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EXPLOSIVE POPULATION GROWTH IN TROPICAL AFRICA: CRUCIAL OMISSION IN DEVELOPMENT FORECASTS—EMERGING RISKS AND WAY OUT

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Our article draws attention to a crucial factor frequently omitted from the global development agenda, namely the explosive population growth inevitably expected in Tropical Africa in the nearest decades as a result of the region's laggardness in fertility transition. Population doubling (or even tripling) in the next decades can seriously undermine the development prospects of Tropical African countries and lead to sociopolitical destabilization or even large-scale violent conflicts with possibly global consequences. Bringing down the population growth rates (mainly through substantially reducing the fertility rates) appears to be crucial for the achievement of the 1977 "Goals for Mankind," as well as the Millennium Development Goals, and, as we proceed to show, can be most effectively achieved through substantially increasing female secondary education, which, in turn, should be achieved by introducing compulsory secondary education and making it the first-rate development priority.

KEYWORDS: Development fertility, Malthusian scenarios, population pressure, secondary education, Tanzania, Tropical Africa.

INTRODUCTION

The seminal approach to global development that we pursue in this article was proposed by Ervin Laszlo and his team and laid out in the fifth report to the Club of Rome, "Goals for Mankind," in 1977. The tenets of the approach were

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reflected in several global goals, including security (reducing the possibility of international conflicts and wars); elimination of starvation, mainly through raising the productivity of labor in agriculture; orientating the development goals towards satisfying the needs of humans; not maximizing the economic growth; and so on.

More than 35 years later, it appears acutely necessary to re-establish these tenets in the African development agenda. In this article we will proceed to show how the omission of the extremely important factor of population growth (Forrester 1971; Laszlo 2003) from the development priorities may seriously undermine the Tropical African prospects of achieving the "security" and "elimination of starvation" global goals in the forthcoming decades. Indeed, a nearly decade-long fertility stall at levels higher than 5 children per woman has had a tremendous impact on the expected population increase in Tropical African countries. We reveal how this fact can significantly enhance the probability of violent conflicts (judging from the practical experience of the recent African past as well as from theoretical grounds [Goldstone 1991, 2002; Korotayev and Khaltourina 2006; Korotayev, Malkov, and Khaltourina 2006b; Korotayev et al. 2011]) and undermine all the recent economic achievements when it comes to eliminating starvation and undernourishment.

In order for the goals in Laszlo et al.'s 1977 paradigm to be finally achieved in Sub-Saharan Africa (SSA), it is necessary to secure substantial fertility decline acceleration in SSA in the nearest future. Basing on the research indicating that secondary education is the most important fertility-inhibiting factor in the region, we propose a model to evaluate the possible effect of various scenarios of increasing the net secondary enrollment upon fertility and infer some policy implications from the modeling results.

EXPLOSIVE POPULATION GROWTH PROSPECTS IN AFRICA: CAUSES, CONSEQUENCES, AND OMISSION FROM THE DEVELOPMENT AGENDA

Unprecedented population growth was specified among the major global processes exerting crucial influence on world development by Jay Forrester (1971) and have attracted considerable scholarly attention ever since. However, by the early 1990s the global community had become well aware of the fact that almost all developing regions were far advanced in terms of fertility decline, and that even in SSA, the most demographically laggard region, most countries had finally entered the fertility transition and had their fertility rates declining as well. Moreover, a widespread opinion prevailed that having once started, fertility decline would proceed rapidly and uninterruptedly until fertility reached the replacement level of 2.1 children per woman. Thus, UN experts forecasted the Sub-Saharan population to become stable at relatively safe levels, and the international community therefore became more or less "calmed down," shifting the focus of attention from the population growth and the necessity of bringing down fertility to other major issues. The shift already was visible at the 1994 International Conference on Population and Development in Cairo, where the widespread slogan "Development

is the best contraceptive" was reflected in priority change from family planning programs to development-related agenda, such as combating infectious diseases and HIV, decreasing infant and maternal mortality, promoting gender equality, and so on. Later on, these and other development-related priorities (such as securing universal primary education, eradicating extreme poverty, etc.) were reflected in Millennium Development Goals.

However, the exclusion of population growth deceleration from the top priorities of international development agenda appears now to have been quite premature. In the late 1990s and the early 2000s the fertility decline in many Tropical African countries experienced a large-scale stall, mostly at very high rates exceeding 5 children per woman.

This near decade-long failure to proceed with fertility decline is bound to have truly dramatic consequences for Sub-Saharan population growth—according to the latest medium forecast by the UN Population Division (2013), the population of such relatively modest East African countries as Kenya and Uganda will strike 150 million in the second half of the century (i.e., it will exceed the present-day population of Russia). Tanzania will reach the same number already by 2050 and is supposed to accommodate 300 million people by 2100. The case of Malawi is particularly astonishing, as according to the UN medium forecast it is supposed to accommodate about 150 million people on a territory of about 100,000 sq km (half of the current U.S. population on the territory of Nevada) in 2100. Equally astonishing is the projection for Nigeria: if its fertility does not fall even more rapidly than in the UN medium projection, its population will exceed the total population of all of Europe (including Russia) by the end of the century. Altogether, nine Sub-Saharan countries are projected to have populations in excess of 100 million each by 2100. The three landlocked Sahel nations of Niger, Mali, and Burkina Faso are projected to grow from a combined population of 47 million in 2010 to over 300 million by the century's end. It is hard to see how the countries in the region can avoid major social and political disturbances or even collapses if this explosive population growth is not curbed.

Thus, the decade-long fertility stall will "cost" many Tropical African countries tens of millions of "additional" population increase, which thus turns to be truly explosive in the nearest decades. However, even these ominous figures are not inertial—the UN medium scenario implies a significant acceleration of fertility decline in the Tropical African countries; in order to achieve that, large-scale effective measures should be urgently taken. Nevertheless, the global community still has not recognized the reappearance of the threat of sociopolitical catastrophes in SSA if rapid fertility decline does not resume very soon.

Indeed, Laszlo's (2003) insightful *You Can Change the World: The Global Citizen's Handbook for Living on Planet Earth* seems one of the very few works in the early 2000s that tried to draw attention to population pressure as one of the major factors retaining its critical role for development. Other major works attempting to forecast the world dynamics and (mainly economic) development of certain countries frequently omitted the development-hindering capacity of fast population growth and increasing population pressure. Thus, PricewaterhouseCoopers only mentioned any demographic factors in one aspect,

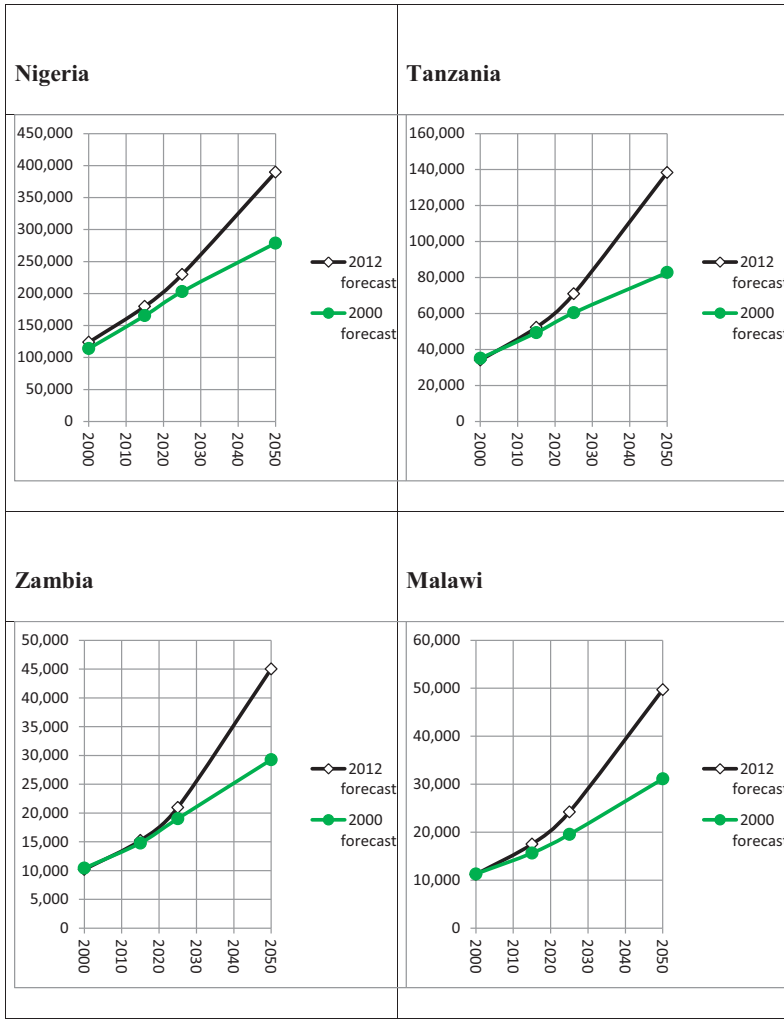

Figure 1. Comparisons of medium population forecasts made by the UN in 2000 and 2012 for selected Sub-Saharan countries, in thousands. Data sources: UN Population Division 2001, 2013.

namely the share of working-age population in a number of developing countries (Hawksworth amd Cookson 2008). For Nigeria 4% GDP per capita annual growth was forecasted in the period 2007–2050,[1] which seems very optimistic indeed considering the explosive-like population growth forecasted by the latest UN projections taking into account the fact that fertility in Nigeria still remains higher than 5 children per woman and largely failed to decline during the last decade.

Surprisingly, even the latest African Development Bank (AfDB) forecast outline of African development in the next 50 years mentioned the lagging in demographic transition as a positive factor, stating that Africa could benefit from the demographic dividend, while the huge sociopolitical destabilizing potential of explosive population growth, increased age-dependency ratio due to numerous cohorts of children, and the youth bulges necessarily preceding the increase in the ratio between the working-age population and the non-working-age population were left out of the scope of attention. The only population pressure-related threat to African development specified in the AfDB forecast is that "Tensions due to scarcity, population density and soil degradation will affect access to land in all regions of Africa over the next five decades. The slow demographic transition and the decrease in soil fertility will put increasing pressure on tenure systems. Unregulated land markets and the failure of land management and administration policies could result in increasing inequalities in access, and a rising number of land-related conflicts in both rural and urban areas" (AfDB 2011, 32). However, the only policy implication inferred from this threat by AfDB is "an urgent need for better governance of land management and improved regulation of land markets" (AfDB 2011, 32), but no measures are mentioned that would allow for urgent and substantial acceleration of fertility decline in order to bring down the population growth rates.

In our opinion, the range of delayed demographic transition's threatening (in the worst case, even ruinous) implications for African development in the coming decades is much broader than the strained land tenure system. Below we try to outline the most relevant population-related risks and to present some evidence why these risks are particularly threatening for SSA in the forthcoming decades.

The first type of risks to be mentioned here largely accords to the classic Malthusian scenario of state collapses. Malthusian discourse is considered largely irrelevant for the most part of the developing world nowadays; however, SSA is the only major region where the threat of Malthusian scenarios still preserves its relevance. Some examples of large-scale violent conflicts, or even state collapses where Malthusian processes, among other factors, significantly contributed to sociopolitical destabilization, can be found in the considerably recent African past, such as Mengistu Haile Mariam's regime failure in Ethiopia in 1989 (Korotayev et al. 2011), and Rwandan genocide in 1992 (Andre and Platteau 1998; Diamond 2005; Verpoorten 2012). Similar examples can be found in Mozambique, Somalia, Democratic Republic of the Congo, and so on (Small and Singer 1982; Crowder, Fage, and Oliver 1986; Korotayev and Khaltourina 2006).

Malthusian scenarios are particularly threatening to African development in the coming decades, as the recent decade (in some cases, decade and a half) of stably high economic growth was only enough for such vibrant African economies as Rwanda, Mozambique, and Ethiopia, to reach the minimal border of World Health Organization (WHO) recommended per capita food consumption level of about 2,100–2,200 kcal/capita/day. An even more ominous situation is observed in such East African countries as Uganda, Tanzania, Uganda, and Zambia, where the economic growth of the last decade did not lead to any substantial improvement in per capita food consumption, which remained practically stagnant in Kenya,

Tanzania, Uganda, and was even falling in Zambia. Considering the population growth momentum gained by now, it will require tremendous economic effort to sustain this level, let alone achieve further increase (which is utterly necessary to securely lead the countries out of the Malthusian trap). If fertility is not substantially reduced in the nearest future, this goal may well become unachievable and the countries will likely encounter full-scale Malthusian collapses.

The tremendous increase in the absolute numbers of children due to persistently high fertility (the number of newborn infants in Tanzania already equals that in Russia) implies a tremendous surge in the absolute numbers of youths in the nearest future. This will create critical strain in rural areas (land pressure, increased struggle for land, increased social tension, etc., much of what was observed in pregenocide Rwanda; Andre and Platteau 1998); moreover, large numbers of youths will invariably be forced to migrate to cities in search for employment, which will put serious pressure upon the greatly underdeveloped urban infrastructure (e.g., only 13% of Ugandans currently reside in urban areas, most of them in the capital city of Kampala, and the capacity of cities to take in really large numbers of rural–urban migrants, providing them with accommodation and work, seems highly questionable).

To conclude this part, we would once more make reference to the *Global Citizen's Handbook*, where Laszlo outlined the prospects of "breakdown" and "breakthrough" global future scenarios, stating population pressure as the first in his list of critical economic, social, and cultural factors the world is currently experiencing (Laszlo 2003, 13). Looking into the Tropical African prospects for development in the nearest decades, we find full support for the critical importance of the population pressure factor due to laggard fertility transition. Unless effective measures aimed at bringing down the population growth (and fertility rates) are urgently introduced, the catastrophic scenarios will become very probable—different from Laszlo's global "breakdown" scenario, but there is hardly doubt that, if the whole region of Tropical Africa (at least, the majority of Eastern Africa, Sahel countries, and Nigeria that are the most lagging in terms of fertility decline) follows the Malthusian scenario, the resulting major sociopolitical disturbances may bear truly global consequences.

SECONDARY EDUCATION: DOES IT SUFFICE TO AVOID THESE RISKS?

Obviously, in order to avoid or at least substantially mitigate the risks outlined above it is necessary for Tropical African countries to urgently introduce effective measures aimed at decreasing the population pressure and population growth rates, first and foremost, through significant acceleration of the fertility decline. The most important measures here lie in the sphere of increasing the female education level. Indeed, the negative relation between increased female education and fertility levels (and, finally, completed family size) is among the most well-established correlations found in demographic literature. See, for example, Susan Cochrane's (1979) comprehensive work describing various channels through which education manifests its fertility-inhibiting potential, its scale and importance for various

levels of education, different stages of fertility transition, and different levels of development, as well as the place of educational factor within the classic theories of fertility transition (see also Korotayev, Malkov, and Khaltourina 2006a, 2006b; Korotayev 2009). The European fertility study carried out by the Princeton University group confirmed that the onset of demographic change is more closely associated with parents' education and cultural affiliation than with economic factors (Coale and Watkins 1986). As regards the developing world, Singh and Casterline (1985) came up with a hypothesis (and sufficient evidence from World Fertility Survey to support their idea) that a certain threshold level of parental education after which education starts to exert visible negative impact upon fertility should differ in various regions depending on the strength of traditional fertility-regulating restrictions:

> Education reduces the demand for children and thus increases the desire, and probably ability, to regulate fertility, but more schooling may also be associated with shorter durations of breastfeeding or post-partum abstinence, which in themselves will act to raise fertility. The expectation, therefore, is that countries characterized by strong traditional restraints on fertility will have higher thresholds, and this expectation is fulfilled. In most Asian countries, a few years of primary education make almost no difference to marital fertility, and only secondary education is associated with substantially lower fertility. This is not the case in Latin America and the Caribbean, however, where any formal schooling, even a few years of primary schooling, usually results in lower fertility, and both upper primary and secondary education also bring substantial reductions in fertility. (Singh and Casterline 1985, 202)

Various anthropological studies, including our previous research, have shown that traditional fertility-regulating restrictions are much more prominent in Tropical Africa than in other developing regions (Boserup 1970, 1985; Schoenmaeckers et al. 1981; Lesthaeghe 1980, 1989; Korotayev and Khaltourina 2006). This made us suggest that in order to achieve an accelerated fertility decline in Tropical Africa it is necessary to spread secondary female education, rather than only securing universal primary education as stated in the Millennium Development Goals. This concords to the results of other research in this sphere: thus, Gupta and Mahy came to conclude that "girls' education from about the secondary level onwards was found to be the only consistently significant covariate" having consistent negative impact on fertility and the age at first birth (Gupta and Mahy 2003).

The global community has by now acknowledged the necessity of disseminating education in Sub-Saharan countries. One of the Millennium Development Goals (MDG) states the necessity of achieving universal primary education by 2015. Let us view how the achievement of this MDG, namely the provision of universal primary education, is likely to impact the TFR in Sub-Saharan countries. We have carried out a regression analysis of the relationship between the share of women aged 15+ having at least incomplete primary education and TFR according to the Demographic and Health Surveys (DHS) data for 35 Sub-Saharan countries for various years (the majority of countries had more than one DHS carried out) (Figure 2).

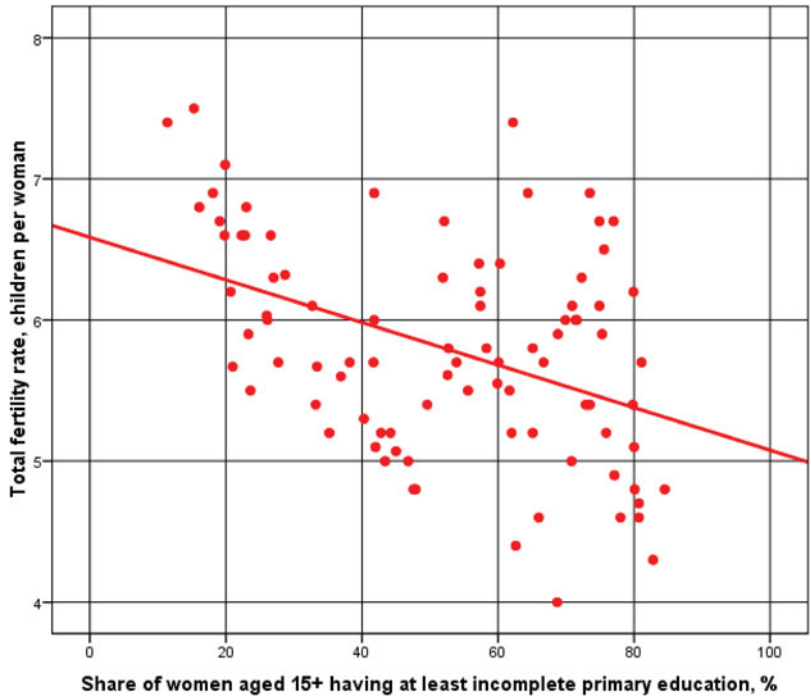

Figure 2. Correlation between the share of women aged 15+ having at least incomplete primary education and TFR in Tropical Africa (excluding countries of South Africa). Scatterplot with a fitted regression line. Data sources: see Appendix. $r = -.42$, $p < .001$.

Our analysis allows drawing an important conclusion: a simple elimination of female illiteracy (100% of women having at least a partial primary education) is utterly insufficient for bringing Sub-Saharan fertility rates down to the replacement level. Regression analysis reveals that if all Sub-Saharan women attain at least partial primary education (but with most of them remaining without secondary education), TFR is only likely to reach a level of slightly higher than 5 children per woman.

Now let us view the impact of secondary education dissemination upon fertility levels in SSA (Figure 3).

The correlation here is obviously much stronger than the one for primary education and TFR. Even more importantly, the regression analysis bears some clear-cut policy implications, as it indicates that at 70% of female population having at least incomplete secondary education the TFR in Sub-Saharan countries is likely to secure replacement level.

However, we should emphasize that this threshold cannot be achieved by simply bringing secondary net enrollment rates to 70%—which in itself is a complicated task to accomplish, achievable only with strong political will and substantial

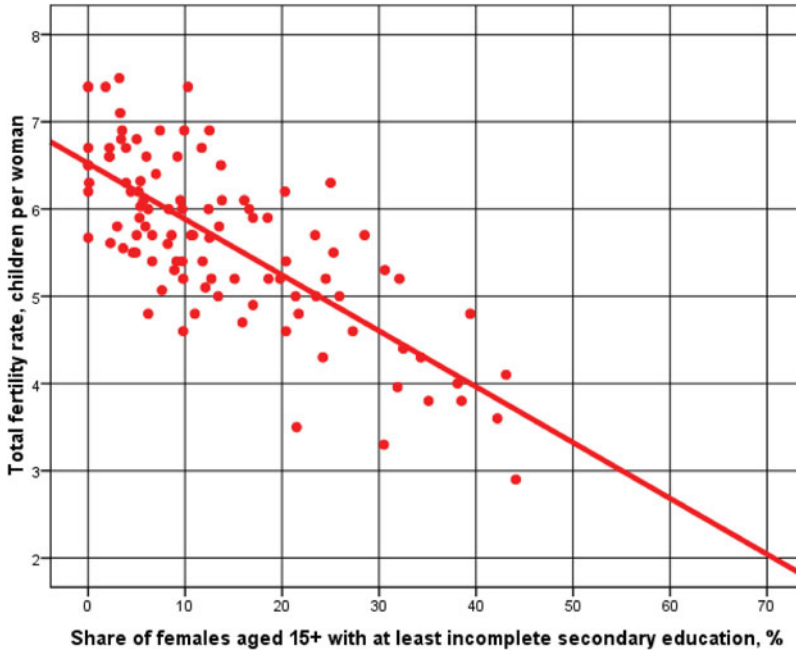

Figure 3. Correlation between proportion of females aged 15+ with at least incomplete secondary education and TFR in Sub-Saharan countries. Scatterplot with a fitted regression line. Data sources: see Appendix. $r = -.757$, $p < .001$.

financial resources. The main problem is that the majority of Sub-Saharan women in fertile ages not having secondary education are far out of the school age. Providing secondary education for, say, 70% of women aged 30+ seems to be an unrealistic scenario, and we cannot regard it seriously. Naturally, opportunities for adults to receive secondary education should be developed as well. However, the first and foremost way of increasing the proportion of women with secondary education is securing a 100% secondary school enrollment rate for all children of relevant ages, especially for girls. Thus, in order to prevent major sociopolitical catastrophes, Sub-Saharan countries should introduce universal compulsory secondary education as soon as possible.[2]

We now proceed to apply mathematical modeling methods to reveal the potential effect of various scenarios of increasing the proportion of women with at least incomplete secondary education upon fertility decline and population dynamics in Tanzania.[3]

Tanzania currently seems to be very close to achieving the Universal Primary Education MDG, with 98% primary net enrollment in 2008; however, its secondary net enrollment rate lags far behind. Yet, Tanzania had some remarkable recent achievements in this sphere as well. According to 2002 Census, only 5.3% of women and 9.8% of men aged 25 and more had secondary education. However,

Tanzania managed to double the secondary net enrollment rates both among girls (from 11.5 to 24.2%) and among boys (from 12 to 28.4%) during 2006–2010. This means that the secondary net enrollment growth rates equaled about 3% in Tanzania, much exceeding the median value for Sub-Saharan Africa, which was 0.8% during that period. Thanks to these rapid achievements, 14.5% of Tanzanian female population aged 15+ had some secondary education (according to our calculations on the basis of the latest DHS 2010 data).

Taking into account these recent trends, we can proceed to mathematical modeling in order to outline several scenarios of the Tanzanian demographic future depending on various scenarios of secondary education diffusion:

1. The "inertial" scenario forecasts the fertility (and population) dynamics if girls' net secondary enrollment continues to grow at the same rate (3% annually) as observed in recent years. This assumption is a rather optimistic one, as, first, secondary net enrollment in Tanzania has recently been increasing much (more than three times) faster than in the Sub-Saharan region in general and, second, as the absolute numbers of secondary school age cohort (14–19-year-olds) will invariably[4] rocket up in the coming years, even sustaining the 3% annual increase will mean a dramatic increase in the absolute number of secondary school pupils, which in its turn will require a significant increase in financial, administrative, and infrastructural resources allocated to secondary education in Tanzania.
2. The "pessimistic" scenario forecasts the fertility (and population) dynamics if girls' net secondary enrollment continues to grow, but at slower rates, closer to medium Sub-Saharan rates of about 1% increase annually. Once more, taking into account the inevitable dramatic increase in the absolute number of secondary school age cohort, this scenario seems very realistic,[5] if secondary education does not enter the list of top development priorities of the Tanzanian government and the world community.
3. The "optimistic" scenario, presumably less probable than the two previous ones, is still possible if secondary education becomes the first-level priority for Tanzanian government and the world community, and 100% secondary net enrollment rate is secured by 2020 (which means about a 10% increase annually).

Scenarios were modeled according to the following algorithm: First, we modeled the forecast dynamics of absolute population numbers and population age structure so as to duplicate the UN medium scenario (i.e., we based the forecast on the same age-specific fertility rates and life expectancy values as those used in the UN Population Division medium scenario forecast for Tanzania). However, for greater accuracy we used the age-specific fertility coefficients stated in 2010 DHS for the base modeling year (2010).

Second, we calculated the proportion of women with at least incomplete secondary education and higher for each 1-year age cohort starting from the 14-year-olds (i.e., what percent of 14-year-old girls has not less than partial secondary

education in a given year; the same for 15-year-olds, etc.). For all three scenarios the change in secondary net enrollment was set to start in 2014 (for 2011–2013 we took the increase in this indicator to be 3% annually, as in 2006–2010; in other words, the proportion of 14-year-old girls enrolling in secondary school increased by 3% annually).

As has been mentioned above, the first and foremost way of increasing the proportion of women with secondary education is securing a 100% secondary school enrollment rate for all children of relevant ages, especially for girls. Accordingly, when modeling each of the three scenarios we applied the annual increase in secondary enrollment as set in the scenario description, namely to the corresponding age cohort of girls (those aged from 14 to 19).

Thus, for 2014 the change in secondary enrollment at a rate set in the scenario (increase by 1%, 3%, or 10%) was applied only to the 14-year-old cohort, those entering secondary school in 2014. The values of net secondary enrollment for all other age cohorts were taken from the previous year unchanged (but, of course, shifted by 1 year of age upward, as each age cohort got 1 year older). For the next year, 2015, the change in secondary enrollment at a rate set in the scenario (increase by 1%, 3%, or 10%) was again applied only to the 14-year-old cohort; however, by 2015 the changes set in the scenario comprise both the 14-year-olds and the 15-year-olds (the 14-year-olds of the previous year). The values of net secondary enrollment for all other age cohorts were again taken from the previous year and shifted by 1 year of age upward. This algorithm was continued until the end of the forecast period (we chose the year 2100 for sake of forecast comparability with the UN Population Division "medium" scenario).

Taking into account the difference in secondary net enrollment increase rates set for our three different scenarios, 100% of 14-year-old girls will be entering secondary school by 2020 in the optimistic scenario (10% annual enrollment increase), by 2036 in the inertial scenario (3% annual enrollment increase), and only by 2080 in the pessimistic scenario (1% annual enrollment increase). Accordingly, 100% secondary enrollment for girls aged 14–19 will be achieved by 2025, 2041, and 2085, accordingly.

Having completed this stage of modeling, we obtained the values for proportion of women with at least incomplete secondary education and higher in each 1-year age cohort starting from 14-year-olds for each year until 2100. This allowed calculating the year when the share of women aged 15+ with at least incomplete secondary education is bound to reach 70%, which, as our correlation analysis has shown, appears to be the level necessary for fertility rates to be brought down to replacement level. According to the optimistic scenario, this 70% threshold will be reached by the early 2040s (2041); inertial scenario has it by the late 2040s (2049), while the pessimistic scenario has it much later, in the mid-2070s (2076).

At the next stage of modeling we used the obtained values of the proportions of female population aged 15+ with at least incomplete secondary education to calculate the forecasted TFR value for each year within the forecast diapason according to each of three scenarios. The calculations were made according to the equation obtained during the regression analysis (see above). The constant and coefficient values in the equation were calibrated to fit the Tanzanian case after the

equation was verified on the historical dynamics of fertility and education level in the country (data obtained from 2002 Population and Housing Census and a series of Demographic and Health Surveys). The calibrated equation is:

$$\mathrm{TFR} = 6.25 - 0.06\mathrm{S},$$

where TFR is the value of total fertility rate (children per woman) and S is the proportion of female population aged 15+ with at least incomplete secondary education.

We then substituted the values of the proportion of female population aged 15+ with at least partial secondary education into the equation (in order to obtain this value for each single year, we summed up absolute numbers of women with such level of education in each age cohort and then divided the total number of women aged 15+ in a given year[6] as stated in the UN Population Division forecast by this sum). For all scenarios we set 1.8 children per woman as the lowest fertility level, somewhat lower than the replacement level. This choice was made consciously, as after a period of extremely high fertility and explosive population growth it seems reasonable to aspire to stabilize fertility not at exactly the replacement level, but somewhat lower; otherwise, the risks related to the explosive population increase will persist for a longer time due to inertia and gained population momentum. This is supported by the experience of other developing countries (e.g., India).

Then for each TFR value in each year within the forecast time diapason we chose the corresponding age-specific fertility rates (the correspondence was mainly defined with the help of the UN Population Division medium scenario with necessary calibration). Finally, we used the obtained age-specific fertility rates to forecast the population dynamics according to each of the three scenarios (the population number for the base year, 2010, as well as forecasted life expectancy values and age-specific mortality rates were once more taken from the UN Population Division Scenario). The results of Tanzanian population dynamics forecast modeling for all three scenarios of secondary education diffusion are presented in Figure 4. UN medium scenario is also presented in Figure 4 for comparison.

Thus, according to all three scenarios, the projected value of Tanzanian population at the end point of the forecast time diapason (2100) appears to be lower than that according to the UN "medium" scenario. However, in all other aspects the three scenarios vary considerably. The "pessimistic" scenario (i.e., if girls' secondary net enrollment will grow only by 1% annually) generates the highest population dynamics, closest to the UN medium scenario (but still lower), with a population of 236 million in 2100. The divergence between these two scenarios becomes particularly obvious starting from the 2080s, as our scenario implies TFR stabilization at 1.8 children per woman as contrasted to 2.3–2.5 children per woman in the UN "medium" scenario.

If Tanzania follows the "inertial" or, even better, the "optimistic" scenario of increasing female secondary education, this will substantially decrease the risks of explosive population growth. According to the "inertial" scenario, the Tanzanian population will count 144 million in 2100, while in the "optimistic" scenario it will be 116 million (growth by 3.2 times and 2.6 times from the current number,

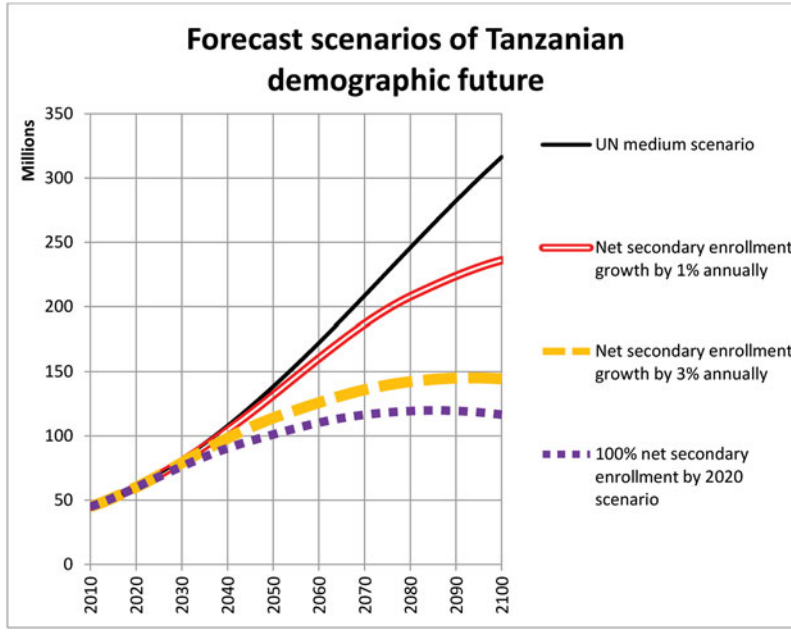

Figure 4. Forecast dynamics of Tanzanian population according to the optimistic, inertial, and pessimistic variant of female secondary education diffusion, compared to the UN Population Division "medium" scenario, until 2100.

accordingly), which is much lower than the values for both "pessimistic" and UN "medium" scenarios. However, even in the "optimistic" scenario the Tanzanian population will double in the next 30–35 years, which seems rather moderate compared to the population tripling forecasted for the same period by the UN "medium" scenario, but in reality population doubling will present tremendous pressure on the economy and both urban and rural infrastructure and bear high risks of increased sociopolitical tensions and destabilization.

This means that making secondary education its top development priority is an indispensable, but insufficient, condition for Tanzania to avoid the risks of major sociopolitical destabilization and violent conflicts caused by rocketing demographic pressure. Even if Tanzania follows the "optimistic" scenario and secures 100% secondary net enrollment of 14-year-old girls from 2020 onward, it is necessary to simultaneously introduce parallel measures aimed at bringing down the fertility rates, such as large-scale campaigns aimed at popularizing and increasing access to modern family planning methods with particular accent on outreach to rural areas. In order to estimate the possible cumulative effect of fast increase in girls' secondary net enrollment and large-scale family planning campaigns we modeled one more population dynamics scenario based on the maximum fertility decline rates achievable—these were taken from the fertility dynamics of Iran,

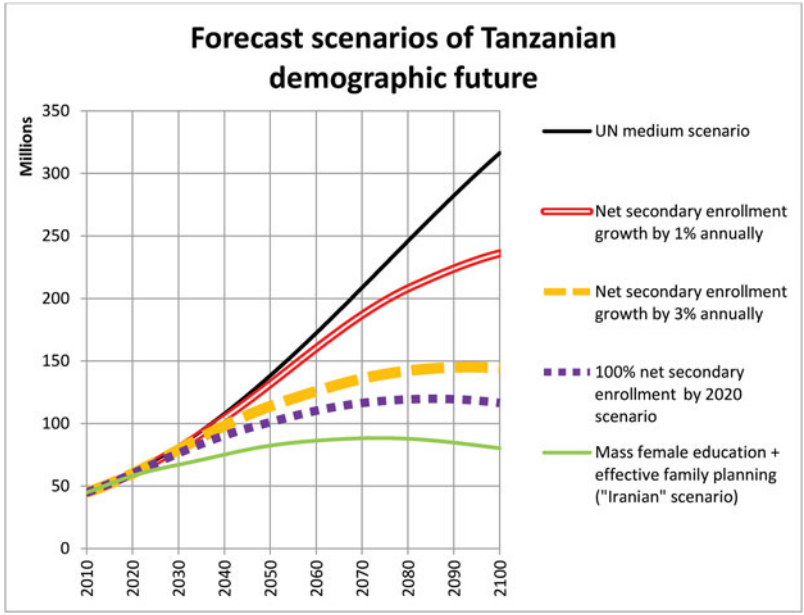

Figure 5. Forecast dynamics of Tanzanian population according to the optimistic, inertial, and pessimistic variant of female secondary education diffusion, compared to the "Iranian" scenario and to UN Population Division "medium" scenario, until 2100.

the country with record fertility decline rates (from 5.6, close to modern Tanzanian TFR, to 2 children per woman in less than 20 years). Modeling results are presented in Figure 5 along with the previous scenarios.

Figure 5 reveals that the "Iranian" scenario allows the prevention of explosive population growth in Tanzania much more effectively than the other four scenarios. Indeed, if Tanzania manages to achieve Iranian rates of fertility decline in the next 20 years, its population will equal 80–85 million by mid-century and stabilize at this relatively safe level, close to what the UN predicted for Tanzania in 2000, before the decade-long fertility stall at higher than 5 children per woman occurred in this country.

However, in order to achieve that, it is necessary to simultaneously introduce measures aimed at securing 100% secondary net enrollment for girls and other effective fertility-inhibiting measures, such as large-scale campaigns aimed at popularizing and increasing access to modern family planning methods with particular accent on outreach to rural areas. Such campaigns have first proved highly effective in Bangladesh and have since been applied in numerous developing countries (Phillips et al. 1982; Bongaarts and Sinding 2009), including the most recent highly successful experience of Rwanda, where such a state-level campaign helped to bring fertility down from 6.1 children in 2005 to 4.6 in 2011 (data from

ICF International 2012; for more detail on the Rwandan case please see Westoff 2013).

CONCLUSION AND POLICY IMPLICATIONS

Our article has shown that in order for the 1977 "Goals for Mankind" to be finally fulfilled in Tropical Africa, it is crucial to pay urgent attention to the extremely important factor of population growth. Explosive population growth in Africa in the nearest decades is the already unavoidable result of the region's laggardness in fertility transition and the recent decade (or more)-long fertility stall in a great number of African countries. This factor tends to be frequently omitted from development forecasts, although it will invariably have dramatic impact on African development prospects, bearing significant risks of Malthusian scenarios for the emergence of sociopolitical destabilization, outbreak of violent conflicts, and even state collapses. The policy implications emerging at this point reveal the obvious necessity for the introduction of urgent and highly effective measures aimed at bringing down the population growth rates, which should be achieved first and foremost through significantly accelerating the fertility decline. Both the existing literature and our own regression analyses support the idea that the fundamental way to decrease fertility rates is related to increasing female education levels; the results of our modeling have shown that for the TFR in Tropical African countries to go down to the replacement level, it is required to secure that 70% of the female population aged 15+ has an at least a partial secondary education. The only reliable way to achieve this highly ambitious, but vitally important, goal is to introduce compulsory secondary education for all school-aged children. However, when modeling various scenarios of achieving 100% secondary net enrollment for girls in Tanzania, we came to conclude that this is a necessary, but insufficient, condition for accelerating fertility decline so as to avoid explosive population growth. Indeed, the diffusion of secondary education is in its essence a fundamental strategic measure with long-term effect[7]; however, the UN forecasts clearly reveal the necessity to significantly decrease the population growth rates in the nearest future. The experience of other countries, such as Iran, states that decreasing fertility from higher than 5 children per woman to about replacement-level in approximately two decades is possible. Following this path would help to effectively prevent the catastrophic scenarios related to rocketing population growth and Malthusian causes in Tropical Africa, but it requires not only introducing compulsory secondary education, but also carrying out large-scale campaigns aimed at popularizing and increasing access to modern family planning methods with particular accent on outreach to rural areas. The combination of strategic long-term measures (universal compulsory secondary education) and tactical shorter-term measures (massive family planning promotion) will be costly. However, mathematical modeling of Sub-Saharan Africa's demographic future proves it to be the only way for many countries to avoid major sociopolitical disasters in the future.

NOTES

1. Undoubtedly, we should note here that PricewaterhouseCoopers made their forecasts using the old series on UN population forecasts, which still did not account for the large-scale fertility stall and looked much less ominous (Figure 1).
2. Let us remind the reader that the introduction of compulsory secondary education invariably implies the presence of universal compulsory primary education, so the majority of Sub-Saharan countries, especially the most lagged behind ones, will have to solve these tasks simultaneously.
3. Currently the system of school education in Tanzania has the following structure: 7 years of primary education (ages 7–13) are followed by 4 years of secondary ordinary (ages 14–17) and 2 years of secondary advanced (ages 18–19).
4. As all the children that will enter this cohort in the nearest decade and a half are already born, so the growth is inevitable.
5. Indeed, taking into account the secondary school age cohort is bound to approximately double in the next 20 years (as in 2010 the number of children aged 0–4 was almost twice as large as the 15–19 cohort, 8.0 and 4.7 mln accordingly), the scenario implying a slowed-down but still continuing growth of secondary net enrollment should be called not a pessimistic, but a medium one, as the most pessimistic scenario would imply the government completely failing to keep secondary schooling up with the rocketing number of potential pupils, which would result in a decrease in secondary net enrollment, a decrease in the proportion of female population aged 15+ with at least incomplete secondary education, and would eventually dramatically handicap the fertility decline, greatly increasing the probability of all the explosive population growth-related risks listed above.
6. We should specify here that this algorithm tends to somewhat underestimate the decreasing effect of secondary education upon population growth in all three scenarios. Indeed, when calculating the proportion of women with a given level of education we use the UN medium values for the total number of women of the given age in a given year. However, as secondary education spreads and fertility declines, the number of children of the first generation with 100% secondary et enrollment will be substantially lower than that forecasted by the UN medium scenario; accordingly, when these children, especially girls, grow up, they will make a less numerous fertile age cohorts than the UN forecast indicates. This divergence will become more visible by the end of the forecast time diapason. However, at this stage we took this underestimation of educational effect as tolerable in order not to overcomplicate the model for the test case.
7. Indeed, mass effect of introducing compulsory secondary schooling on fertility will become visible only after 8 to 10 years, as more women who have acquired secondary education enter their fertile ages.

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APPENDIX

Sources of data used for correlation/regression analyses and the construction of scatterplots 2 and 3.

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