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**Improving Education as Key  
to Enhancing Adaptive  
Capacity in Developing  
Countries**

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By **Wolfgang Lutz**, International  
Institute for Applied Systems Analysis  
(IIASA), Laxenburg, Austria, Vienna  
Institute of Demography (VID) of the  
Austrian Academy of Sciences, and  
Vienna University of Economics and  
Business (WU), Vienna, Austria

## SUSTAINABLE DEVELOPMENT Series

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### Improving Education as Key to Enhancing Adaptive Capacity in Developing Countries

By Wolfgang Lutz, International Institute for Applied Systems Analysis (IIASA), Laxenburg, Austria, Vienna Institute of Demography (VID) of the Austrian Academy of Sciences, and Vienna University of Economics and Business (WU), Vienna, Austria

#### Summary

This paper summarizes new scientific evidence supporting the hypothesis that among the many factors contributing to international development, the combination of education and health stands out as a root cause on which other dimensions of development depend. Much of this recent analysis is based on new reconstructions and projections of populations by age, sex and four levels of educational attainment for more than 120 countries using the demographic method of multi-state population dynamics. It also refers to a series of systems analytical population–development–environment case studies that comprehensively assess the role of population and education factors relative to other factors in the struggle for sustainable development. The paper also claims that most concerns about the consequences of population trends are in fact concerns about human capital, and that only by adding the ‘quality’ dimension of education to the traditionally narrow focus on size and age structure can some of the long-standing population controversies be resolved.

**Keywords:** Human Capital, Education, Health, Root cause of development, ‘Quality’ dimension in population analysis

**JEL Classification:** I18, I28

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*Address for correspondence:*

Wolfgang Lutz

IIASA

Schlossplatz 1

A-2361 Laxenburg

Austria

Phone: +43-2236-807-294

Fax: +43-2236-71313

E-mail: lutz@iiasa.ac.at

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Fondazione Eni Enrico Mattei

Corso Magenta, 63, 20123 Milano (I), web site: [www.feem.it](http://www.feem.it), e-mail: [working.papers@feem.it](mailto:working.papers@feem.it)

The international workshop on “The Social Dimension of Adaptation to Climate Change” – jointly organized by ICCG, CMCC and FEEM - held on February 18-19, 2010 at Palazzo Querini Stampalia in Venice – has been a special occasion to face an emerging aspect of the climate change issue, the social dimension and the consequences of climate change for human societies.

This perspective has been neglected in climate change studies, even if in recent years a social science-oriented approach investigating social system dynamics and individual behaviour in connection with climate change has emerged and the importance to identify the impacts of the climate policy architecture on societies - and especially on the world’s poorest and most vulnerable people - is today included in the climate agenda.

A variety of scholars and practitioners enriched the debate on what social adaptation means in different contexts and geographical areas: the success of adaptation will largely depend on the extent to which individuals and societies will be willing to accept change and to adopt lifestyles and behaviours that reduce social-environmental vulnerabilities by improving adaptive capacities and resilience.

In order to overcome the existing trade-off between the two main avenues of climate policies, adaptation and mitigation, which labels adaptation as a local-based intervention while mitigation actions are seen as the first-best measures, the papers presented at the Venetian workshop contributed to highlight the importance of developing context-specific analyses as a complementary knowledge to reconcile climate actions with the development and growth agenda especially for vulnerable countries.

Climate research will be challenged in the near future by the need to develop an holistic approach to climate impacts, considering physical and environmental ecosystems as well as the human and social systems. This perspective will provide an effective foundation to adaptation to future climate change and will lead to the inclusion of equity and social justice issues into climate policies.

# Improving Education as Key to Enhancing Adaptive Capacity in Developing Countries

*Wolfgang Lutz*<sup>1</sup>

This paper presents a hypothesis and discusses its possible implications and ways to test it. The hypothesis has three components:

- (a) Strengthening adaptive capacity to climate change is not fundamentally different from strengthening general human development.
- (b) Human capital as defined by the combination of education and health (with special emphasis on female primary and junior secondary education and basic health care including reproductive health) is the key to such development.
- (c) Under conditions of uncertainty about the exact climate changes to be expected, this general empowerment to self help and to flexibly react to the still unknown challenges as they arise is the only meaningful investment in longer term adaptive capacity.

In terms of empirically testing this hypothesis, one encounters the same basic problem of all hypothesis testing concerning the impacts of climate change on people: There are not many empirically well-documented events that present the same kinds of hazards that can be expected in the future under conditions of climate change. As part of my ERC project on “forecasting societies’ adaptive capacities to climate change” my team is currently trying to collect all available and relevant empirical information on differential vulnerability (by age, sex, education, household income/wealth, place of residence and other characteristics) in Asia (tsunami and river flooding events), Africa (the Sahelian drought) and Latin America (Hurricane Mitch). This work has just started and the data availability turns out to be worse than we expected.

But even before having the above-described empirical analysis, one can assess the hypothesis and its elements at a more general level, using some other existing data that were not collected in direct association with studying the consequences of climate change. This is particularly the case with the second element of the hypothesis.

The first part of the hypothesis is essentially a matter of classification and definition of terms. Here the test is whether we can think of any important element of adaptive capacity which is not also an important element of development in general. This is best assessed through the specific risk that adaptive capacity is assumed to reduce vulnerability. Whether we are talking about fatalities, injuries and disease, or loss of material assets and livelihood, of all the factors that can be seen as reducing vulnerability, I cannot think of one that would not also be considered an important element of general development. As long as no other important factor has been identified, this first part of the hypothesis is not falsified and will be maintained.

The second part of the hypothesis is probably the most controversial and is open to a lot of possible empirical testing. A comprehensive analysis of the evidence in this field was

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<sup>1</sup> Professor Dr. Wolfgang Lutz is the Leader of the World Population Program at the International Institute for Applied Systems Analysis (IIASA), Laxenburg, Austria; Director of the Vienna Institute of Demography (VID) of the Austrian Academy of Sciences; Professor of Social and Economic Statistics at the Vienna University of Economics and Business (WU); and Professorial Research Fellow at Oxford University. His contact address: IIASA, Schlossplatz 1, A-2361 Laxenburg, Austria; Tel. +43-2236-807-294; Fax +43-2236-71313; E-mail: lutz@iiasa.ac.at

recently published in “*Sola schola et sanitate: Human capital as the root cause and priority for international development?*” (Lutz 2009). It is the revised version of a keynote speech delivered at the 40<sup>th</sup> anniversary of the founding of the Club of Rome (hence the Latin title) and was recently published in *Philosophical Transactions*. Since it makes no sense to try to summarize this very dense paper (which in itself is a summary), it is included below in its entirety and constitutes the main part of my presentation. In a nutshell, there seems to be a strong case to assume that indeed the combination of basic education and health is a root cause of development under a longer term perspective in the sense that many other important dimensions of development, including economic growth, social capital and governance, are enhanced by this root cause. But it is equally apparent that human capital is a necessary but not always sufficient prerequisite of development.

The third element of the hypothesis is difficult to test empirically and is more of a qualitative and speculative nature. Here the main argument is that the investment in human capital and in general empowerment is the best and safest option, particularly in cases when it is not well known what kind of climate change induced hazard the people of a specific location will have to confront in the future. While, e.g., improvements in irrigation systems may seem a good investment to maintain and improve agricultural productivity under conditions of longer or more frequent seasonal droughts, it may not be the best investment if under a more dramatically changing climate certain kinds of agriculture become untenable in this region, or if tropical storms of seasonal flooding will turn out to be the major hazards. On the other hand, empowering the people through improvements in health and education to acquire literacy and possibly a general junior secondary education – as is compulsory for good reasons in all industrial countries – will give the skills and social capital that will enable them to flexibly find appropriate solutions to the climate-induced problems as they arise. Moreover, better female education will lead to lower fertility and hence lower population densities in the future, implying that few people will be exposed to the hazards and many responses will be easier. There is also ample evidence that better health and longer life expectancy, together with education, foster a more forward looking and planning attitude to life that makes it easier to react to anticipated risks that have not yet become manifest. This attitude of broad segments of the population will be key for effective adaptation strategies because if one waits until the problems become unbearable, by that time the range of options may be rather limited.

## **1. Introduction**

Why did I choose a Latin title and what does it mean? An earlier version of this hypothesis was presented as a keynote speech at the 40<sup>th</sup> anniversary of the foundation of the Club of Rome and the centenary of its founder, Aurelio Peccei, in the Auditorio Roma in June 2008. I began by pointing out that I had been born half a century before, just a mile away from the Auditorio because during that time my father had been working for seven years in the Vatican archives to study how the popes in Rome in the early 16<sup>th</sup> century perceived the news about Martin Luther’s teaching in Germany. Luther’s famous principles *sola fide, sola gratia* (freely translated: salvation comes only through personal faith and God’s grace rather than blind subordination to the church hierarchy) gave priority to personal conscience over institutional conformity and paved the way for the occidental path toward individual human rights, personal empowerment, empirical science and in consequence modern economic growth (Landes 1998). In this context I suggested that half a millennium later, *sola schola et sanitate* (only through the combination of education and health, i.e., only through human capital formation rather than corrupting monetary dependencies) could become a powerful new

principle for international development cooperation toward improving human quality of life and reducing poverty, empowering women and men alike and reducing population growth, being able to cope successfully with the consequences of climatic change, improving governance, reducing global inequalities and assuring long-term sustainable development. In this paper I will try to present some of the mounting scientific evidence that indeed human capital deserves to be singled out as the root cause among the many other factors that contribute to development. I should also stress that I consider human capital to be a necessary but not always sufficient precondition, and that I put a question mark after the title because I consider this claim to still be at the stage of a plausible hypothesis that needs further testing and analysis.

Continuing on a personal note, I remember well, when in 1972 at the age of 15, I came across an advance copy of the *Limits to Growth* by the Club of Rome (Meadows et al. 1972). As a consequence, this topic caused me to work for the last quarter of a century at the International Institute for Applied Systems Analysis (IIASA) which, since its foundation in 1972, has been a leading center for the international interdisciplinary long-term analysis of global change. Applied systems analysis can also help to assess which factors matter more than others for certain outcomes. It is an appropriate tool for trying to overcome the widespread qualitative relativism (everyone thinks his/her own agenda matters most) and to arrive at a comprehensive and science-based assessment of priorities. Now, after 35 years of studying the complex interacting determinants of long-term human wellbeing within different continents and around the world, I think I have found a good candidate for an unambiguous answer about what is the most universal root cause of desirable developments and has the greatest long-term effect on human wellbeing for all cultures and subgroups of the world population. For someone who as a youngster hated two things more than anything else – school and vaccinations – and whose first published article written for a student paper at the age of 15 was entitled “Elementary school: A crime on children” (Lutz 1972), the difficult to accept result was: This root cause lies in education combined with health.

In the following, I will go through the different pieces of scientific evidence that convinced me to change my original attitude toward schooling and preventive health and which, if taken seriously, suggest a radical refocusing of international aid: Empowering people through education rather than corrupting them through money. Directly strengthening humans and their capabilities and health is likely to be a very effective strategy for improving human wellbeing in the longer run. Since resources are limited, there is no doubt that the proposed massive investment in empowering people to help themselves needs to come at the expense of traditional development policies focusing predominantly on infrastructure and direct financial support to governments. In this paper I will not focus on the sad stories of how past development policies have largely failed to reduce poverty and often made things worse due to enhancing corruption and stabilizing bad regimes (see, e.g., Glennie 2008) or how some visible improvements have been short lived partly due to rapid population growth. Instead I will try to tell some success stories, where a radical focus on human capital has already produced developmental benefits.

Recently, there has been a series of new and broad-ranging assessments of the few successes and many failures of international development cooperation over the past decades. Books with titles such as *The Trouble with Aid: Why Less Could Mean More for Africa* by Jonathan Glennie (2008), or *Does Foreign Aid Really Work?* by Roger Riddell (2007), or *The Bottom Billion: Why the Poorest Countries are Failing and What can be done about it* by Paul Collier (2007) share to a large extent their critical assessments of past international development efforts with a focus on Africa, but come up with quite different proposals for the future. Interestingly, these recent assessments mostly focus on the way in which international

development assistance is organized and delivered, and do not try to comparatively assess which sectors of investments are relatively more important for development than others. It is also interesting to see that population is hardly mentioned as a factor in these studies, and even education and human capital – although mentioned in passing as a very good and very important thing – do not get any specific attention in their recommendations for the future.

I will go the opposite way and intentionally disregard the organizational side of international development aid and focus on the substantive question: Which factors and investments are more important than others in achieving equitable and sustainable development? I will do so by going from the bottom up, i.e., by starting with people because they are the agents of development and their wellbeing is the criterion and ultimate objective of any development. But people not only matter through the changing size of their population or its age structure and regional distribution, but rather by what they do for their own wellbeing and that of others. This depends in the first instance on their capabilities and skills. The best technologies are of no use without the people to operate them.

I will start the focus on population by discussing why I think that limiting the attention to human numbers and not considering human capabilities at the same time is too narrow a perspective and only leads to a dead end. This will be followed by an explanation of how more advanced demographic methods are ideal tools for quantitatively capturing the human capital dimension. I will also present some empirical assessments of the interactions between education, health and fertility, and demonstrate through quantitative scenarios how education matters for population growth. This will be followed by a summary of two recent comprehensive studies based on global panel data (based on new human capital data by age and sex) that unambiguously show for the first time that education is a key determinant for macro-economic growth and that more education tends to result in better governance and more democracy. Next I will quickly sketch some national-level success stories of countries which developed well against all odds, primarily because they had previously invested heavily in education. I will conclude by bringing education back into the frame of comprehensive systems studies, which is the only scientific way to find out which factors within a large set of interacting factors are more important than the others.

## **2. Why the “Population Issue” is in Fact a Question of Human Capital**

When I went to the US in the early 1980s to earn a doctorate degree in demography at the University of Pennsylvania, the broader population community seemed to be deeply divided between those who thought that population growth was a major problem for the world and others who thought that it was neutral or even a good thing. Interestingly, it was not so much the demographers themselves who fought this battle, but mostly biologists and ecologists on the one side, and economists on the other. This debate centered around two men, the biologist, Paul Ehrlich, whose books *The Population Bomb* (1968) and later *The Population Explosion* (Ehrlich and Ehrlich 1990) painted an alarmist picture, and on the other extreme, the economist, Julian Simon, whose book *The Ultimate Resource* (1981) stressed that there could never be too many children because there will be many geniuses and inventors who in the end would be able to solve all possible problems. While at Penn, Sam Preston, my teacher in the methods of demography, chaired the Panel of the US National Research Council that in 1986 published a report based mainly on empirical data up to 1980 which essentially concluded that with respect to economic growth, population growth seemed to be neither good nor bad, but rather irrelevant (National Research Council 1986).

Upon my return to Europe, I found that I had received an excellent education in the methods of demography, but I remained deeply unsatisfied with respect to getting a clear answer about whether in the end population growth was good, bad or irrelevant. I had carefully studied the arguments on all sides and many of them seemed to make good sense to me, but unfortunately they were mutually exclusive because they led to contradictory conclusions. Hence, my first independently developed, major research project that was conducted at IIASA and funded by the UNFPA tried to produce a comprehensive systems analytical model, not for the whole world but only for a small island with excellent data. The Population-Development-Environment (PDE) model for Mauritius was published in book form (Lutz 1994) and will be discussed in more detail below. Its explicit objective was the establishment of a common modeling platform based only on assumptions on which both Julian Simon and Paul Ehrlich would be able to agree. Based on this common platform, it should then be possible to identify which specific further quantitative assumptions would reflect Ehrlich's versus Simon's thinking. Behind this effort was the conviction that this conflict could not simply be an irresolvable matter of belief or ideology, but should be open to rational scientific modeling and analysis.

Let me jump to the results rather than going through the entire learning process. It turned out that the explicit consideration of population not only by age and sex but also by level of educational attainment provided the necessary model expansion that helped resolve the seemingly irresolvable Ehrlich – Simon controversy. After transcending the level of purely staring at population numbers and adding the additional dimension reflecting human capital (what some economists call the “quality dimension”), all of a sudden the controversy seems resolved. On the one hand it is evident – as will be demonstrated below – that rapid population growth makes it more difficult to expand education and therefore hinders economic growth. Without new technologies, an “explosion” of unskilled people is likely to bring many of the problems that Ehrlich writes about. On the other hand, Simon is also right in stressing that the solutions must come from the people. But these solutions and innovations are unlikely to come from undernourished and uneducated people struggling for daily survival; they will rather be spearheaded by well-educated people with a broader horizon living in societies that appreciate such education. Hence, when combining Ehrlich and Simon terminology, I would say that “human capital is the ultimate resource for sustainable development”.

### **3. Education, Health and Fertility**

It has been long established in demography that education is one of the most important, if not the single most important covariate of both fertility and mortality/health, second only to the demographic core dimensions of age and sex. There have been many comprehensive assessments of these relationships and there is no need to summarize them here. The most comprehensive recent assembly of data on educational fertility differentials from medieval times to the present has recently been published by Skirbekk (2008). The differentials in both fertility and mortality are so pervasive and so consistent that Lutz et al. (1999) suggested that education should routinely be explicitly included in any demographic analysis in the same way that age and sex are. They argue that this is not only substantively justified by the fact that educational attainment is a well-specified and almost universally observed independent source of population heterogeneity at the individual level, but also that the analytical tools for dealing with population dynamics by age, sex and educational attainment are readily available in the form of multi-state models and there is no excuse – except for ignorance about these methods – for not using them.



While the following section will illustrate the power of such multi-state models for studying population dynamics by age, sex, and level of education, in this section we will still focus on educational fertility and mortality differentials in the context of the ongoing discussion of a stalled fertility decline in Africa, which is partly associated with worsening child mortality conditions. Figures 1 and 2 will show that the explicit consideration of mothers' education adds an important new dimension to explaining these recent trends.

Figure 1 illustrates the changes in child mortality rates in three large African countries (Ethiopia, Kenya, and Nigeria as derived from recent DHS surveys), which are indicative of the region's recent developmental crises. In all three countries, the under 5 mortality of children born to women with secondary education has been significantly lower than that of women with no education or only primary education. Better education, among many other things, results in better health for mothers and children because of improved access to crucial information and health care. It is noticeable that out of the three countries, only Ethiopia has seen an improvement in child mortality over time. In both Kenya and Nigeria the overall child mortality conditions have actually worsened. And in this context, female education has become even more important. While for women with low or no education, things have clearly become worse over time, for women with secondary education, things have actually improved or at least not worsened. This illustrates the fact that the development and humanitarian crisis in Africa is to a large extent an education crisis and – as we will illustrate in the following analysis – coincides with a population growth crisis.

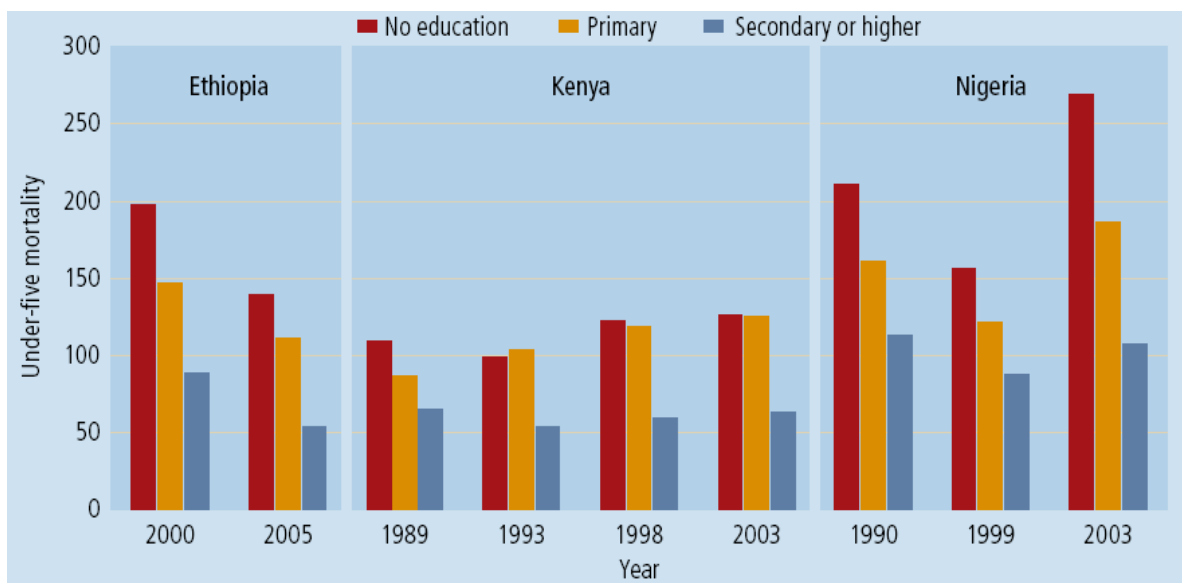


Figure 1. Child mortality rates (under age 5) in three African countries by mothers' education level. Source: Selected Demographic and Health Surveys from <http://www.measuredhs.com/>.

The picture of fertility rates by level of education looks very similar to that of child mortality rates. Women with secondary education consistently have much lower fertility rates and in all three countries their fertility rates have continued to decline over time, whereas for uneducated women and those with only some primary education, the fertility rates have increased somewhat, which is the reason for the stalled overall fertility decline. In Ethiopia today, women with no formal education have on average six children, while those with primary education have five, and those with secondary education only two. These are indeed

stunning differentials that shed a different light on the discussion of the stalled fertility decline.

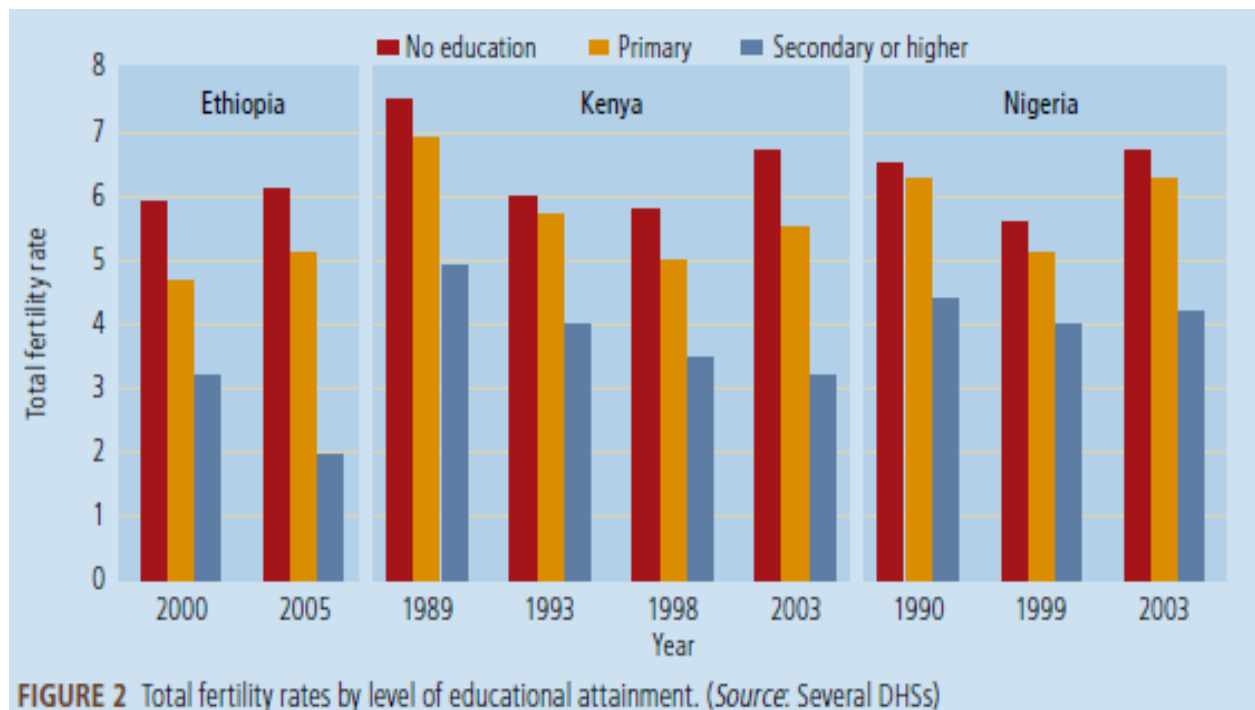


Figure 2. Recent trends in total fertility rates by women’s level of education in Ethiopia, Kenya and Nigeria. Source: Selected Demographic and Health Surveys from <http://www.measuredhs.com/>.

Given the key role of female education in lowering fertility and the fact that the transition to at least junior secondary education typically makes the biggest difference, it seems obvious that rapid improvements in female education should – in addition to many other positive effects on empowerment, health and wellbeing – be viewed as a highly efficient population policy. This point was made very clearly in a recent Commentary by Joel Cohen in *Nature* (Cohen 2008), where he suggested that the benefits of such an effort would include a dramatically smaller increase in world population by 2050.

While I fully share Cohen’s reasoning and conclusions, his quantitative assessment of a difference of about one billion people in the world population of 2050 is only a crude approximation of the effect of universal female secondary education derived from simply comparing the high and the low variants of the UN population projections which differ by a total fertility rate (TFR) of 1.0. It does not consider that even the most rapid improvement in female education over the coming years will only gradually change the educational composition of the reproductive age population, that the educational fertility differentials vary over the course of demographic transition, and that education also leads to lower mortality rates. In the following I will present a true multi-state model that explicitly considers all of these factors for 120 individual countries and the world as a whole.

#### **4. Interactions between Education and Population Growth**

The methods of multi-state population dynamics were developed in and around IIASA during the 1970s and 1980s (Rogers 1975; Keyfitz 1979) and have since become a standard component of the demographic tool box. Originally developed to simultaneously project the populations of different provinces of one country, where fertility and mortality levels differ by province and during the projection period people move from one province to another (transitions), the methodology can be applied to any subdivision of the population according to clearly defined criteria. A subdivision of the population by highest educational attainment naturally lends itself to such a model, where the pattern is actually simplified by the fact that transitions only go in one direction (from lower to higher attainment) and typically only take place at young ages. After a certain age, transitions to higher levels of formal education are negligible and highest attainment remains invariant until death (in contrast to actual skills that may well decline after a certain age). This persistency of educational attainment along cohort lines is the reason why it is feasible to reconstruct and project the educational composition of the population of any country for several decades, even if empirical data exist only for one point in time.

Recently, IIASA's World Population Program in collaboration with the Vienna Institute of Demography (VID) applied such methods to systematically reconstruct the educational attainment structure of 120 countries to 1970 for five-year age groups and with explicit consideration of educational mortality differentials, thus producing a more detailed and more consistent historical dataset than was previously available (Lutz et al. 2007). This method – which is illustrated for the case of South Korea below – has now also been applied to project the population of 120 countries according to alternative scenarios about future fertility, mortality, migration and education trends. Figure 3 shows the results for the world as a whole (extrapolating the results of the 120 countries, covering 93 percent of the world population, to the entire world population) as reconstructed for 1970 and projected to 2010 and 2050 according to the global education trend (GET) scenario. The GET scenario assumes national fertility, mortality and migration trends similar to those of the medium variant of the UN 2006 assessment (United Nations 2007), except for China, Japan, South Korea and the European countries, where fertility is assumed to be somewhat lower than in the UN assessment, which assumes convergence to a TFR of 1.85. With respect to future educational transition rates from lower to higher levels, the GET scenario assumes the rather positive trend of a continuation of the recent global trend of improvement in the age- and sex-specific proportions moving to a higher level. The three pyramids in Figure 3 are plotted on the same absolute scale and impressively illustrate that despite the massive population growth of the world population from 3.7 billion in 1970 to 6.9 billion in 2010, the absolute number of adults (above age 15) without any formal education (the portion in red) has actually declined somewhat, while those with secondary and higher education (in light and dark blue) have increased significantly. By the middle of this century, the GET scenario results in a further significant improvement of the educational structure of the world population. Much of this future increase is already embedded in the current age and education structure, with younger cohorts being typically better educated than older ones due to past improvements in education. The global pattern is greatly influenced by educational improvements in Asia. The expected increase in the number of women and men with tertiary education is particularly impressive. Given the importance of secondary and tertiary education for economic growth (as discussed below) this points at a very positive longer term trend of human development, if recent trends in improving education around the world can be maintained. This picture gives the human side of “the world in 2050” which is the title of our conference.

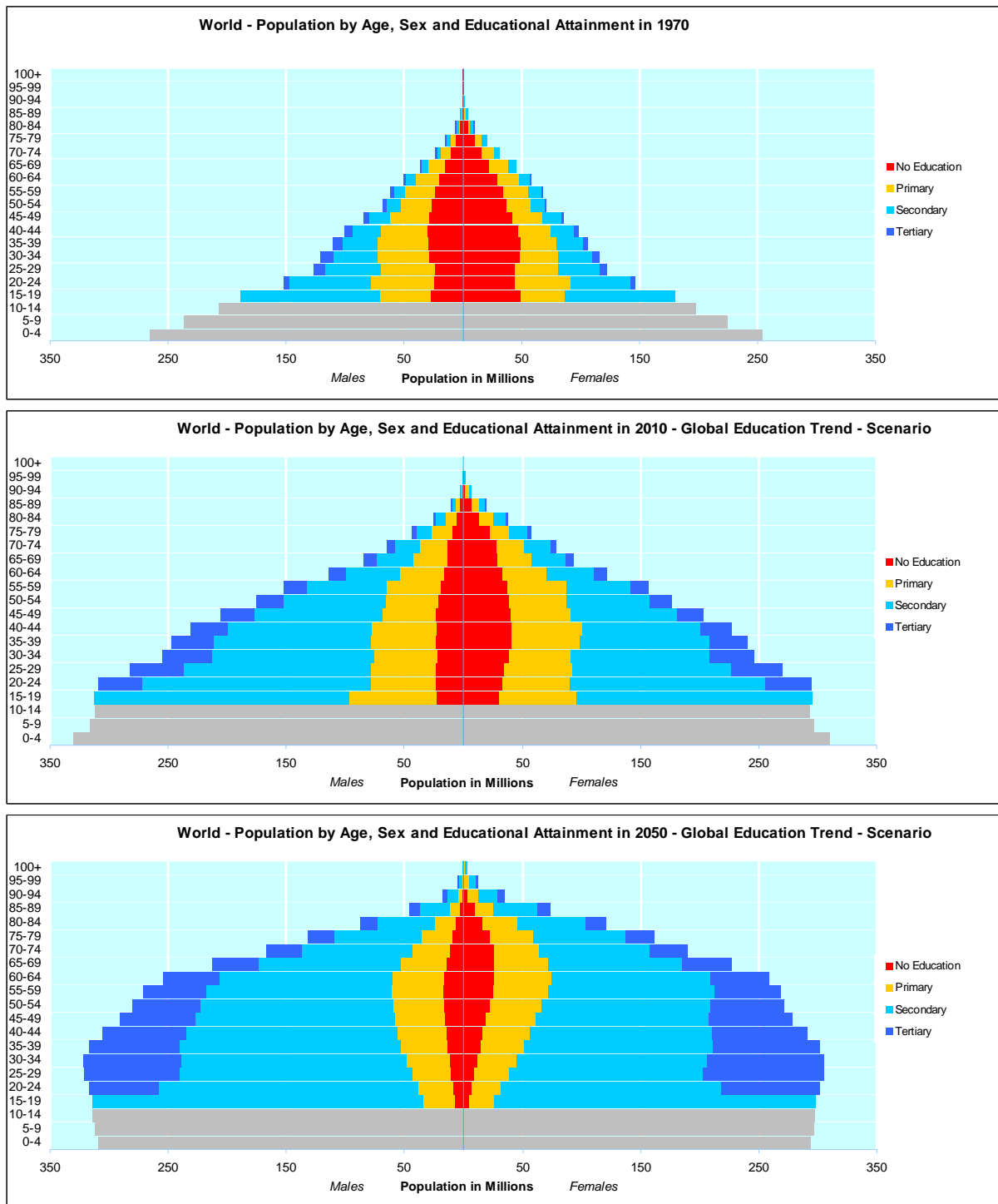


Figure 3. World population by age, sex and four levels of educational attainment in 1970, 2010 and projected to 2050 under the global education trend (GET) scenario. Based on KC et al. (2008).

In addition to the GET scenario, several other education scenarios were calculated for all countries of the world. They range from the even more positive fast track (FT) scenario to a scenario assuming constant school enrolment (educational transition) rates (CER) and the still more pessimistic scenario of constant absolute numbers of students (CEN) which implies declining school enrolment rates under conditions of an increasing school age population.

Since the assumed trends in the education-specific fertility rates are identical for all three education scenarios, the different population sizes and age structures resulting from the different scenarios are only the consequence of different weights of the different education categories. If in one scenario the proportion of women with more education is higher than in another scenario, the overall fertility rate of the population will be lower. At the global level this purely education-induced difference between the most optimistic FT scenario and the most pessimistic CEN scenario turns out to be about 1.1 billion people by 2050.

While methodology, empirical data, assumptions and results of these different scenario projections for 120 countries are discussed in detail elsewhere (KC et al. 2008), in the following we will look only at the results for selected world regions and selected countries. Table 1 gives the population size in 2000 as well as the sizes resulting from the four different education scenarios for 2050. Given that the different scenarios are based on identical fertility assumptions at the level of each education category, the different population growth only results from the different educational composition of the population. As Table 1 shows, these differences can be very substantial.

Table 1. Total population in 2050 resulting from the four different education scenarios and based on the assumption of identical education-specific fertility rates across scenarios for the world, major world regions, and selected countries.

	Total population in millions				
	2000 (Base)	2050			
		FT	GET	CER	CEN
World	6111	8580	8792	9362	9684
Africa	820	1827	1935	2201	2399
Asia	3704	4908	5009	5276	5420
Europe	695	623	628	621	598
Latin America & Carribean	522	761	765	854	908
North America	315	456	458	457	402
Selected countries					
Pakistan	144	285	292	316	334
India	1046	1594	1658	1802	1884
Kenya	31	84	85	103	123
Ethiopia	69	160	183	209	218
Uganda	25	91	93	110	125
Ghana	20	42	42	47	53
Nigeria	125	278	288	331	365

Figure 4 illustrates the case of Kenya in more detail. Kenya has recently made quite some efforts in expanding school enrolment which was also associated with a policy of free primary education. While there are evident shortcomings in the implementation of this policy, particularly in urban slums and remote rural areas, the education composition of the population above age 15 in 2010 as shown in the upper part of Figure 4 reveals almost universal primary education (this only refers to some primary and not completed primary) and more than a third of the younger cohorts having completed junior secondary education.

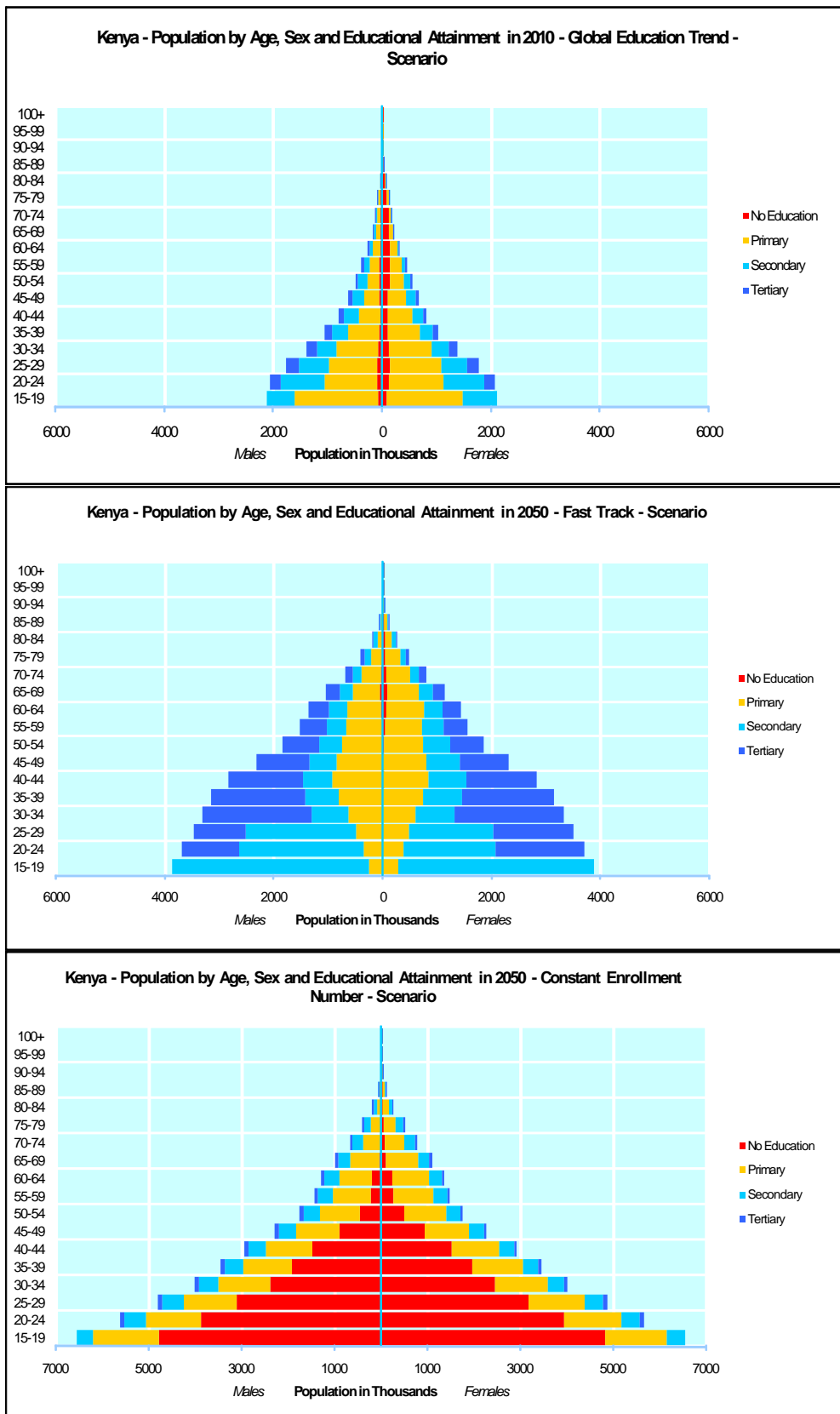


Figure 4. Alternative scenarios for the population structure of Kenya by age, sex and level of educational attainment for 2010 (top), 2050 according to the FT scenario (middle), and 2050 according to the CEN scenario (bottom). For definitions, see text. Based on KC et al. (2008).

The lower part of Figure 4 contrasts the results of the two most extreme education scenarios considered for the year 2050. Under the fast track (FT) scenario that assumes very rapid educational expansion as has been experienced by some of the most successful countries such as Singapore and South Korea, the educational composition of Kenya in 2050 does indeed look similar to that in Singapore today. (It may be worth noting that in 1960, both in terms of education and income, Singapore was in worse condition than Kenya in 1960 and than Kenya today). In other words, this scenario shows that with corresponding education efforts at all levels (but leaving out the possibility of adult education), Kenya could possibly achieve a very good educational composition of its working-age population by 2050 that – as our analysis below will show – is very likely to be associated with much better health, income and democratic governance.

The opposite picture results from the constant enrolment numbers (CEN) scenario that assumes that due to financial, institutional or other limitations, no more new schools are being built and the government simply manages to maintain the current absolute level of enrolment. Because the school-age population will rapidly increase over the coming years due to very high fertility, this scenario will result in a marked decrease of school enrolment rates and hence an increase in the number of young adults without any formal schooling (red area). Such declines in the average level of schooling were actually experienced during the 1990s in some African countries, where public spending on education had been reduced due to IMF-imposed structural adjustment programs. For Kenya, such an admittedly very pessimistic course of events resulting in more than half of the much bigger total population being (again) without any formal schooling would likely result in a reversal of all of the (modest) social development successes of the past decades. The two other education scenarios come to lie between these two extreme ones.

It is interesting to note that due to the high educational fertility differentials in Kenya (see Figure 2), these different education scenarios result in greatly differing patterns of population growth (even when assuming identical fertility trends for each education category). The size of the youngest age group 0-5 (not shown in the figure) is almost twice as large under the CEN scenario as under the FT scenario.

## **5. Education and Economic Growth**

It is commonly assumed that education has an important positive effect on economic growth, but to date the statistical evidence for this assumption has been surprisingly weak. Evidence shows beyond any reasonable doubt that, at the individual level, more years of schooling generally lead to higher income. But, at the macroeconomic level, empirical evidence relating changes in education measures to economic growth has so far been ambiguous. Many authors suggest that this may be due to problems with the global empirical data on human capital (Barro and Lee 1996; de la Fuente and Doménech 2006; Cohen and Soto 2007; Benhabib and Spiegel 1994; Pritchett 2001).

In a new major study recently published in *Science*, Lutz et al. (2008) provide for the first time the unambiguous statistical evidence (based on econometric models) that education is a consistently significant determinant of a country's aggregate level of economic growth. The key to these new results lies in the more detailed and more consistent nature of the new IIASA-VID dataset on educational attainment by age and sex for 120 countries back to 1970 as described above. While in most previous studies (e.g., Barro and Lee 1996) the educational attainment of the entire population above the age of 25 was considered as the human capital variable (which is relatively insensitive to rapid improvements in the education of the younger

working-age population), the new data provides information by five-year age groups and the full attainment distribution (which includes more signals for statistical analysis). In addition to the greater detail, the consideration of differential mortality by level of education and the strict consistency over time of the definition of educational categories evidently turned out to be decisive advantages of the new dataset over previous ones.

While the new study and the specific models estimated cannot be described in any detail here, I only want to point out one important finding of great policy importance: For poor countries with low human capital, only the combination of universal primary education with broadly-based secondary education results in the kind of rapid economic growth that has the potential to push countries out of poverty. This additional investment in secondary education provides a huge boost to economic growth, much greater than in the case of universal primary education alone. In these simulations the effect of secondary education works primarily through the adoption of new technologies. From this we can conclude that the current Millennium Development Goals' focus on universal primary education is important but insufficient. It needs to be complemented with the goal of giving broad segments of the population at least a completed junior secondary education or even better, universal secondary education.

Last but not least, the analysis illustrates that the fruits of investments in education need a long time to ripen, to translate the education of children into better human capital of the adult labor force. The fruits will come slowly but surely. While education is not always a sufficient condition to growth, it can be considered a necessary one, at least in the longer run. Education is a long-term investment associated with near-term costs, but in the longer run it is one of the best investments a society can make for its future (Lutz et al. 2008).<sup>2</sup>

## **6. Education and Democracy**

A recent study by Crespo Cuaresma and Lutz (2009) applies the new IIASA-VID education dataset to reassess the relationship between improving educational attainment of the population as well as the education differentials between men and women and indicators of civil liberties and the quality of democratic institutions. The results turn out to be highly significant and reaffirm on a broader and more consistent basis the findings from earlier studies in the field. In the study of the process of democratization, the so-called modernization hypothesis (Lipset 1959) considers the level of development of a country, and in particular its educational attainment, as the main determinant of the birth and sustainability of democratic political institutions. While in the broader literature in this field a high level of education is not usually considered a sufficient condition for democracy, formal education tends to be mentioned as a necessary condition for democratic institutions to develop and persist.

The theoretical arguments relating education to democracy are manifold. At the individual level, education is a determinant of political participation. As the educational level increases, individuals tend to develop a stronger sense of civic duty and a greater interest in politics. However, to the extent that education causes economic growth, it is also an indirect determinant of democracy through the link between wealth at the macroeconomic level and democracy. Recent contributions to the theoretical literature on the link between educational

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<sup>2</sup> We are currently using these new education data by age and sex to reassess the role of the “demographic bonus” resulting from changing dependency ratios on economic growth. First results indicate that the “bonus” only works if it is associated with increasing human capital.



attainment and democracy emphasize the increase in the benefits of political participation caused by education as the catalytic link relating changes in educational measures to changes in democracy. Glaeser et al. (2007) present a theoretical model where the effect of education on the (otherwise weak) incentives faced by individuals to support democratic regimes leads to higher stability of democratic regimes in more educated societies. The empirical evidence on the effect of education on democracy lends support to a positive relationship between these two variables when we exploit differences across countries. Barro (1997) and Glaeser et al. (2007) find a positive effect of education on the level of democracy by exploiting differences across countries from panel data. A simple scatterplot showing the average level of democracy against average years of schooling for all countries for which data exists in the period 1970-2004 (see Crespo Cuaresma and Lutz 2009) depicts a clear significant positive relationship. The democracy variable is the variable Political Rights, from the Freedom House, which has been normalized to lie in the [0,1] interval. The education variable is average years of schooling of an adult over 15 years of age, sourced from the IIASA-VID dataset and evaluated in the first year of the sample. The index of democracy summarizes information on the existence of electoral freedom, based on the level of adult suffrage and the existence of competition for public offices, political accountability and lack of corruption.

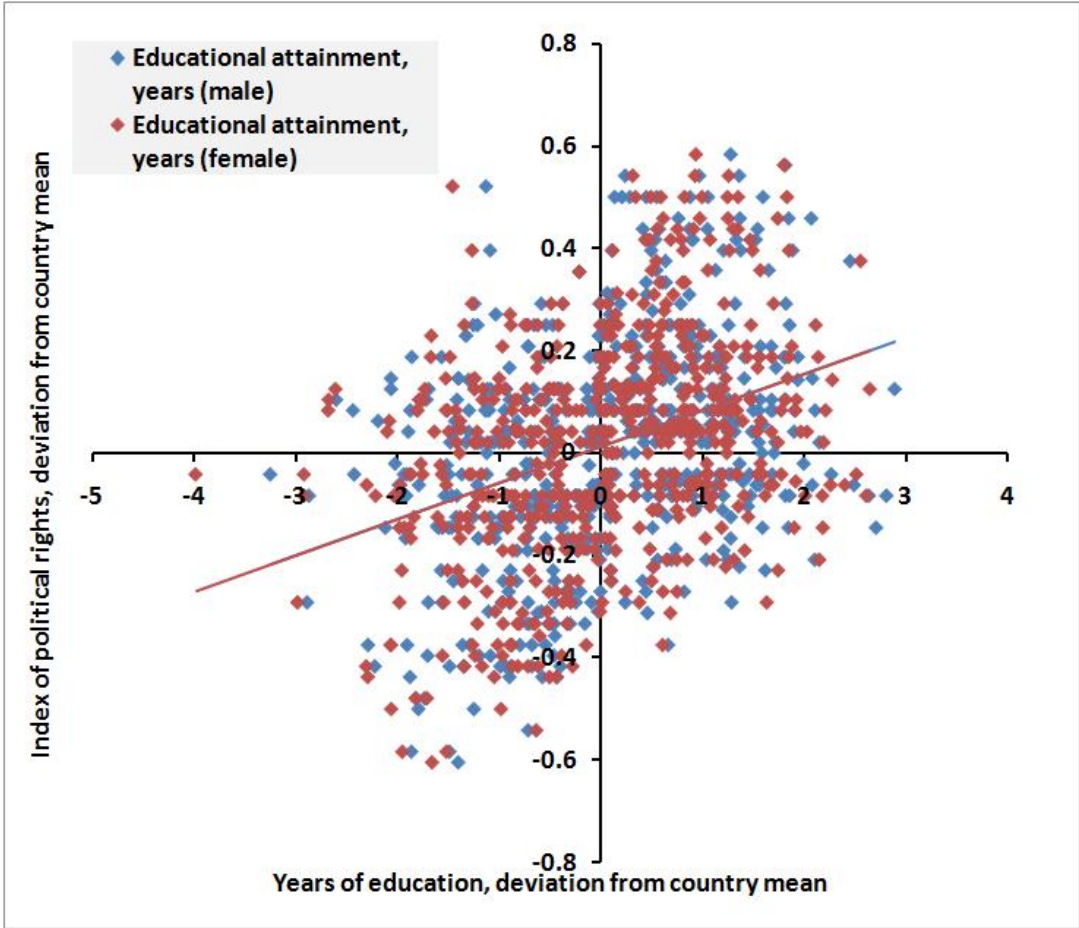


Figure 5. Relationship between improvements in the index of political rights and the mean years of schooling of men and women in a panel of 120 countries. Source: Crespo Cuaresma and Lutz (2009).

The positive relationship also appears if we concentrate on variations within countries over time as shown in Figure 5. While the previous empirical evidence on the effect of changes in education on democracy within countries is more mixed (Arellano and Bond 1991; Bobba and Coviello 2007; Blundell and Bond 1998), the richer information of the IIASA-VID dataset allows evaluation of the differential effect of educational attainment depending on its distribution across age groups and genders.

Econometric studies by Crespo Cuaresma and Lutz (2009) based on the educational attainment for age groups of men and women in five-year steps for 120 countries in the period 1970-2000 and also controlling for GDP per capita, the investment rate, life expectancy, the urbanization rate, the share of agricultural output on total output, and the change in the young-age dependency ratio show several interesting findings: Societies in which high proportions of young people tend to have a lower probability of achieving democratic regimes; increases in urbanization and investment tend to lead to political changes in the direction of democratization; and education turns out to be a significant and robust determinant of democracy. This was tested for mean years of schooling as well as the full educational attainment distribution. With respect to gender differentials the findings also show that an increase in female relative to male education is a robust predictor of changes towards more democratic rights (Crespo Cuaresma and Lutz 2009).

Hence of all the variables studied, increases in human capital and in particular the improvement of female education relative to male education turned out to be the most important systematic social change associated with more democracy and higher levels of civil rights and liberties. Since the education efforts that later result in higher human capital come well before the evaluated improvements in democracy, there is little doubt about the direction of causation.

## **7. Selected Country Experiences**

The strong relationship between advances in human capital and success along many dimensions, ranging from economic growth to health and quality of governance, is not only visible at the cross-country global level. There are also many national success stories that are testimony to the decisive role of early investments in education. Since, as I stated in the introduction, I consider human capital a necessary but not always a sufficient condition for success, there are of course examples where under specific conditions (often the rule of communist regimes) improvements in education did not directly translate into higher wellbeing. But in the following I want to focus on a few of the many success stories.

### **7.1. The story of Finland in the 19<sup>th</sup> and 20<sup>th</sup> century**

During the 19<sup>th</sup> century, Finland was one of the poorest regions in Europe. It had no natural resources except for wood, which grew more slowly than farther south on the continent. During the late 1860s, Finland experienced a major famine that killed more than 10 percent of the total population and more than half of all infants (Lutz 1987). This was probably the last major “natural” famine in Europe. Unusually cold weather conditions had resulted in almost complete crop failure and vulnerability to diseases. Other northern European countries managed to cope better with these weather conditions than marginalized and poverty stricken Finland.

Today, Finland is one of the world's leading industrialized countries and, according to different independent studies, it has the world's most competitive economy. What caused it to change from being one of Europe's most backward regions to a model of efficiency, competitiveness, gender equity and human wellbeing? One thing that distinguishes Finland from many other European countries is that it was one of the first countries in the world to reach universal literacy of its population. This is mostly due to the efforts of the Lutheran Church of Finland, which put a lot of emphasis on improving the literacy skills of the rural population and at some stage even made it impossible for young people to marry unless they could pass a basic literacy test. After New Zealand, Finland was the second country in the world to grant women the right to vote. Subsequently, massive efforts in the secondary education of women were made, and already by the 1970s more girls than boys had passed the matriculation examinations in Finland (Lutz 1987). Although there have been other economic and political reasons for the recent impressive economic performance of Finland, there is little doubt that the strong early investments in human capital formation and the status of women were among the decisive factors.

## 7.2. The Story of Germany 1945-1970

History has offered several natural experiments that allow us to assess the relative roles of human versus physical and financial capital in bringing about economic growth. In most cases they resulted from tragic events in which at least one sort of capital was completely destroyed while others survived. While it is evident that in the extreme case of human capital being completely destroyed (i.e., all or most people that carry knowledge and skills are killed by war or disease), no amount of physical or financial capital can be of any help. Several collapsed historical cultures from the Easter Islands to pre-Columbian American cultures give testimony of this, but it hard to find more recent examples. For the opposite case of human capital surviving while physical and financial capital were completely destroyed, one can find several examples from post-war experiences during the past century.

Here I will focus on one of the most astonishing episodes of rapid economic growth after complete destruction, namely, the case of Germany right after World War II. While German physical infrastructure and productive capacity for industry was almost completely destroyed in 1945 through large scale bombing, and even the remaining financial assets in Germany had lost all of its value after a money reform, the situation was made even more difficult because of the millions of ethnic Germans entering the country from other parts of Europe where they could no longer live. Like most of the people in Germany, they had nothing except for a surviving body and in many cases well-educated brains.

Let me cite as an unsuspected witness of these events the most influential French demographer, Alfred Sauvy, who in 1958 wrote in his book *Fertility and Survival: Population Problems from Malthus to Mao Tse-tung* about the "miracle" of Germany's economic rise after total destruction in 1945 and the fact that it had to absorb five million refugees: "Why this success, contrary to the forecasts of all doctrines ...? Because these men without capital came with their knowledge, their qualifications. They worked and they recreated the capital that was lacking, because they included a sufficient number of engineers, mechanics, chemists, doctors, sociologists, etc. If five million manual workers had entered Western Germany instead there would be five million unemployed today." (Sauvy 1958, cited from the English translation of 1963, p. 169). Despite the demographic prominence of Sauvy, mainstream demography over the past half century has not really incorporated this important

line of thinking which complements the consideration of numbers and age-structures of people with consideration of their skill levels.

Of course the German “Wirtschaftswunder” (the economic “miracle”) did not happen entirely without financial capital. The investments made through the Marshall Plan were instrumental in facilitating this surprising economic growth, but they could only be brought to productive ends because the eager human capital was there. After all, the sums spent in the context of the Marshall Plan were rather minor compared to more recent efforts to stimulate economic growth in other parts of the world that remained rather unsuccessful. (Germany received a total of 1.4 billion US\$ which was less than half of what France and the UK each received and compares to hundreds of billions of accumulated aid to Africa). Past expectations that a “Marshall Plan for Africa” would yield similar results, if only the money would be made available, failed to heed this important fact. In some African countries over the past decades, financial flows from outside without the necessary human capital actually seem to have made things worse rather than better (e.g., Glennie 2008).

### **7.3. The Story of Mauritius 1960-1990**

The Indian Ocean island of Mauritius started its demographic transition almost a century later than European countries, but went through it much more rapidly. Up to the 1940s birth and death rates in Mauritius were very high and resembled the pattern typical of pre-modern societies with high annual fluctuations. After the end of World War II, however, mortality started a precipitous decline, owing mostly to the eradication of malaria and the spread of modern medicine, with antibiotics playing a major role. Birth rates continued to stay at a high level, or even increased, owing to better health of women combined with a high desired family size. Hence, during the 1950s Mauritius experienced population growth rates of more than 3 percent per year and was frequently used by scholars (Meade et al. 1967; Titmuss and Abel-Smith 1968) as a textbook case of an island stuck in the vicious circle of poverty and high population growth, each assumed to reinforce the other.

Then during the 1960s the government of Mauritius launched a strong but strictly voluntary family planning program in which even the influential Roman Catholic Church cooperated with the government by advocating “natural” contraceptive methods together with the need for smaller families. From 1963 to 1973 the total fertility rate on Mauritius declined from more than 6.0 to less than 3.0, one of the world’s most rapid fertility declines (only recently surpassed by Iran as described below). Why were these family planning efforts on Mauritius so successful, while similar efforts in other parts of the world showed less success during that time? Again, the answer can be found in the almost universal literacy of women on Mauritius, a result of early investments in human capital formation even under conditions of extreme poverty. Already by 1962, more than 80 percent of all young women could read and write, a factor that both brought down desired family size and increased access to family planning (Lutz 1994).

Subsequently, Mauritius experienced the benefit of the so-called demographic bonus through a decline in youth dependency combined with still very low old age dependency, resulting in a period of economic growth, investments in infrastructures and further education. In Mauritius the young and better-educated women postponing their childbirths were clearly a major factor in facilitating the rapid expansion of the textile industry and later of the development of upscale tourism. Today, the former textbook example of a country stuck in poverty is leading the African region in terms of quality of life indicators and is already being compared to the Asian tigers.

#### 7.4. The Story of South Korea 1970-2000

South Korea exhibits a story that is quite similar to that of other Asian tigers. Here we will use the example of South Korea for a dual purpose: to illustrate the method of back projection and to show what seems to be the main underlying reason for the stunning economic growth and social transformation which these Asian tiger countries have experienced over the past decades.

Figure 6 (upper part) shows the distribution of the population by age, sex and level of educational attainment for South Korea in 2000. The past improvements in education can be readily seen from the fact that younger cohorts are much better educated than older ones, and among the older ones, women are clearly less educated than men. Among the women above age 65, half have never been to school because when they were young, Korea was still a poor developing country with very low levels of female school enrolment. Since more educated people have lower mortality risks than less educated ones, these data on women surviving to the age of 65 actually overstate the level of education their cohort had at a young age. The fact that among the daughters of these poorly educated women, all already have secondary and around a third has tertiary education, shows the incredible speed of improvement in human capital in Korea that is only rivaled by that of other tiger states such as Singapore. This is about as fast as social development can possibly happen. But it also illustrates that there can be no leapfrogging in social development, something that is often forgotten by economists enchanted by rapid technological progress. Societies essentially change along cohort lines and it takes decades for the better educated or otherwise different younger cohorts to make it up to the age of political and business leaders.

This education structure by age together with the fact that educational attainment improves along cohort lines is also the basis for the reconstruction of human capital mentioned above. Using this age-specific information we can go backwards in time (in 5-year steps) until 1970, reaching the distribution depicted in Figure 6 (lower part). The cohort aged 65-69 in 2000 was aged 35-39 in 1970. It is bigger in size than in 2000 because some people have died over the course of the years, but the educational attainment distribution is very similar because most people had received their final attainment level by age 35. We only had to adjust for the fact that people with higher education tend to have lower mortality and – where necessary – for the existence of educational migration differentials. This new dataset is superior to other existing datasets through its detail (four educational categories for 5-year age groups of men and women), through the consideration of differential mortality and through the strict consistency of the definition of educational categories over time, which is a major problem in empirical historical datasets, in which the underlying educational definitions often change.

The economy of the Republic of Korea has grown by more than 8 percent each year since the 1960s, making it the fastest growing economy in the world. Korea's performance is considered particularly impressive because it has been achieved in spite of such obstacles as Japanese colonial rule, the devastation of the Korean War, political turmoil and heavy military expenditures under national partition (Lee 2008). Economic growth rates were highest from the mid-1980s to the early 1990s when they were above 9 percent, which coincided with the entering of much better educated cohorts into the young labor force ages. There seems to be agreement among researchers that Korea's economic growth has benefited from the education level of its human resources, which have played a key role in absorbing advanced technology from the developed countries (Lee 2008). School enrolment in Korea already started to increase rapidly in 1945, and although economic growth later provided the means to further enhance schooling, there seems little doubt that the expansion of education

was a driver of economic growth rather than the opposite. Lee (2008) argues that the outward orientation of Korea was a major incentive for the government to rapidly increase education and that the contribution of human capital to growth goes beyond that indicated by conventional growth accounting because the abundant well-educated human resources have been playing a key role in the absorption of advanced technology from developed countries, thereby bringing about Korea's high levels of technological progress.

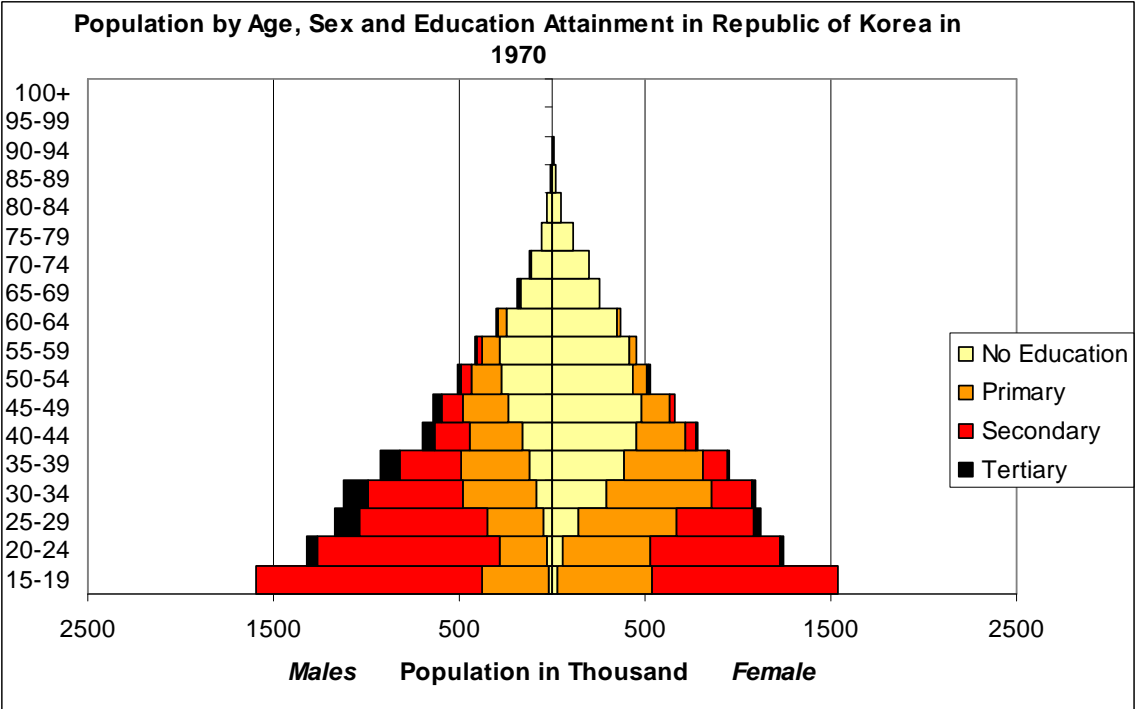
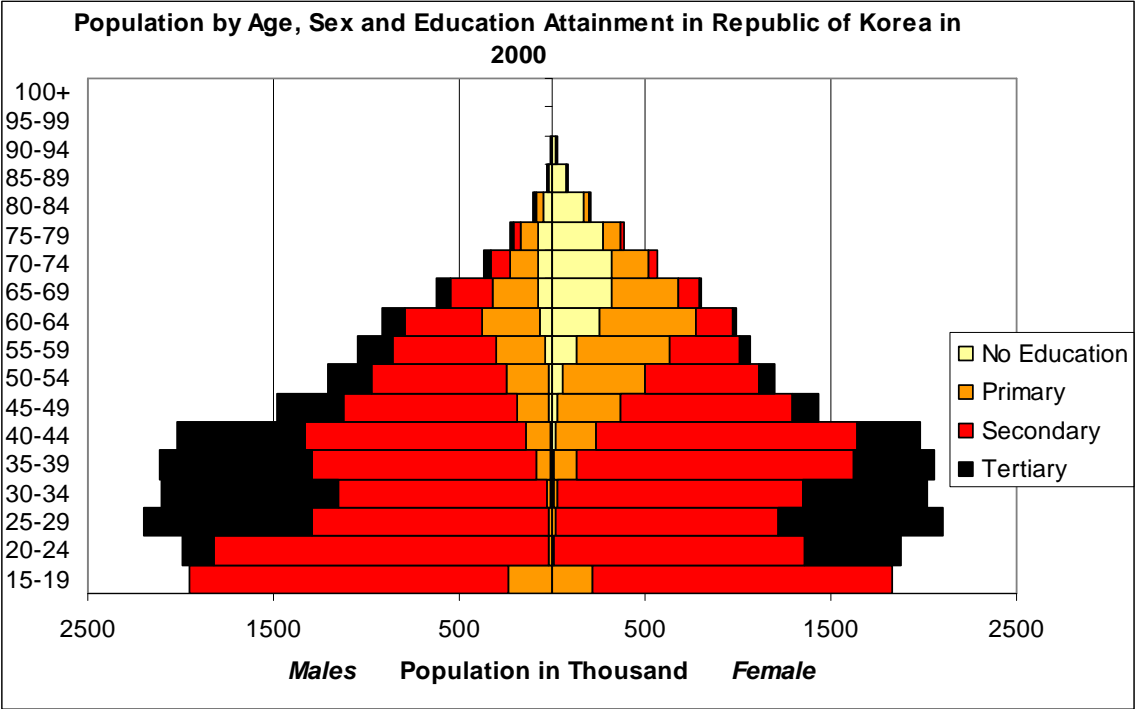


Figure 6. Population pyramid by level of education for South Korea in 2000 (upper part) and as reconstructed for 1970 (lower part).

## 7.5. The Story of Iran 1980-2006

The last story in this set of national examples describes a still incomplete success story. It is the story of the world's most rapid fertility decline in a country that is considered one of the world's most pronounced Islamic states. While the TFR in Iran increased somewhat after the 1979 revolution and was around 7.0 in 1984, a first analysis of the Iran 2006 census results shows a sensationally low fertility level of 1.9 for the whole country, and only 1.5 for the Teheran area, which after all has about 8 million people (Abbasi-Shavazi et al. 2008). The lowest TFR of 1.3 was recorded for Gilan and Mazandaran provinces. In a recent study, Abbasi-Shavazi and McDonald (2006) emphasized the likely role of greatly improved female education in this trend. A more recent study by Abbasi-Shavazi et al. (2008) presents a more formal quantitative analysis of the role of education in this astonishing fertility decline and confirms the very important role of female education in tandem with the broadly-based provision of strictly voluntary family planning services.

Originally the religious leadership of Iran had been rather pro-natalistic and abolished the beginnings of a family planning system after the revolution in 1979. This was also the time when many soldiers were needed due to the war with Iraq. But around 1989, after the end of the war, a major policy change took place in Iran because the religious leadership was convinced by population experts that the very high fertility rates were no longer in the interest of the country. These policy changes with respect to family planning coincided with a remarkable increase in the educational level of younger women in Iran, particularly in rural areas. While the census of 1976 showed that only 10 percent of rural women aged 20-24 were literate, this rate increased to 37 percent in 1986, 78 percent in 1996 and 91 percent in 2006. During this period the number of women in this age group tripled due to very high past fertility, making this expansion in literacy even more remarkable.

Today Iran has one of the best-educated populations in the Middle East – much better than Egypt, for example – together with very high gender equality in education. Currently women aged 20-29 have on average 7.0 years of schooling compared to 8.6 for men of the same age (Abbasi-Shavazi et al. 2008). For those aged 15-19 there is almost no gender difference. Based on the strong association between education (and particularly the education of women relative to men) and economic growth as well as improvements in civil liberties and democracy – as discussed above – there seems to be a good chance that Iran will also see significant progress along these lines in the not so distant future. (During my recent visit to Teheran conditions there reminded me very much of those in Eastern Europe before 1989).

Following these selected historical case studies, I would like to say a word on the role of causality concerning the effect of education. In all empirical studies of the multi-dimensional process of development over time, simultaneity tends to be a big problem because many of the factors change at the same time and influence each other. The study of the effects of education, however, is easier in this respect because there is (both conceptually and empirically) a clear lag between the time in which the investment is made (school enrolment increases) and the time when the positive effects are to be expected (better educational attainment level of adults). Economists often include current school enrolment rates into their economic growth regressions. In this case there is indeed some problem of simultaneity because better economic conditions can facilitate the expansion of schooling at the same time, although it normally takes a few years to set up the infrastructure and train the additional teachers. But why should current enrolment rates have a positive effect on current economic growth? If anything, then young people are taken out of the labor force and sit in school rather than being involved in economic activities. In terms of timing, only when additional students have left school and entered the labor force and hence improved the

educational profile of the younger labor force, can economic benefits be expected. If the age group considered is only the total adult population aged 25 and over, then the time lag of expected causality can be very long. It may take up to three decades until an increase in junior secondary school enrolment results in a measurable increase in the human capital of the 25+ population. And it will be a very gradual effect as the better educated cohorts slowly gain more weight among all adults. This is also the reason why many economic growth models using the 25+ age group do not find a statistically significant effect of education because there is no clear signal in the data. The lag gets shorter and the signal gets clearer once the focus is, e.g., on the 20-30 year age group, or one looks at tertiary education which is attained at a higher age. But in general, since the cause always needs to come before the effect (where the cause can also be an expectation), in the case of education it is fairly straightforward to sort out causality in terms of temporal sequencing.

Another way of getting an analytical handle on the issue of cause and effect is systems analytical modeling in which different chains of influence are specified (mostly based on theory and to some extent on the estimation of past associations) including feedbacks and interdependencies. Systematic sensitivity analysis of the behavior of the resulting system can then indicate which forces are primary drivers and which are only intermediate drivers or outcomes.

## **8. From Applied Systems Analysis to Identifying Priorities**

I started this paper with a reference to the 1972 study by the Club of Rome – *The Limits to Growth* – which introduced large segments of the public to a then new methodology of thinking about the future. Systems analysis is the quantitative study of interdependent multi-sector systems which are characterized by feedbacks and non-linearities. This approach originally comes from engineering and was pioneered in its applications to human societies by Jay Forrester (1969) and colleagues at MIT. While this early study deserves credit for its methodological innovation and for raising the awareness of the international community in terms of environmental limitations, from today's perspective the World3 model that is the basis for *The Limits to Growth* got several things wrong. Mostly, the study has been criticized for its assumption of limited natural resources and in particular oil, which later turned out to be in much greater abundance, and for its lack of considering prices as a mechanism for managing relative scarcity.

Looking more closely at the population part of World3, there are a few interesting aspects worth noting. First of all, the model was very bold in assuming fertility and mortality functions in which the levels of fertility and mortality directly result from combinations of income, food supply, pollution levels and some other factors. Interestingly, this model assumed a reversibility of the demographic transition: Not only was the death rate assumed to increase again in the future as a consequence of collapsing food supply and increasing pollution, but also the birth rate was assumed to go back up to pre-modern levels as a consequence of such worsening conditions. While significant increases in the future death rate could still be viewed as a possible (although unlikely) scenario, significant increases in the birth rate for countries that have already completely gone through the process of fertility transitions does not seem to be a realistic possibility. The irreversibility of the fertility transition has been a key postulate of demographic transition theory (Coale 1973) and there are many examples to support this view. For instance, Moldova is currently considered the poorest country in Europe. Rural Moldovan women are about as poor as many rural African women surviving only because of their kitchen gardens. Yet the TFR in rural Moldova is



estimated to be around 1.2. Also, the experience from many other Eastern European countries shows that once family limitation has been accepted among broad segments of the population, there is no reversal and worsening economic conditions actually result in even lower fertility.

Human capital and education were also absent from the World3 model. This may be attributable to the lack of valid empirical data on human capital. Because of the absence of the explicit consideration of education as a factor in the system of feedbacks and interactions, education did not show up as a key variable. While during the 1970s there was a series of other global models that tried to improve upon the World3 model and which were critically evaluated in a book by Meadows et al. (1982) entitled *Groping in the Dark: Findings from the First Decade of Global Modelling*, there was never a second decade of global modeling. Global modeling went out of fashion mostly because it was considered not to do justice to the highly complex real world interactions; it could not consider the very different geographic and cultural settings in different parts of the world and was generally considered as not scientific enough because it depended too much on (the more or less arbitrary) specific assumptions of the model. As a consequence, much of the global-level analysis restricted itself to the modeling of specific sectors, such as energy systems, climate change, economic globalization and global population. This came at the expense of truly comprehensive studies of the possible interactions between those different sectors.

To my knowledge the first comprehensive systems analytical model that gave explicit attention to changing educational attainment by age and sex was the Population-Development-Environment (PDE) model developed by IIASA for the island of Mauritius (see Lutz 1994). This study was part of an attempt to return to the truly comprehensive analysis of the interactions between the different sectors, but confined to the application of a specific and well-documented micro-cosmos, as was the island state of Mauritius for which excellent data exist on many aspects of the natural environment and human development for many decades into the past. As described above, Mauritius had been a famous case study for a population trapped in the vicious circle of high population growth, poverty and environmental degradation. The interdisciplinary study concluded that the main reason why Mauritius managed to escape this trap was the combination of early efforts in female education and family planning which then helped to facilitate the later developments in export-oriented textile industries and tourism. The success story that followed has already been described above.

Several other comprehensive PDE case studies followed the Mauritius study. At IIASA these were studies on Cape Verde, the Yucatan peninsula, Namibia, Botswana and Mozambique. The latter three also gave explicit attention to the consequences of HIV/AIDS on the longer term prospects of those countries. In all of these studies improvements in education and human capital were explicitly included and turned out to be a key to development. This series of studies was summarized in Lutz et al. (2002).

I also had the opportunity of being involved in the advisory board of a much bigger series of Population-Consumption-Environment (PCE) studies funded by the MacArthur Foundation which were less ambitious than the IIASA studies in terms of being truly comprehensive, but were more representative for different regions and cultures around the world and for specific forms of population-environment interactions. Summarized in a special issue of *Ambio* (Curran et al. 2002), these studies showed that wherever education was explicitly considered, it turned out to play a key role.

Another series of systems models was commissioned by the United Nations Economic Commission for Africa (UNECA) with funding from UNFPA for which the so-called Population-Environment-Development-Agriculture (PEDA) model was developed. This

model included education only in terms of literacy but had fertility, mortality as well as agricultural productivity specified as differing by literacy. The model was applied to seven countries in Eastern and Western Africa with the most detailed application to Ethiopia (Lutz et al. 2004). Improvements in female literacy, together with improvements in family planning, came out as the most robust investments for improving food security and other indicators of wellbeing in this multi-sectoral context.

Despite the problems associated with models that try to be truly interdisciplinary and comprehensive, such models offer the only way for comparing the relative importance of different interacting factors in contributing to a specific goal function, such as increasing human wellbeing as measured, e.g., by long-term health, income and environmental quality indicators. Multivariate-linear (or log-linear) models cannot fully capture such real world interactions that tend to be full of non-linearities and feedbacks. Hence, not surprisingly, the tools of applied systems analysis developed largely from engineering, where the task was to come as close as possible to a comprehensive modeling of real world conditions because the building or bridge would collapse otherwise. There is no other science-based way to go beyond the currently dominant silo approach in sustainable development analysis, where people concerned with water systems think that water is the key to sustainable development; people concerned with energy think that energy is the key; people concerned with delivering health services or building roads or trying to improve the quality of governance think that their specific fields of concern are more important than others. Needless to say, people concerned with population and reproductive health also tend to think that these aspects make a major difference. And all these people are probably right to some extent because all these factors are indeed important, but they need to be viewed together as part of a bigger picture.

What then should be the priority focus of development policies? How should the efforts and available funds be distributed among these many sectors? At the moment, I think it is fair to say that those sectors that have the bigger lobby and the louder voices get the greater attention and the better funding. Substantive reasoning, rational arguments and comparative analysis only play a minor role. And truly comprehensive quantitative systems-analytical studies about which of the factors make the biggest difference in the long run and which have the best cost-benefit ratios in reaching human development targets, do not seem to play any role whatsoever in this process.<sup>3</sup> The set of Millennium Development Goals, clearly the most important guidelines for international development efforts, also provide no consistent picture of priorities. They give the impression of a set of rather independent targets that were the result of an auction of who pushes hardest for which target, rather than providing a systematic strategy of how to most effectively proceed in order to achieve poverty eradication and sustainable development. More specifically, the different goals mix specifications in terms of desired outcomes (such as the reduction of absolute poverty) without saying through which strategies these outcomes should be achieved using long-term strategic investments (such as universal primary education), and without saying what will be the longer-term benefits of such investments and how they will interact with the other goals. In short, they seem to provide a potpourri of goodwill without clear priorities and no comprehensive vision for the future and a conspicuous absence of scientific input and reasoning.

The short summary of studies presented in this paper argues that comprehensive systems-analytical studies as well as broad-based sectoral and intersectoral studies make a convincing case that indeed massive investments in universal primary and secondary

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<sup>3</sup> For example, the people working on the PDE studies on Namibia, Botswana and Mozambique that were funded by the development policy office of the European Commission were not even invited to that unit for a discussion of findings and implications because the priorities had been set beforehand for political reasons.

education for both girls and boys together, with health care focused on these children as well as their mothers (including reproductive health services) and their younger siblings, should become a clear priority for international development. All the other desirable outcomes are then likely consequences of such improvements of human capabilities. Most importantly, poverty does not disappear by just giving the poor money, but by empowering them to help themselves. Although this view is nothing new, it is currently not (yet) dominating the international development debate.

What about climate change and education? Does the tide of international concern about climate change not make the more traditional social development concerns, including education, less important? I think the opposite is the case. Most of the above-described systems-analytical models explicitly include key aspects of climate change ranging from water availability to agricultural productivity to extreme events and tropical storms. While the association between education and greenhouse gas emissions is a rather complex one (more educated people tend to emit more because they have higher incomes, while for people at the same level of income, those with a higher education can be expected to be more environmentally conscious), there is little doubt that education helps improve the adaptive capacity toward already ongoing and unavoidable future climate change. Adaptation strategies are a rapidly increasing field of international collaboration and aid. But adaptation investments mostly focus on improving specific infrastructures, such as irrigation systems in agriculture, without considering the bigger question of whether the supported agricultural techniques will still be tenable under changed climate conditions, or whether the development of alternative livelihoods, such as work in industrial production or service, would be the better option for the people concerned. Education may well be the key to such transitions that facilitate better future livelihoods under conditions of climate change rather than trying to maintain outdated modes of subsistence agriculture. Over the coming five years I will carry out a major project on this topic entitled “Forecasting societies’ adaptive capacities to climate change” which is supported by the new European Research Council Advanced Grant scheme. Through a series of multi-national case studies of past drought, flooding and storm events and analysis of global-level panel data, the project will specifically focus on the role of education for successful adaptation. First results can be expected within three years.

## **9. Conclusions**

I started out by mentioning a few recent assessments of the effectiveness of international development assistance. It is interesting to note that all of them make reference to education as an important precondition of development, but they do so more in passing than in emphasizing it as a priority. Paul Collier, in his 2008 book on *The Bottom Billion*, puts the emphasis on several “traps” that have to do with conflicts, natural resources, bad neighbors and bad governance, but does not explicitly focus on the human capital, on the people who should be empowered to change these conditions. Jonathan Glennie (2008), in *The Trouble with Aid: Why Less Could Mean More for Africa*, is more explicit about the failures of past development efforts and in particular the danger of directly contributing money, which in his view brings more harm than good. But he does not differentiate between different kinds of aid, e.g., such that directly empowers people and others that increase dependence, when he makes statements such as: “It is unlikely that aid increases to Africa will have a significant impact on poverty reduction and long-term development. On the contrary, aid has frequently damaged development prospects in Africa and further increases in aid could make the situation even worse” (Glennie 2008). While I tend to agree with much of his critical assessment of past aid to Africa, he throws out the baby with the bathtub. One can still

provide aid based on the understanding that people matter more for development than money, and that it is better to invest in human capital and thus empower Africans to arrange their own affairs.

So what should be done in terms of specific activities according to this triple “s” (*sola schola* and *sanitate*) view? The goal, in a nutshell, is to have all girls and boys between the ages of 5 and 15 in school (all kids in school = AKIS 5-15) and provide them with a decent quality of education primarily aimed at personal and mental empowerment (rather than having to learn irrelevant things by heart or being driven into foreign cultures). Since this is pretty much the standard today in most industrialized countries, it does not seem to need much additional explanation and justification. This provision of free and universal schooling needs to be accompanied by free school lunches (to provide students with at least one good meal a day) and by basic health care services primarily for the students, but also for their mothers (including reproductive health services) and (younger) siblings. These local units of human capital “production,” which have an integrated education and health approach, should be directly sponsored by donors in collaboration with local authorities. Particularly at the secondary level, the teaching staff could include volunteers from the North. Since this paper is conceptual rather than practical, I will not go further into the implementation issue, which clearly needs much more attention, once the principle has been accepted.

This human capabilities-based approach – which could also be viewed as one way of putting Amartya Sen’s thinking into practice – has the further advantage of being rather uncontroversial on ethical and religious grounds. It would be hard to find arguments against providing children in the South with the same kind of education that has long been compulsory in most countries in the North. In terms of viewing education as a population policy, it avoids the controversies around abortion and around the question of what is strictly voluntary family planning, while at the same time having the potential of being even more effective in reducing fertility levels. It not only addresses the presumed gap between desired and actual family size (while taking high desired family size as a given), but it also leads to a decline in desired family size as a consequence of the value change associated with better education.

The only controversial part of this message lies in the “*sola*”, i.e., in the claim that investments in human capital and health should have priority over all other kinds of investments in international aid. It is important to note here that the claim only pertains to international aid. In all other kinds of development activities within countries and between countries, the actors empowered by better education shall and will apply the full spectrum of investments necessary for improving their living conditions in a sustainable way, ranging from agriculture to industry, infrastructure, the environment and good governance.

The evaluation of this controversial “*sola*” has two dimensions: one political and one scientific. The political refers to the decision to concentrate aid around what has been identified as a root cause, a determinant that is more important than others. The scientific question is whether human capital is indeed such a root cause. This paper has only dealt with the scientific question, which is an important prerequisite for addressing the political question.

In this paper I consider the claim, that human capital is the root cause and key to development and hence should be given priority over other investments, to still be at the level of a hypothesis. For this reason, the title of this paper has a question mark. I have found enough empirical support from comprehensive systems models as well as from multivariate global-panel analyses to decide to put it on the table for public discussion and invite everyone to come up with possible counter-arguments. Clearly, we need more rigorous testing and analysis before billions of dollars of aid are cut from existing financial transfer and

infrastructure programs and redirected to education and health. But since the real world allocation of funds over competing programs seems to be more based on ideologies, fashions and vested interests rather than rational scientific evaluation processes, we might as well start the discussion process now. Let us hope that these discussions will be *sola schola* and *sanitate* which can be interpreted more loosely as: only based upon scholarship and sanity.

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