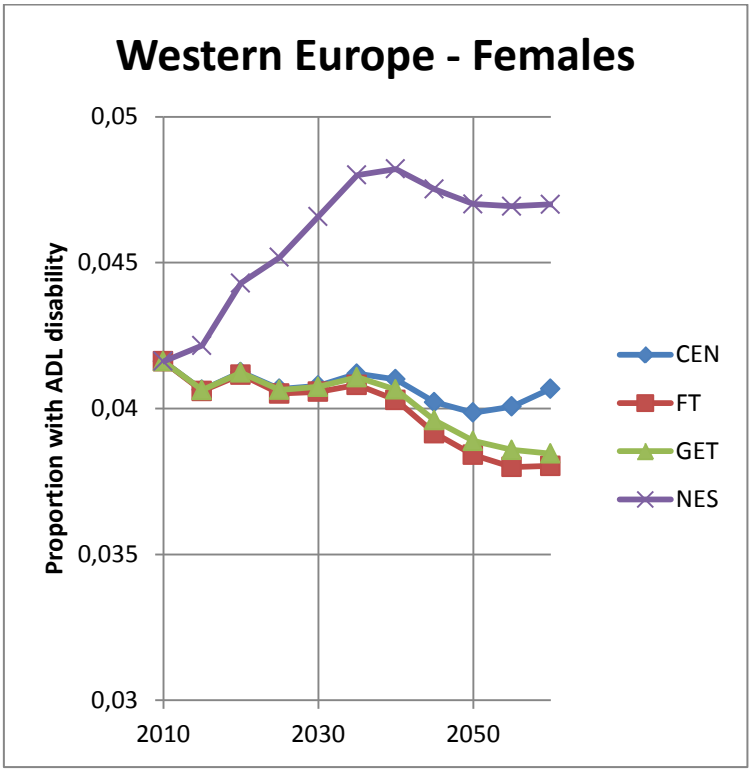
than 100 countries (covering approximately 90 per cent of the world's population) were grouped into five regions for this exercise. The population projections themselves are extensively documented elsewhere (Lutz et al. Forthcoming) and need not be described here.

The results of these alternative projections of disability are shown in Figure 3 for women aged 30-74 for three selected world regions. Without factoring in education and only considering the age pattern of disability (labeled as NES – No Education Scenario) the conventional forecast appears that shows a significant increase in future disability rates simply as a function of rapid population ageing combined with the fact that older people have a higher prevalence of ADL. This projected increase is particularly strong in Asia where due to the rapid speed of fertility decline, population ageing over the coming decades will be even faster than in most other continents; it is also very pronounced in the figure for Western Europe. Since the population in Sub-Saharan Africa is still very young and continues to grow rapidly over the coming decades, this ageing effect is only visible in the longer run.

Once education is explicitly factored into the model the picture looks completely different. With education taken into account, under all three scenarios there will actually be reductions in disability by 2050 for adult women aged 30-74. Again, the gap between the two kinds of projections is most pronounced for Asia. The reason for this lies in the fact that paralleling rapid population ageing in Asia, the elderly population will also be much better educated than today's elderly. This in turn is a result of the very rapid expansion of schooling among young Asians over the past decades. In some countries (including e.g. South Korea and China) in the 1960s a majority of the adult population still had no formal schooling at all. Today the young cohorts are very well educated and even among the best educated in the world in Korea. As a consequence, today's elderly still have a very low levels of education and we know for sure that the future elderly will be much better educated. This finding holds for all three future education scenarios. As shown by the CEN (Constant Enrollment Numbers) Scenario, even no further improvements in school result in a much lower level of overall disability than when education is simply not factored into the model, i.e. when the apparent heterogeneity by level of education is disregarded. The most rapid improvement in disability is clearly shown under the very optimistic FT (Fast Track) scenario.

Of the three regions, in Africa the picture is a bit different because of the still rapid population growth. Under the very pessimistic CEN scenario – which assumes that no new schools are being built – the educational composition of the population actually worsens over time due to larger and larger young cohorts. As a consequence of the worsening education of the younger generation over time, this scenario will also result in lower education of the adult population and hence higher disability under our model. Under the medium GET (Global Education Trend) and the very optimistic FT scenarios, the future prevalence of disability is also expected to decrease for Africa.


Asia - Females
Proportion with ADL disability
0,17
0,16
0,15
0,14
0,13
0,12
0,11
0,1
0,09
0,08
0,07
2010
2020
2030
2040
2050
2060
CEN
FT
GET
NES


Western Europe - Females
Proportion with ADL disability
0,05
0,045
0,04
0,035
0,03
2010
2030
2050
CEN
FT
GET
NES

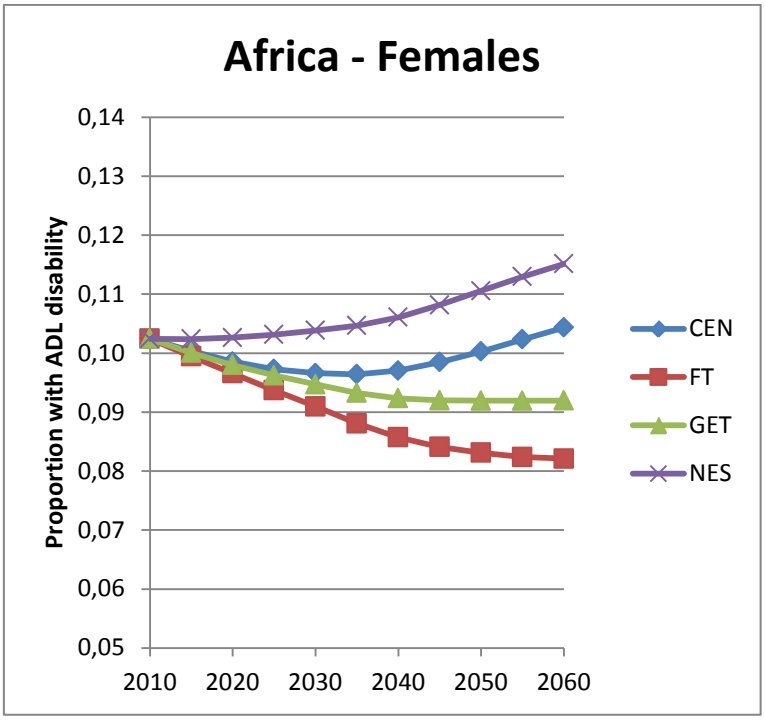


Figure 3. Projected Prevalence of ADL Disability for Women Aged 30-74 in Asia, Western Europe and Africa

In conclusion, this section on adult disability has clearly demonstrated that the vulnerability of men and women, in terms of falling into disability, not only varies greatly among countries and across age groups but there are also significant and consistent differences with respect to the level of education. The scenarios presented above also show that the future looks very different once education is explicitly factored in. Instead of the ubiquitous projections that show massive increases of future disability rates as a consequence of population ageing, this analysis shows that we can actually expect declining adult disability for women aged 30-74 even in the rapidly ageing populations of Asia and Western Europe. This also has important consequences beyond individual health and well-being in so far as it may allow people to stay longer in the labor force and increase the productive potential of ageing societies.

5 Differential Vulnerability to Natural Disasters by Level of Education

In this fourth and final section of the paper we will address the vulnerability to natural disasters which can also be viewed as a proxy for likely future vulnerability to possible consequences of climate change. Vulnerability to natural disasters is of significant interest in its own right as a source of premature death, particularly in developing countries. But it becomes even more relevant when we assume 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. Hence, this study of differential vulnerability has significant relevance beyond the specific disasters studied. In other words, if we have a better understanding of the risk factors associated with currently observed vulnerabilities to natural disasters, we can draw conclusions about the risk factors associated with future climate change, in particular with respect to

the likely higher frequency and intensity of tropical storms, extreme flooding events and severe droughts.

This vulnerability 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 being 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 et al. 2007; Moser & 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 & Stacey 1997; Neisser et al. 1996; Nisbett 2009). Education enhances the acquisition of knowledge, influencing values and priorities as well as the capacity to plan for the future and improve allocation of resources (Glewwe 1999; Thomas et al. 1991). Besides that, as described in the previous section on disability, education leads to better health and physical wellbeing (Fuchs et al. 2010; Baker et al. 2011; KC & 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 & Ryan 2002; Schnell-Anzola et al. 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 & 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 his 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 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 & Plümper 2007; Frankenberg et al. 2011). 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 a main characteristic explaining inequalities in all aspects of disasters (Fothergill & Peek 2004).

At the macro level, economic inequalities in impacts from natural disasters have also been reported across communities, regions, and nations (Cavallo & 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 & 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.

5.1 New Empirical Evidence

Based on the above described rationale, we hypothesize 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 & 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, 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 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 9 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 1980 to 2010 across 152 countries 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).

Table 9. 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***	-2.983***	-1.227	-3.100***	-1.253	-1.932**	-2.062**
	(0.774)	(0.761)	(0.838)	(0.788)	(0.841)	(0.868)	(0.876)
Log (#Disasters)	1.650***	1.562***	1.569***	1.574***	1.578***	1.535***	1.555***
	(0.119)	(0.118)	(0.118)	(0.120)	(0.120)	(0.118)	(0.119)
Pop Growth Rate	1.401***	1.220***	0.987**	1.076**	0.873*	1.037**	0.745
	(0.517)	(0.449)	(0.455)	(0.512)	(0.527)	(0.452)	(0.525)
Log (Lagged Pop)	0.252***	0.300***	0.266***	0.296***	0.262***	0.288***	0.278***
	(0.082)	(0.081)	(0.081)	(0.082)	(0.082)	(0.081)	(0.081)
Polity Score	-0.376***	-0.233*	-0.320**	-0.238*	-0.326**	-0.226*	-0.234*
	(0.132)	(0.134)	(0.130)	(0.134)	(0.131)	(0.133)	(0.134)
GDP per Capita (1000s)	-0.005			0.006	0.005		0.012
	(0.010)			(0.011)	(0.011)		(0.011)
Lagged IMR		0.010***		0.011***		0.008***	0.009***
		(0.003)		(0.003)		(0.003)	(0.003)
Female 20-39 Sec+Edu			-1.472***		-1.523***	-1.076**	-1.173***
			(0.414)		(0.431)	(0.434)	(0.443)
Deviance	1.135.210	1.100.223	1.104.476	1.099.509	1.104.081	1.087.360	1.084.830
AIC	2.010.264	1.993.109	1.995.223	1.994.753	1.997.027	1.988.664	1.989.388
BIC	2.130.839	2.113.685	2.115.799	2.119.635	2.121.909	2.113.546	2.118.576
N	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.

The remaining part of this section converts these findings into alternative scenarios for possible future disaster vulnerability in Sub-Saharan Africa depending on three different scenarios of future education trends (results for 19 other world regions are available on request). These three education scenarios were defined in the introduction of this paper. In Figure 4 we posit two alternative assumptions about the future trends in disaster hazard by combining our results from Model 7, which was chosen based on model selection criteria, with the population and education projections according to these three education scenarios. In the picture on the left, we assume that over the decades to come Sub-Saharan Africa 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 CER scenario is more than double the predicted number of deaths in the FT scenario.

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 Sub-Saharan Africa. While in the FT scenario the increase in educational attainment is still able to offset the effect of the assumed increase in hazard on future disaster fatalities, the assumption of a world evolving according to the CER scenario predicts an exponential increase in fatalities to extreme events. By 2050, the predicted decadal number of casualties in the CER scenario reaches 1132000, a 50 percent increase compared to the figure predicted by the GET scenario and more than twice the figure predicted by the FT scenario.

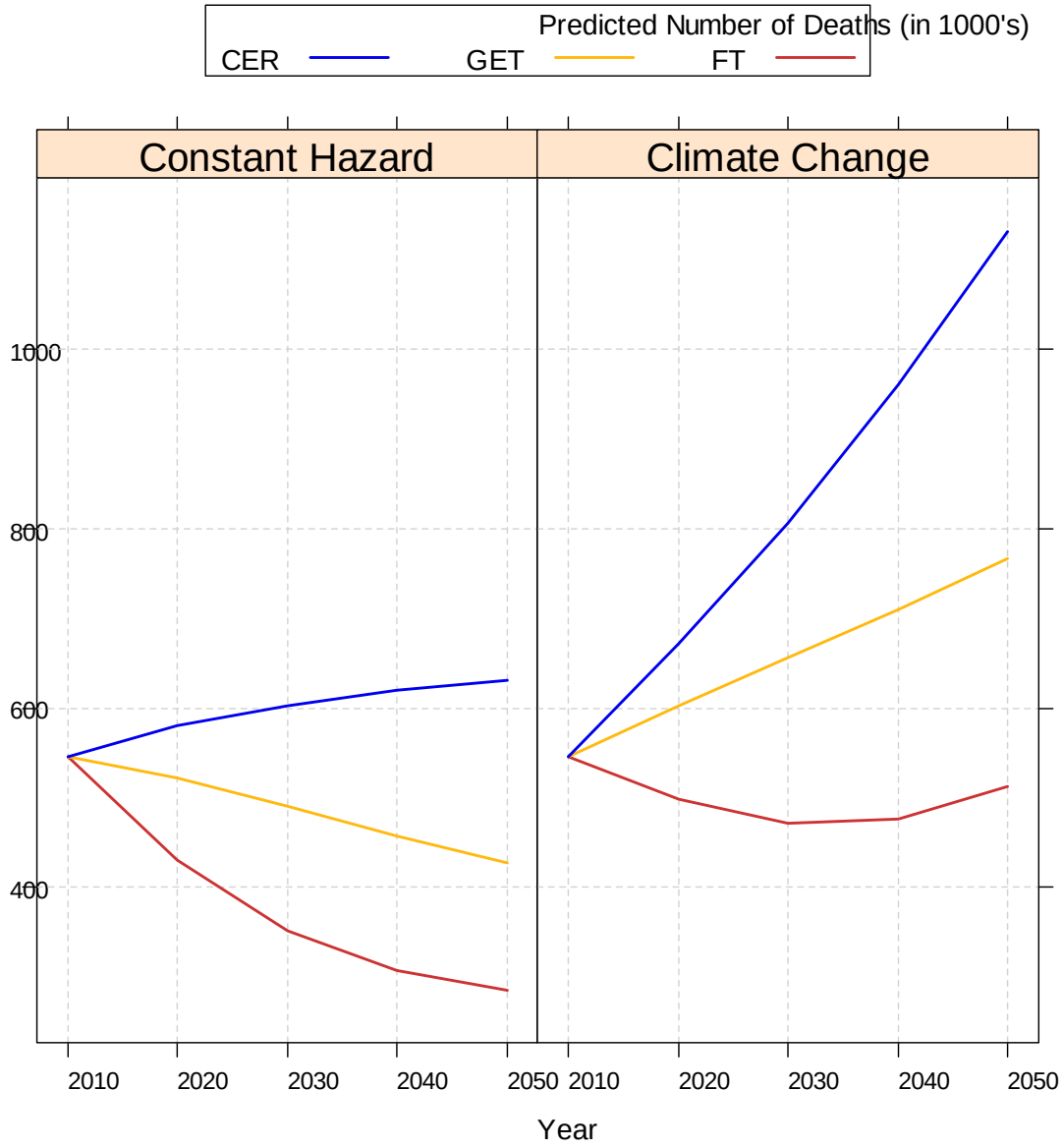


Figure 4. Predicted Number of Deaths (in 1000s) Due to Natural Extreme Events in sub-Saharan Africa Assuming "Constant Hazard" (left) and "Climate Change" (right) under the Constant Enrolment Rate (CER) Scenario, Global Education Trend (GET) Scenario, and Fast Track (FT) Scenario

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.

These new insights about the important role of education for adaptive capacity presented in this section are already reflected in the new SSP (Shared Socioeconomic Pathways) scenarios that have been produced by a joint effort of the international Integrated Assessment (IA) community to serve as a common reference point for IPCC related modeling (O'Neill et al. Forthcoming). Much more context-specific analysis of differential 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.

In conclusion, in this paper we have shown that over the entire life cycle of individuals the changes in behavior that tend to be associated with more education (of mothers or the persons themselves) can be viewed as a potent factor in reducing child mortality, reducing the risk for unemployment at young age, reducing the vulnerability to natural disasters, and finally reducing the risk of falling into disability. These general long-term benefits of near-term investments in education hold for individuals as well as for entire societies.

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7 Appendix

Table I. WHS Countries Used in the Analysis by Region

Africa	Asia	Western Europe	Eastern Europe	Latin America
Burkina Faso	Bangladesh	Austria	Georgia	Brazil
Chad	China	Belgium	Bosnia and Herzegovina	Dominican Rep.
Comoros	India	Denmark	Croatia	Ecuador
Congo	Israel	Finland	Czech Republic	Guatemala
Ivory Coast	Kazakhstan	France	Estonia	Mexico
Ethiopia	Laos	Germany	Hungary	Paraguay
Ghana	Malaysia	Greece	Latvia	Uruguay
Kenya	Myanmar	Ireland	Russia	
Malawi	Nepal	Italy	Slovakia	
Mali	Pakistan	Luxembourg	Slovenia	
Mauritania	Philippines	Netherlands	Ukraine	
Mauritius	Sri Lanka	Norway		
Morocco	Turkey	Portugal		
Namibia	UAE	Spain		
Senegal	Vietnam	Sweden		
South Africa		United Kingdom		
Swaziland		Australia		
Tunisia				
Zambia				
Zimbabwe				

Table II shows the regional distributions of the sample population by age, sex, and level of education. Europe has by far the oldest population, about one-fifth in the 30-39 age group and a little less than two-fifths at 65 and older, whereas Africa has the youngest adult population with about two-fifths in the 30-39 age group and 20 per cent aged 60+. The educational disparities are striking, with the proportions of those with no education ranging from 46 per cent in Africa, 27 per cent in Asia, and 7 per cent in Latin America to 2 per cent in Europe. Each of the regions had more women than men in the sample.

Table II. Age, Sex, and Education Structure in the Sample

	Sample (proportion)				
	Africa	Asia	Western Europe	Latin America	Eastern Europe
Age					
30-39	19083 (38%)	23561 (36%)	4574 (22%)	15902 (34%)	2980 (20%)
40-49	12685 (26%)	18225 (28%)	4548 (22%)	11539 (25%)	3388 (23%)
50-59	7997 (16%)	11025 (17%)	4047 (19%)	8006 (17%)	2958 (20%)
60-69	5490 (11%)	7233 (11%)	3783 (18%)	5860 (13%)	2710 (18%)
70+	4389 (9%)	4557 (7%)	4042 (19%)	4825 (10%)	2912 (19%)
Sex					
Female	26618 (54%)	34882 (54%)	12308 (59%)	26015 (56%)	9407 (63%)
Male	23026 (46%)	29719 (46%)	8686 (41%)	20117 (44%)	5541 (37%)
Education					
None	23012 (46%)	17694 (27%)	610 (3%)	3012 (7%)	191 (1%)
Primary	17541 (35%)	22989 (36%)	5371 (26%)	15765 (34%)	2095 (14%)
Secondary	6895 (14%)	17569 (27%)	10939 (52%)	25559 (55%)	8563 (57%)
Tertiary	2196 (4%)	6349 (10%)	4074 (19%)	1796 (4%)	4099 (27%)
Total	49644 (100%)	64601 (100%)	20994 (100%)	46132 (100%)	14948 (100%)