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LINKING THE EARTH'S FUTURE TO MIGRATION

Scenarios of environmental change and possible impacts on forced migration

Johannes Frühmann[1] and Jill Jäger[1]
1. Sustainable Europe Research Institute, Vienna, Austria

ABSTRACT: Environmental change has various effects on livelihoods and may force people to migrate. Several case studies are carried out within the EACH-FOR project to investigate the contribution of natural degradation to migration flows. Hotspots of environmental degradation have been identified in more than 20 countries and regions worldwide ranging from desertification to sea level rise and from natural disasters to industrial pollution. The paper summarizes the hotspots and their characteristics and discusses scenarios that have been developed for some selected countries/regions. The scenarios are based on the GEO-4 narratives and downscaled to the specific level of each case study to investigate possible changes in the environment and impacts on forced migration flows within a time frame of 2050.

Key Words: Scenarios, Environment, Global Change, Migration.

1. INTRODUCTION

This paper discusses how to use scenarios of environmental change to estimate future migration flows that are forced by environmental degradation. The methodology as well as the examples presented in this paper were developed in the EU-funded project EACH-FOR (www.each-for.eu). The EACH-FOR project investigates the linkage between environmental degradation and forced migration in various case studies worldwide. It aims to better understand the linkages and to provide scenarios of migration flows towards the EU that might be caused by environmental change. This paper focuses on the task of linking scenarios of environmental change to possible migration patterns.

In the next section the paper discusses environmental degradation. and gives an overview of the 'hot spots' in the case studies. This section is followed by an introduction in to scenarios in general and the scenario narratives of GEO 4 and IPCC/SRES which were used within the EACH-FOR project. The fourth section gives a detailed description of the EACH-FOR approach – including two case study examples from Egypt and Mozambique. The paper finishes with conclusions that sum up the first results of the work with scenarios in the case studies and reflect the approach taken in the EACH-FOR project.

2. HOT SPOTS OF ENVIRONMENTAL DEGRADATION

2.1 Environmental degradation

Environmental degradation is the deterioration of the environment through depletion of resources such as air, water and soil; the destruction of ecosystems and the extinction of species. UNEP's Global

Environmental Outlook, published in October 2007 (www.unep.org/geo4), concludes that there is evidence of unprecedented environmental change at global and regional levels. These changes include the warming of the Earth's surface with associated changes in water availability, melting of snow and ice, rising global-average sea-level and loss of biodiversity. Unsustainable land use and climate change are driving land degradation including soil erosion, nutrient depletion, water scarcity, salinity, desertification, and the disruption of biological cycles. The per-capita availability of freshwater is declining globally and contaminated water remains the greatest single environmental cause of human sickness and death. Aquatic ecosystems continue to be heavily exploited with a large-scale decline in fish catches. While air pollution has been controlled in some areas, it continues to increase in many cities and indoor air pollution due to the improper burning of solid biomass fuels continues to impose an enormous health burden.

2.2 Case studies

For the EACH FOR project a series of case studies is being carried out in order to explore the links between environmental degradation and migration. As a first step, the main types of environmental degradation or environmental stress in each of the case study areas were identified.
A survey of the case studies suggests four general patterns of environmental change to be explored in terms of potential impacts on migration. First, many of the case study areas discuss natural disasters, in particular floods and droughts. The Fourth Assessment Report of the Intergovernmental Panel on Climate Change (Working Group 2) notes that confidence has increased that some extreme weather events will become more frequent, more intense and more widespread in the 21st Century. This has implications for migration. Secondly, almost all of the case studies mention land degradation and/or desertification. These are slow processes resulting from a number of causes including poor soil management, over-fertilization, over-withdrawal of groundwater, and removal of protective vegetation cover, as well as climatic change. As GEO – 4 (UNEP, 2007) notes, poor people suffer disproportionately from the effects of land degradation, especially in the drylands, which support some 2 billion people. Thirdly, two of the case studies focus on sea-level rise. The IPCC notes that coastal zones are likely to be exposed to increasing risks including coastal erosion due to climate change and sea-level rise. Furthermore, the IPCC states that "Many millions more people are projected to be flooded every year due to sea-level rise by the 2080s." (IPCC 2008, p. 7). Fourthly, two of the cases focus on forced migration as a result of dam-building projects. The driving factors behind such projects often have an environmental origin when the dams are built in order to provide irrigation water for irrigation.

In addition to exploring possible current links between environmental degradation, natural hazards and development projects and forced migration, it is of interest to discuss how these links and their consequences could evolve in the future. This can be done using scenarios.

3. SCENARIOS

3.1 What is a scenario?

A scenario is not a prediction of what the future will be. Rather it is a description about how the future might unfold. Scenarios explore the possible, not just the probable and challenge their users to think beyond conventional wisdom.

Scenarios are carefully created stories about the future. They include an interpretation of the present, a vision of the future and an internally consistent account of the path from the present to various futures. Scenarios support informed action by providing insights into the scope of the possible. They also can illustrate the role of human activities in shaping the future and the links among issues. In the process of helping to clarify possible future developments and their effects, scenarios often are a source of inspiration for creative ideas. Jäger et al. (2008) describe the development and use of scenarios in integrated environmental assessments.

3.2 The GEO4 scenarios

Under *Markets First* the private sector widens its influence into previous governmental areas (i.e. privatization of education, security, research, health and other social services) together with a continued movement towards free trade and the commoditization of nature. International trade accelerates although no global free trade zone is achieved. Existing regional agreements are strengthened and new South-South cooperations emerge. Formal environmental protection is limited by efforts to increase economic investment and expand trade. The Kyoto Protocol sees no significant international follow up after 2012. Ecosystem services are turned into commodities. The economic exchange of goods like water, genetic material, knowledge and culture increase dramatically. Terrestrial and marine biodiversity decreases. Agriculture is intensified in all regions, which increases the potential of soil degradation. This could lead to problems especially in Latin America, the Caribbean and Africa where the intensification is not accompanied by a net reduction in cropland. Water use efficiency increases in most regions (due to privatization and better technologies), but the number of people living with severe water stress grows significantly because of growing populations and climate change (UNEP 2007).

Security First can be also described as 'Me First' and brings a fairly narrow notion of security that implies increased limits on how people live, both physically and physiologically. Restrictions on migration reduce the movement of people and trade barriers that of goods. Governments are strong in decision making, but multinational corporations and private interests increase their influence. The authority of international institutions declines and public participation gets marginalized. Total energy use increases significantly while energy efficiency slowly improves. A dramatic resurgence in the use of coal results in strongly rising levels of atmospheric CO_2. The combination of climate change, growing populations and greater economic activity strains freshwater resources (both quantity and quality) and brings a dramatic increase of people facing severe water stress; conflicts on shared resources result. Both terrestrial and marine biodiversity are under great pressure (UNEP 2007).

The *Policy First* scenario is a highly centralized approach with a move to a more holistic government balancing economic growth with social and environmental issues. National governments and international organizations (e.g. United Nations) lead in those efforts. Subsidies that encourage the overexploitation of resources are reduced or eliminated. Public investments in science and technology grow and the number of protected areas increases with more or less effective efforts in preventing land-use change in these areas. International agreements increase energy efficiency and induce a move to more low carbon and renewable sources (i.e. biofuels). But: Total energy consumption continues to increase. The higher demand for biofuels results in a significant increase in land devoted to pasture and a decrease of forest land. Growing populations and economic activities still put pressure on resources, particularly in developing regions. The number of people living under severe water stress continues to rise, but institutional efforts to better share resources help to limit the impacts. The increased demand, however, places a strain for on the quality of water resources. The loss of biodiversity is dramatic, mainly due to climate change and agriculture (UNEP 2007).

In *Sustainability First* actors from all levels (local/national/regional/international) and from all sectors (government/civil/private) address environmental and social concerns. The rules of international trade are reformed and public resources are shifted from military to social and environmental issues. Climate change remains a persistent problem. Even though the growth in the level of CO_2 is limited, it is not possible to avoid potentially significant warming and sea level rise. In the energy sector total energy use increases, but the mix of fuels change significantly with wind, solar and modern biofuels becoming an important fraction beside natural gas as the dominant source. The expansion of agricultural land comes at the expense of forest land, but the loss of the latter slows significantly over time. The growth of water stress is reduced, but some regions still face increasing problems, both with quantity and quality. Efforts to reduce biodiversity loss are high, but the challenges are strong and there is significant species loss in some areas (UNEP 2007).

3.3 The IPCC scenarios

IPCC used narrative storylines for the development of quantitative scenarios, i.e. climate projections. The narratives describe the relationships between the drivers of greenhouse gas (GHG) and aerosol emissions and their development until 2100. The storylines were written for large world regions and a global scale and differ in demographic, social, economic, technological, and environmental lines of development that result in different levels of GHG emissions. Furthermore, the storylines assume that no specific climate policies are implemented, and thus form a baseline against which narratives with specific mitigation and adaptation measures (as the GEO 4 narratives) can be compared.

Basically the IPCC storylines differ along two axes: Global vs. regional and economic vs. environmental emphasis. The A1/B1 narratives are more global, whereas the A2/B2 narratives are more regionally orientated; The A1/A2 have more economic emphasis, while the B1/B2 have more environmental emphasis. More details to differentiate the narratives are given in Table 1.

	A1b	A2	B1	B2
World	Market-orientated	Differentiated	Convergent	Local solutions
Economy	Fastest per capita growth	Regionally oriented; lowest per capita growth	Service & information based; lower growth than A1	Intermediate growth
Population	2050 peak; then decline	Continuously increasing	2050 peak; then decline	Continuously increasing at lower rate than A2
Governance	Strong regional interactions; income convergence	Self-reliance with preservation of local identities	Global solutions to economic, social and environmental sustainability	Local and regional solutions to environmental protection and social equity
Technology	Balanced across all (energy) sources	Slowest and most fragmented development	Clean and resource-efficient	More rapid than A2; less rapid & more diverse than A1/B1

Table 1: Summery characteristics of the SRES storylines used in the IPCC scenarios (according to Carter et.al. 2007)

3.4 Linking different scenarios

The distinction between global/regional and economic/environmental makes it quite easy to relate the GEO 4 narratives to the IPCC narratives (Figure 1). The combination of different scenarios offers more insights into possible future developments. For the work of the EACH-FOR project the IPCC climate projections offer detailed information on changes in temperature and rainfall patterns. This is an important addition to the GEO 4 scenarios – especially in case studies focused on desertification and/or water shortage.

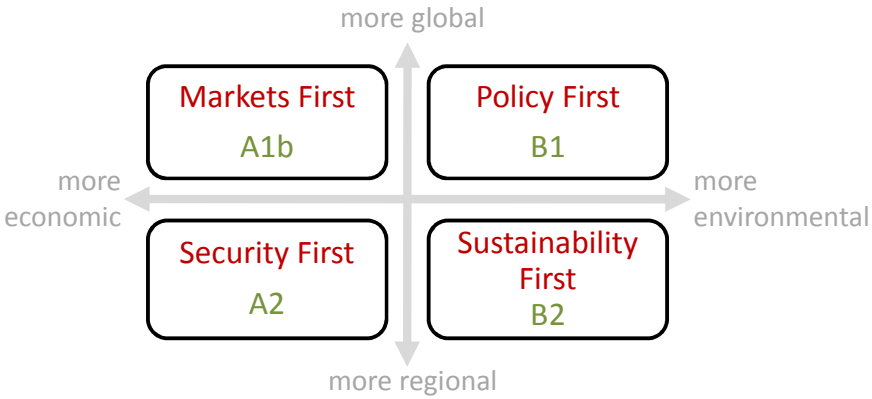

Figure 1: Linking narratives from GEO 4 and IPCC

4. THE EACH-FOR APPROACH

4.1 Methodology

Environmental degradation and migration patterns differ from region to region. Therefore, the methodological approach of the EACH-FOR project is designed to be as flexible as possible and geographically based to be able to tackle the (regionally or locally) different research questions. In total there are 23 case studies.

The EACH-FOR project is carried out in four steps: In the first step general overview studies were conducted to describe the existing situation regarding environmental problems and migration for each region and each case study. In the second step the field work in the case studies was carried out. The third step contains the work on forced migration scenarios (described in detail below), before in the last step key findings for policy makers can be formulated.

In order to generate scenarios for environmentally forced migration, we followed a three step approach:

(1) Develop 'scenario input papers' on environmental degradation for nine selected case studies
(2) Consortium partners that carried out the case studies amend specific information on migration and develop environmental-migration scenarios
(3) Discuss these results with local experts in each case study to refine the scenarios

The 'scenario input papers' have been developed with a consistent outline to generate local scenarios that are comparable. They are based on the scenarios of GEO 4 and IPCC and other relevant studies with a regional or local focus and take a multi-level approach. The papers start with the global perspective of the GEO 4 narratives, where two contrasting storylines are selected; one of the pair Markets First / Security First and one from Policy First / Sustainability First. For the regional level the implications of the two storylines with emphasis on the significant hot spots of the case study are developed. The national level is then covered by a set of indicators (see Table 2) derived from International Futures (IFs 2008). The indicators show divergent developments under different scenarios and are interpreted according to the focus of each case study. The IPCC climate projections are added on the regional level to show changes in temperature and rainfall patterns. Finally, other studies that contain relevant scenarios for the case study area are included in the input papers (e.g. the African Environment Outlook 2 (UNEP 2006), reports from the Environment and Security Initiative (ENVSEC 2008) and others).

Indicator	Unit
Yield	tons per hectares

GDP per capita at PPP	Thousand $
Land (forest cover)	Million Hectare
Water usage, annual	Cubic Km
Aid (foreign), net	Billion $
Population	Million People
Life expectancy	Years
Malnourished children	Percent
Physical quality of life index	Index (max. 100)

Table 2: Set of Indicators used from International Futures.

Each 'scenario input paper' is then complemented by the consortium partner that led the case study. Often this is done in cooperation with local scientists in the case study area that supported the field work. This process aims to relate the specific information on migration to the scenarios and results in integrated environmental-migration scenarios.

Those scenarios can then be discussed with local experts – preferably in a workshop setting – for further refinement of the scenarios. However, this step is expensive and time consuming and often not possible within the limited budget, time and structure of the EACH-FOR project.

4.2 Example 1: Mozambique

4.2.1 Brief introduction to the case study area

Mozambique is located in southeastern Africa with a 2500 km long coastline along the Indian Ocean, between South Africa and Tanzania. About 20 million people live in the country that covers an area of 800 000 km². The climate varies from tropical and subtropical in the north to semiarid and dry in the south. Temperatures are hot and the average annual precipitation is 1032mm with a rainy season from October to April. Variations in rainfall range from 2000mm in the north and central regions to less than 400mm in the southern inland (FAO 2007). For further details see UNU-EHS (2008).

The hot spots of environmental degradation we focused on were floods and droughts. For example, in 2000 the Limpopo river swelled up to 80km wide and caused a huge flood for more than 3 months that affected 4.5 million people and destroyed their livelihoods, seed reserves and crop fields. After a smaller flood event in 2003, the latest flood of the Zambezi river in 2007 affected 500,000 people when six major cyclones hit the country.

4.2.2 Scenarios

For this case study we decided to use the Markets First and Policy First scenarios. In both scenarios the increasing population is an important driver. Under Markets First an intensified and profit-driven agriculture comes along with unsustainable practices and leads to severe land degradation. Privatization and amalgamation of sectors improves human development, but trade-offs from globalization and limited efforts in environmental issues show negative impacts. In Policy First regional integration and policies with economic and environmental stewardship are guided by the regulatory frameworks of NEPAD and the African Ministerial Conference on the Environment and help reaching environmental and human development goals.

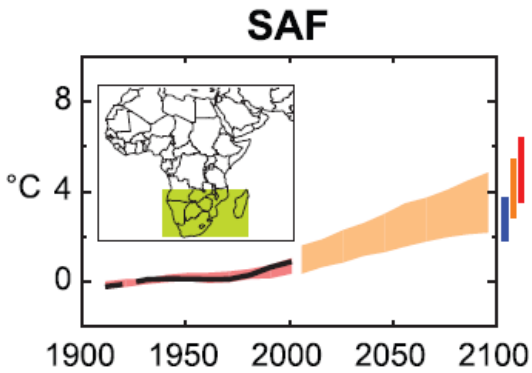

Figure 2: Temperature anomalies with respect to 1901 to 1950 for South Africa for 1906 to2005 (black line) and as simulated (red envelope); and as projected for 2001 to 2100 by MMD models for the A1B scenario (orange envelope). The bars at the end of the orange envelope represent the range of projected changes for 2091 to 2100 for the B1 scenario (blue / left), the A1B scenario (orange / middle) and the A2 scenario (red / right). (Christensen et al. 2007)

According to the IPCC scenarios the potential of (summer) floods and (winter) droughts rises significantly – especially under the A1b narrative. The median temperature increase for the A1b scenario is about 1,5 times higher than the global mean response. As shown in Figure 2 the temperature rise is significantly higher under Market First (= A 1b) conditions by 2100. Precipitation decreases slightly – at least in the A1b scenario as displayed in Figure 3. The main changes in precipitation occur in the dry season which has minor effects on the overall water resources but could lead to more droughts - especially in combination with the increase of the frequency of dry austral winters to about 20%. At the same time the frequency of extremely wet summers will double in southern Africa (Christensen et. al. 2007).

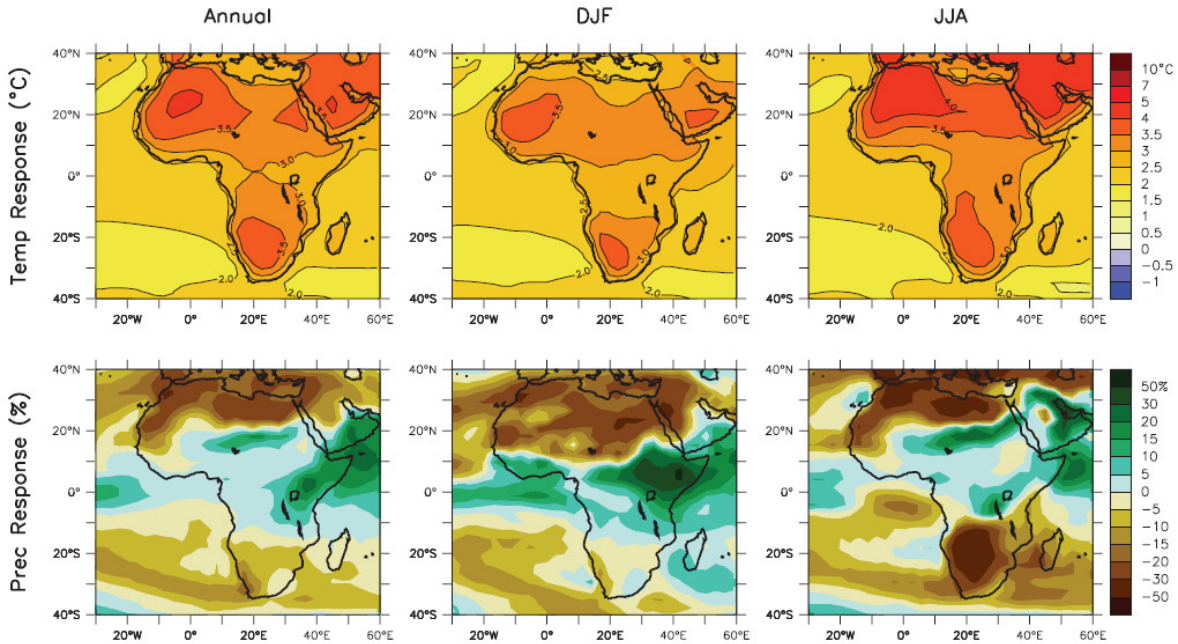

Figure 3: Temperature and precipitation changes over Africa from simulations of the A1b scenario. Top row: Annual mean, December/January/February and Juli/June/August temperature change between 1980 to 1999 and 2080 to 2099, averaged over 21 models. Bottom row: same as top, but for fractional change in precipitation. (Christensen et al. 2007)

On the national level the IFs indicators show similar trends under both scenarios, though there are some important differences. Agriculture yields rise more under Markets First, but the slower increase of population almost compensates the lower food productivity in Policy First (Figure 4). Under the projection

of increasing frequency and intensity of extreme weather events in combination with the high vulnerability of the local population, another indicator becomes crucial: Foreign Aid (Figure 5). Mozambique's ability to cope with floods and droughts will probably depend on financial support from outside and this support is significantly higher in a Policy First world.

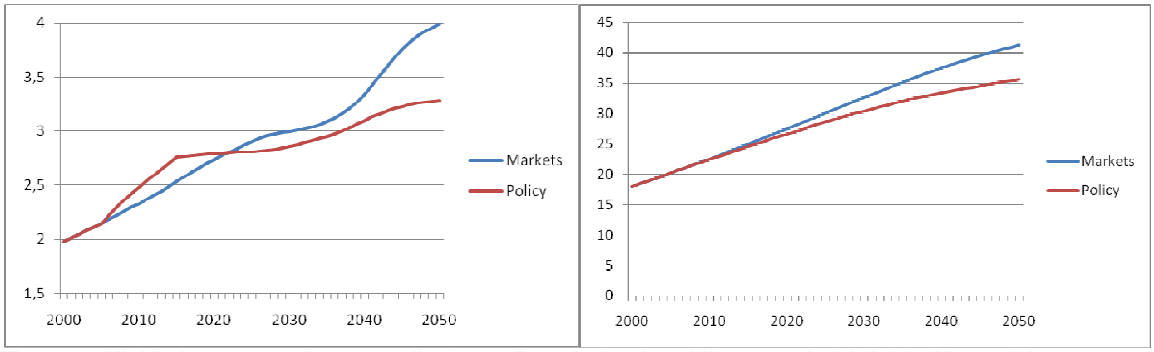

Figure 4: Yields in tons per hectares (left) and Population in million people (right) in Mozambique. (figures derived from data from IFs 2008)

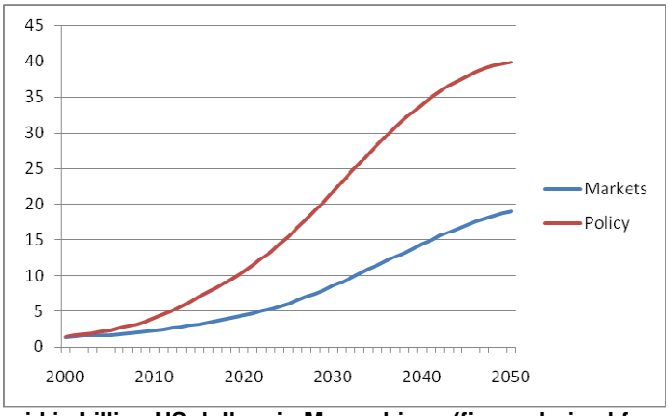

Figure 5: Net foreign aid in billion US dollars in Mozambique (figure derived from data from IFs 2008)

4.3 Example 2: Egypt

4.3.1 Brief Introduction to the case study

Egypt lies in the very northeast of Africa with an area of 1 million km² and about 80 million inhabitants. Hot dry summers and moderate winters with very low annual rainfall (ranging from 200mm in north to almost zero in the south) characterize the desert type of climate. As the main source of freshwater, the Nile River is "the lifeblood of Egypt" (EIA 2003). The river also contributes about 20% of the country's energy and is important for transportation. Egypt's development was and still is strongly related to the Nile River (ERASMUS 2008). Egypt in regard to development and migration is of special interest to the EU because of its close geographical position.

Water shortage and desertification are big issues today, but in the next decades sea level rise could become the biggest challenge. The Nile delta is especially vulnerable, because it is the most important agricultural land of the country and highly populated, but lies widely below the mean sea level.

4.3.2 Scenarios

In the Egypt case we compared the Security First and Policy First scenarios. Security First is – especially in Africa – characterized by poor economic policies that lead to overexploitation of water, land and mineral resources. In contrast, responsibility for social equity and the environment is taken in the Policy First scenario and regional integration is strengthened. Population increases significantly more in the

Security First scenario, while the GDP per capita increases much less than in Policy First. This leads to only a small decline in the population with income less than 1 US$ per day and a slightly increasing level of childhood nutrition by 2050.

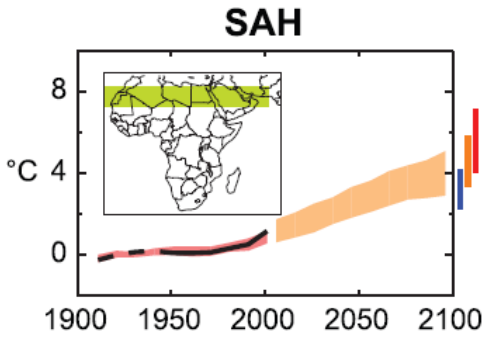

Figure 6: Temperature anomalies with respect to 1901 to 1950 for North Africa for 1906 to2005 (black line) and as simulated (red envelope); and as projected for 2001 to 2100 by MMD models for the A1B scenario (orange envelope). The bars at the end of the orange envelope represent the range of projected changes for 2091 to 2100 for the B1 scenario (blue / left), the A1B scenario (orange / middle) and the A2 scenario (red / right). (Christensen et al. 2007)

Figure 6 shows big differences between the A2 (Security First) and B1 (Policy First) scenarios in the Saharan region. Under A2 conditions the mean temperature rises at least 4°C that is about the maximum temperature anomaly in the B1 (Policy First) world in 2100. The maximum rise in A2 could even reach 7°C. Figure 3 shows that the main temperature rise takes place in the already hot summer months. Furthermore, Egypt faces a dramatic drying of about 20% in 2100 especially in its northern parts – which comes along with a drying pattern in the whole Mediterranean region. But a differentiated look at the precipitation maps shows that the Nile basin is not affected by the drying pattern at all, but it remains unsure if this increases the water resources of Egypt. Even though the maps in Figure 3 are based on the A1b scenario, we can estimate that the effects shown will be somewhere between A2 (probably more extreme) and B1 (probably less dramatic).

On the national level both scenarios show very similar trends, both paths bring a better overall quality of life for Egypt. But, for all indicators, Policy First conditions bring more improvements – for some indicators the differences are large. For example, foreign aid increases much more in a Policy First world – as also found for Mozambique.

Figure 7 shows two more examples: The fast rising food productivity under Policy First can cope with the increasing population, probably even increase food exports towards the EU and supports the growth of GDP. However, it also increases the risk of human-induced land degradation and could lead to environmental problems. From this perspective also the New Valley Project and other plans to pipe water to desert areas for creating agricultural land have to be seen critically. According to IPCC reports (Boko et al. 2007) Egypt is one of the most vulnerable African countries to climate change, because of its impact on water availability. Already in 2000 water use exceeded the available resources. So the IPCC report estimates that temperature rises will be likely to reduce the productivity of major crops and increase their water requirements, thereby directly decreasing crop water-use efficiency. At the same time water stress in all sectors will increase due to the population increase. There is a high degree of uncertainty about the flow of the Nile and the ongoing expansion of irrigated areas will reduce the capacity of Egypt to cope with future fluctuations.

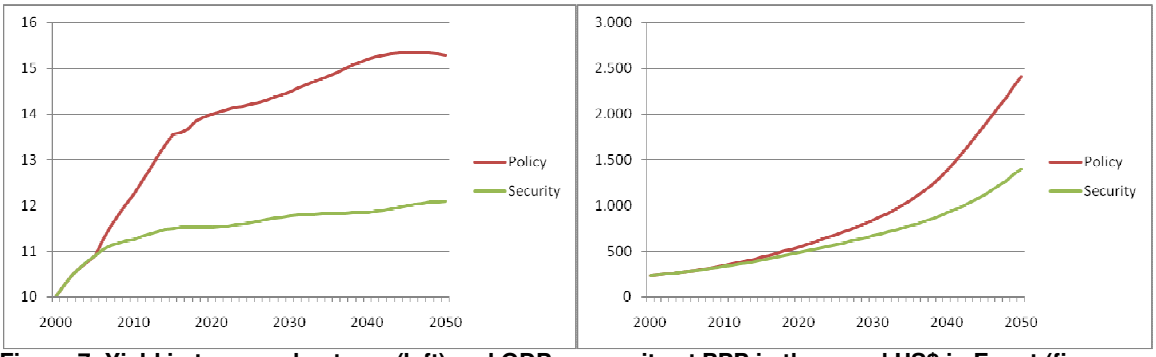

Figure 7: Yield in tons per hectares (left) and GDP per capita at PPP in thousand US$ in Egypt (figures derived from data from IFs 2008)

However, the possibly biggest future challenge for Egypt is sea level rise – especially for the Nile Delta. According to the first results of the field work, even local experts are not always conscious about this risk. IPCC reports (Bindoff et al. 2007) project that the global sea level by the mid-2090s reaches 0.22 to 0.44 m above 1990 levels, and is rising at about 4 mm per year under the A1B scenario. The Nile Delta is especially sensitive, because most of a 50 km wide land strip along the coast is less than 2 m above sea level and is protected from flooding by a 1 to 10 km wide coastal sand belt only, shaped by discharge of the Rosetta and Damietta branches of the Nile. In recent years erosion of the protective sand belt is a serious problem and has accelerated since the construction of the Aswan Dam (UNEP 2002). Figure 8 shows possible impacts of 0,5m and 1,0m sea level rise scenarios.

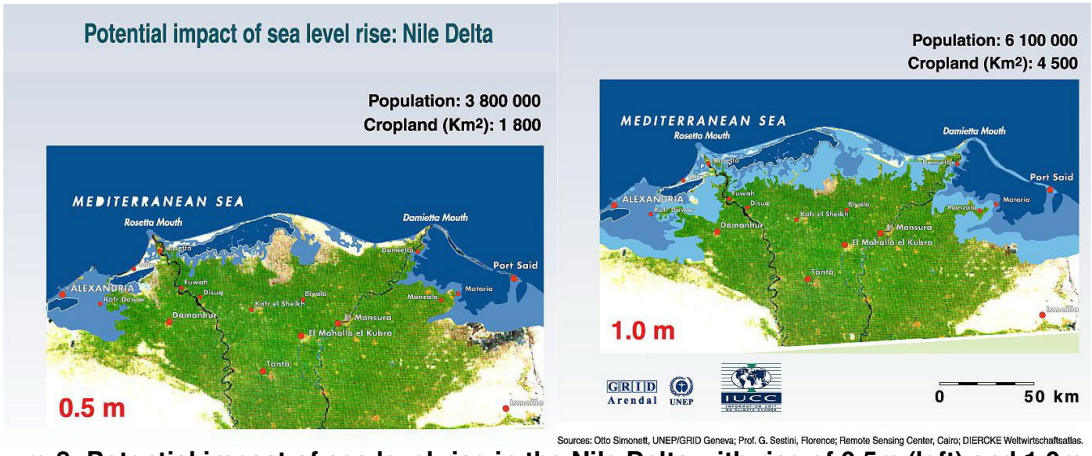

Figure 8: Potential impact of sea level rise in the Nile Delta with rise of 0,5m (left) and 1,0m (right) (UNEP 2002)

5. CONCLUSIONS

For the case studies in the EACH-FOR project, floods and droughts, land degradation and sea-level rise are the main environmental forcing factors for migration. In addition, migration results from large scale development projects and two EACH-FOR case studies examine the effects of building large dams on rivers. The question that we have addressed here is: How could the environmental, economic and social patterns look in the future? We have used scenarios developed for UNEP's Global Environmental Outlook as well as those developed by the IPCC and, where relevant these have been supplemented by other scenarios. This paper provides examples of scenarios for two of the EACH-FOR case studies: Mozambique and Egypt. For Mozambique we compare the *Markets First* world with the *Policy First* world. In *Markets First* Mozambique experiences significant warming and an increase of winter droughts. The temperature increase is not as high in the *Policy First* scenario. An important difference between the two scenarios is the availability of foreign aid, which is significantly higher in the *Policy First* scenario. The

larger climatic changes and lower availability of foreign aid suggest that there would be more migration in the case of the *Markets First* scenario. For Egypt we compare the *Policy First* and *Security First* scenarios. Again there are important differences between the scenarios. For example the agricultural yield is around 25% higher in the *Policy First* scenario. However, the biggest future challenge for Egypt could be sea level rise – especially for the Nile Delta.

The examples shown here show how plausible stories about the future can be developed for case study regions. The scenario descriptions do not, however, include estimates of migration rates. The latter need to be derived with the help of local experts. The next step would therefore be to use expert workshops and discuss the scenario narratives, asking the question: What would happen to migration in Scenario A versus Scenario B? The expert input would be used to refine the narratives and provide some quantification of the level of migration. Further the scenarios can be used in the discussion of policy options. On the one hand they illustrate in broad terms the differences, say, between taking a "markets-based" approach versus an "environmental protection-based" approach. On the other hand the scenarios can be used to guide discussions on "What kind of a future do we want?" and "What do we need, in order to reach that future?".

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