International demographic trends and environmental services

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Summary

The aim of this paper is to enquire in demographic processes expected to have an impact on the future development of the environment. The relationship between the recent global demographic change and the environment is conceptualized at a micro-level by using the concept of environmental services. Important demographic processes modifying the demand of environmental services at a local (ecosystem-based) level are, at first instance, the growth of the global population and the increase of the population density as well as the regional redistribution of population concentration by migration or by differential rates of natural population growth, both resulting in a rising demand of e.g. food and natural resources leading to an increased environmental stress. Furthermore, the ageing of the population will have an impact on the traditional agricultural patterns and spatial effects of economic activities. Finally, the urbanization and suburbanization will change the traditional land use in the affected regions and modify local ecosystems. Due to the lack of micro-level data at a global scale, all demographic patterns to be investigated can only be analysed at a macro-level by using aggregated variables. The paper describes the availability of global demographic data and the theoretical background of recent population projections made by the UN Population Division. In addition, the limits of demographic projections will be discussed. The main part of the paper presents selective quantitative results of the UN population prospects relevant to the micro-level conceptualization of the relationship between demographic and environmental change described above.

Keywords: Global demographic change, demographic transition, ageing, urbanization, population growth.

Introduction

The following article is an updated and shortened version of the key note lecture speech, given at the NATO CCMS pilot study meeting in Lecce/Italy on September 6th 2004. The aim of this lecture was to give a short introduction on basic concepts and theories of demographic research related to the global demographic change in order to foster the discussion on the development of a first draft proposal *"Ecological and Health Implications of the Future European Demographic Development"* for the EU 6th framework programme (EcoPop). The first conceptualization of the relationship bet-

ween demographic and environmental change (demographic driven environmental stressors) drafted for the initial lecture was replaced for this article by a more elaborated one developed by J. Sabbagh, R. Seppelt, M. Zurek and the author during the CCMS meeting in Lecce. All data presented in this paper are drawn from the most recent world and urban population prospects of the UN Population Division.

The first section covers the conceptualization of the relationship between demographic and environmental changes. The text of this chapter is based on the final proposal of the aforementioned project submitted to the EU 6th framework programme and edited by F. Müller and R. Seppelt, coordinated at the UFZ Leipzig. The following sections cover the models of demographic and mobility transition, and the methods of demographic projections including a discussion of the reliability of such projections based on a comparison of the two latest UN projections. In the main section data on the global population growth, the ageing of the population and the ongoing urbanization and growth of mega cities is analysed for more developed, less developed and least developed countries. Additional data are provided to differentiate among major regions.

Conceptualization

Different landscape processes are influenced by demographic processes, e.g. through the growth of the population living in an area and modifying it for purposes of agriculture, industry, housing, streets etc. By using the landscape for human needs the ecosystem is altered through anthropogenic environmental stressors and, as a consequence, the ability to provide ecosystem services may be altered too. Especially the ability to provide a healthy environment for human living and the suitability for human activities may be challenged. Schematically, the relationship between demographic and environmental processes can be deemed as result of the interaction of two subsystems: an ecological-environmental subsystem and a socio-economic subsystem. The relevant processes of both subsystems are investigated by two different fields of research and the theoretical and empirical knowledge in both fields is intensely developed. The interaction of the two subsystems in the conceptual model shown in Figure 1 is defined by the section of the ecosystem services, where both subsystems intersect.

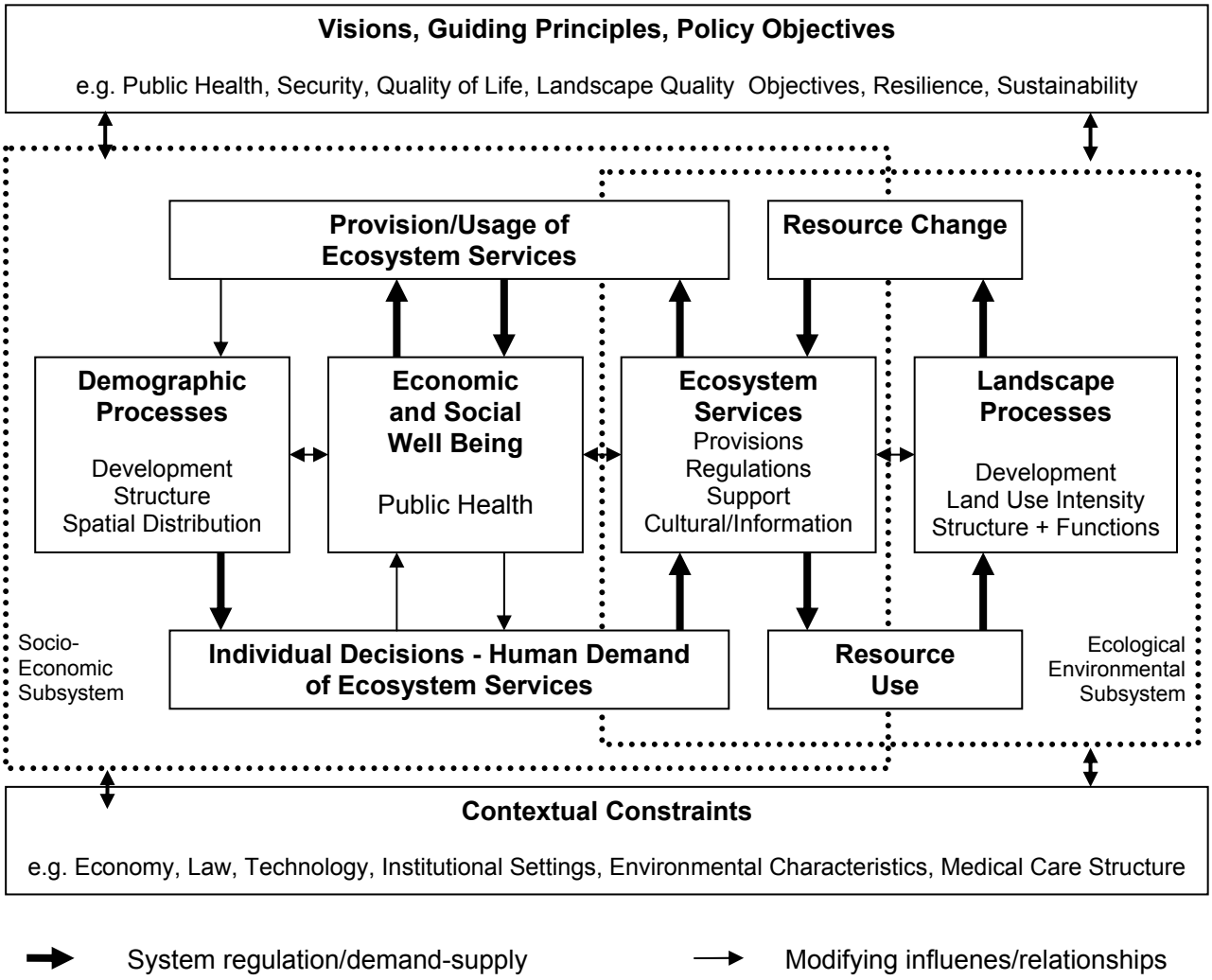
Three aspects are of interest:

1. The response of ecosystem services on stressors and the ability to provide ecosystem services (supply side).
2. The demand and usage of ecosystem services based on individual human decisions, moderated by changing demographic patterns (demand side).
3. The provision of ecosystems services as a condition of economic and social wellbeing embedded in a context of visions, guiding principles, and policy objectives related to e.g. public health, security, quality of life, landscape quality objectives, resilience, and sustainability as well as contextual constrains such as e.g. economic structures, law system, available technology, institutional settings, environmental characteristics, and health care structure.

As far as the demographic and social science research is concerned, a conceptual model of the decision-based demand of ecosystem services (using micro-data on individual preferences and demands) is missing and has to be developed. Using this model the impact of demographic changes on the demand structure can be analysed and projected (using scenario techniques), e.g. the future de-

mand of housing or infrastructure of a declining and ageing society. Based on a conceptual model of the demand side a set of demographic indicators can be selected to project the future demand of environmental services at a large scale level.

Figure 1: Conceptualization of demographic and environmental processes (EcoPop)



Source: modified after Sabbagh, Seppelt, Swiaczny and Zurek edited by Müller and Seppelt (unpublished).

Evaluation of models, data and projections on global demographic change

Most aspects of the global demographic processes are currently related to three theoretical models:

- The model of the *First Demographic Transition*, describing the change of demographic patterns during the late 18th till the mid 20th century in the more developed countries, and the recent developments in some of the less developed countries. The model is also used to derive the assumptions for the population prospects made for the less and least developed countries.
- The model of the *Second Demographic Transition*, describing the further decline of the fertility below the replacement level in most of the developed countries since the sixties.

- The model of the *Mobility Transition*, describing the change of mobility and migration patterns in the developed countries since pre-industrial times. The model summarizes the currently available knowledge on different aspects of mobility and migration at an abstract level and therefore can also be used to derive scenarios for the migration patterns of population projections.

First Demographic Transition

The model of the First Demographic Transition (DAVIS 1945) describes the change since the late 18th century from a high and highly variable mortality and fertility level to the low mortality and fertility patterns of industrialized countries today. During the phase of transition, when the decline of mortality started before the decline of the fertility took place, that resulted in high rates of population growth. During the transition, the median age of the population and the dependency ratio was falling ("demographic dividend"). At the end of the transition the life expectancy was far higher than before. The reduced mortality in industrialized countries was initially induced by better nutrition, better hygiene, improved medical care, and reduced excess mortality during crises, with the highest effects on a reduced infant mortality in the beginning. Declining fertility is usually explained as a socio-economic and socio-psychological adaptation to changing socio-economic conditions during the industrialization and the reduced infant mortality, and usually showed a time lag of at least one generation respect to the declining infant mortality in the industrialized countries. The model was derived from the population history of the industrialized countries and is used today by the UN Population Division as a universal theory for the modelling of population projections for developing countries.

Second Demographic Transition

The model of the Second Demographic Transition (VAN DE KAA 1987) was developed to describe the decline of the fertility below the replacement level of approximately 2.1 children per women since the 1960th in most industrialized countries. The explanation of this new and unprecedented trend in demography is usually related to the modernization of society, with changing family patterns, changing normative values concerning family and children, and a secularization and individualization in terms of the decision to have or not to have children. The result of the Second Demographic Transition is a declining and ageing population and a strong increase of the dependency ratio (relation of population below 16 and over 65 to population at working age 16-65 years), now no longer caused by a high share of children but a high share and growing absolute number of pensioners. This trend with its negative effects is widely attributed to society and economy, such as reduced innovation, reduced work force, negative impacts on pension funds and social security systems as well as problems of infrastructure or spatial planning.

Mobility Transition

The model of the Mobility Transition (ZELINSKY 1971) was developed in 1971 and summarizes the spatial mobility patterns in industrialized countries since pre-industrial times till the second half of the 20th century. One of the main findings of migration research in the industrialized countries is an increasing internal and international migration in the 19th and 20th century. In the now highly

urbanized and developed regions migration patterns are characterized by less rural-urban, more urban-urban, urban-suburban, and circular migration. The model is as a whole unable to provide precise information on future migration patterns for population projections. Nevertheless, the systematic description of different migration patterns by the model allows to enquire in the relationship of different kinds of mobility and migration. Due to the current incorporation of the less developed regions in a global world with intensifying economic linkages and improved means of international transport, migration patterns in the developing countries are thought to follow the phases of the Mobility Transition model.

Data sources and projections

The problems of data sources for modelling demographic processes of many developing countries rely on the lack of reliable census data and of precise population register-based data for the time interval between census years. The available data are also unable to cover aspects of the spatial population distribution, the population development of the fast growing cities and the internal migration. Because of the scarce information on the population processes in developing countries, the assumptions derived for demographic projections are to be questioned.

The demographic projections of the UN Population Division are made using the deterministic cohort component method. The population of the base year, differentiated by age and sex, is modified for the following year by applying the assumptions on age specific fertility, mortality and migration surplus on the population structure of the base year. The result is used to compute the number and composition of the population for each following year.

Projections based on deterministic models will be reliable, if the assumptions for fertility, mortality and migration are true. In this case, deterministic models are highly accurate. While the assumptions on mortality were mostly accurate in the past, the past assumptions of fertility levels were unable to predict e.g. the fast declining fertility during the Second Demographic Transition. The assumptions on internal and international migration are dependent on the economic development and the political framework and can change considerably in the future.

Demographic models using probabilistic methods provide simulations of the population development based on the analysis of time series data and account for the statistical probability of future population developments within a given range of confidence. Breaks in the future development caused by changing conditions for fertility and international migration that could not be derived from the experience of the past, are not accounted for by probabilistic models.

General problems of demographic projections based on the models of Demographic or Mobility Transition concern that there is no evidence that demographic models derived from observations in developed countries in the past could be valid for all present and future societies. As shown in Table 1, the UN Population Division assumes a convergence of the level of the total fertility rate (TFR: average number of children per woman) in developed, less and least developed regions. Table 2 shows the development of the TFR for different countries according to the World Population Prospects 2002. According to the assumptions made for Mali and Chad, their future TFR will show a strong decline and nearly reach the low fertility level of Germany and France. To reach this goal, the future development of the TFR in Mali and Chad have to decline faster than in Pakistan and Nigeria, where the decline of the TFR started already around 1980. All demographic theories used

to model future population developments are, as explained above, unable to predict changing paradigms of fertility and migration in the future. Even the assumptions for the mortality, which were highly accurate for developed countries, can show an unexpected unreliability for less and least developed countries. Due to the increased mortality by AIDS/HIV (and reduced estimations for the level of fertility) in some African and Asian countries the estimations of the UN World Population prospects had to be reduced by approx. 400 million people in 2050 (medium variant) between the 2000 and 2002 Revisions (UN, 2002 and 2003).

Table 1: Total Fertility Rate (TFR) according to the UN World Population Prospects 2002: DCs, LDCs, LLDCs, different variants 1970-2050*

Region/Variant	1970-1975	1975-1980	1980-1985	1985-1990	1990-1995	1995-2000	2000-2005	2005-2010	2010-2015	2015-2020	2020-2025	2025-2030	2030-2035	2035-2040	2040-2045	2045-2050
LLDC high	6.58	6.40	6.28	6.02	5.77	5.46	5.36	5.19	4.90	4.55	4.22	3.91	3.61	3.35	3.13	2.95
LLDC medium	6.58	6.40	6.28	6.02	5.77	5.46	5.13	4.78	4.40	4.05	3.73	3.42	3.13	2.87	2.65	2.47
LLDC low	6.58	6.40	6.28	6.02	5.77	5.46	4.88	4.35	3.91	3.56	3.24	2.93	2.65	2.40	2.17	2.00
LDC high	5.42	4.63	4.13	3.83	3.40	3.11	3.16	3.17	3.13	3.01	2.90	2.79	2.70	2.63	2.57	2.52
LDC medium	5.42	4.63	4.13	3.83	3.40	3.11	2.92	2.78	2.65	2.53	2.41	2.31	2.22	2.14	2.09	2.04
LDC low	5.42	4.63	4.13	3.83	3.40	3.11	2.68	2.37	2.16	2.04	1.93	1.83	1.75	1.67	1.61	1.56
DC high	2.13	1.91	1.85	1.83	1.69	1.58	1.64	1.73	1.83	1.91	2.00	2.12	2.21	2.28	2.33	2.35
DC medium	2.13	1.91	1.85	1.83	1.69	1.58	1.56	1.57	1.60	1.64	1.69	1.75	1.81	1.84	1.85	1.85
DC low	2.13	1.91	1.85	1.83	1.69	1.58	1.48	1.40	1.37	1.36	1.38	1.40	1.40	1.40	1.38	1.35

* Average for period of 5 years

Source: World Population Prospects 2002 [online: http://esa.un.org/unpp/]

Table 2: Total Fertility Rate (TFR) according to the UN World Population Prospects: DCs, LDCs, LLDCs, regions, and selected countries, 1970-2050*.

Region	1970-1975	1975-1980	1980-1985	1985-1990	1990-1995	1995-2000	2000-2005	2005-2010	2010-2015	2015-2020	2020-2025	2025-2030	2030-2035	2035-2040	2040-2045	2045-2050
World	4.48	3.90	3.57	3.37	3.03	2.83	2.69	2.59	2.50	2.41	2.33	2.25	2.18	2.12	2.06	2.02
DC	2.13	1.91	1.85	1.83	1.69	1.58	1.56	1.57	1.60	1.64	1.69	1.75	1.81	1.84	1.85	1.85
LDC	5.42	4.63	4.13	3.83	3.40	3.11	2.92	2.78	2.65	2.53	2.41	2.31	2.22	2.14	2.09	2.04
LLDC	6.58	6.40	6.28	6.02	5.77	5.46	5.13	4.78	4.40	4.05	3.73	3.42	3.13	2.87	2.65	2.47
Africa	6.71	6.59	6.43	6.08	5.63	5.22	4.91	4.57	4.19	3.84	3.52	3.23	2.98	2.75	2.56	2.40
Asia	5.06	4.17	3.66	3.40	2.98	2.72	2.55	2.42	2.30	2.21	2.13	2.06	2.00	1.95	1.93	1.91
Europe	2.16	1.97	1.88	1.83	1.58	1.42	1.38	1.37	1.40	1.44	1.52	1.63	1.72	1.79	1.83	1.84
Latin America	5.03	4.48	3.90	3.39	3.01	2.72	2.53	2.36	2.23	2.13	2.04	1.98	1.94	1.91	1.88	1.86
Northern America	2.01	1.78	1.81	1.89	2.02	2.01	2.05	2.05	2.03	2.02	1.99	1.96	1.94	1.91	1.89	1.85
Oceania	3.25	2.82	2.62	2.56	2.55	2.45	2.34	2.23	2.16	2.12	2.08	2.04	2.00	1.97	1.94	1.92
France	2.31	1.86	1.87	1.81	1.71	1.76	1.89	1.89	1.89	1.88	1.88	1.87	1.86	1.86	1.85	1.85
Germany	1.64	1.52	1.46	1.43	1.31	1.34	1.35	1.37	1.42	1.46	1.53	1.61	1.69	1.76	1.83	1.85
Pakistan	6.28	6.28	6.23	6.08	5.83	5.48	5.08	4.62	4.11	3.60	3.14	2.79	2.53	2.34	2.18	2.06
Nigeria	6.90	6.90	6.90	6.70	6.38	5.92	5.42	4.88	4.31	3.74	3.27	2.92	2.69	2.51	2.36	2.24
Mali	7.11	7.11	7.00	7.00	7.00	7.00	7.00	6.85	6.40	5.93	5.44	4.91	4.34	3.77	3.28	2.90
Chad	6.66	6.65	6.65	6.65	6.65	6.65	6.65	6.40	5.93	5.42	4.86	4.25	3.68	3.22	2.85	2.56

* Average for period of 5 years

Source: World Population Prospects 2002, medium variant [http://esa.un.org/unpp/]

Results of the UN World Population Prospects

The three most important aspects of the global demographic change are: the population growth and increasing population density, the ageing of the population and the urbanization. All three topics will be described in the following section (see Swiaczny 2005 for an extended coverage of this topic).

Population development

The global population growth is a result of the high level of fertility in most of the less and least developed countries. While the TFR of the developed countries had been falling below the replacement level of 2.1 children per women in the 1970th, it remained high throughout the rest of the world. Nevertheless it declined from 5.42 in the less, and 6.58 in the least developed countries to 3.11 and 5.46 respectively in 2000. The medium variant of the latest World Population Prospects assumes a further decline to 2.04 and 2.47 till 2050. Even the highest variant forecasts a decline of the TFR to 2.52 and 2.95 compared to 2.35 for the developed countries (Table 1).

As a result the average number of children per women will fall below replacement level at a global scale after 2040. During this time most of the regions will have a TFR of around 1.9, only in Africa the TFR will remain considerably higher at about 2,5 (Table 2). The world population has increased from 3.7 billion in 1970 to approximately 6 billion in 2000. The future growth is predicted to reach nearly 9 billions in 2050. The population of the developed countries will remain stable at around 1.2 billions in this medium variant scenario. The population of less developed countries will then reach more than 7.5 billion people and the least developed countries will have more than twice the population of 2000, then about 1.6 billion. The largest absolute increase will took place in Asia (5.2 billion in 2050), the largest relative increase in Africa (1.8 billion in 2050). The only region with an absolute decline of population will be Europe with nearly 100 million less compared to year 2000 (Table 3).

Table 3: World population (in 1,000): DCs, LDCs, LLDCs, and regions, 1970-2050.

Region	1970	1980	1990	2000	2010	2020	2030	2040	2050
World	3,692,492	4,434,682	5,263,593	6,070,581	6,830,283	7,540,237	8,130,149	8,593,591	8,918,724
DC	1,007,479	1,082,989	1,148,917	1,193,872	1,220,855	1,237,398	1,242,278	1,235,384	1,219,662
LDC	2,685,013	3,351,693	4,114,676	4,876,709	5,609,428	6,302,839	6,887,870	7,358,208	7,699,061
LLDC	312,714	400,164	516,907	667,757	845,418	1,043,429	1,256,815	1,471,709	1,674,521
Africa	357,283	469,618	622,443	795,671	984,225	1,187,584	1,398,004	1,608,329	1,803,298
Asia	2,143,118	2,632,335	3,167,807	3,679,737	4,148,948	4,570,131	4,886,647	5,103,021	5,222,058
Europe	655,855	692,431	721,582	727,986	719,714	705,410	685,440	660,645	631,938
Latin America	284,856	361,401	441,525	520,229	594,436	659,248	711,058	747,953	767,685
Nothern America	231,937	256,068	283,549	315,915	348,139	379,589	407,532	429,706	447,931
Oceania	19,443	22,828	26,687	31,043	34,821	38,275	41,468	43,938	45,815

Source: World Population Prospects 2002, medium variant [http://esa.un.org/unpp/]

The global population growth per year was 1.9% in 1970/75, 1.2% in 2000/05 and is expected to be only 0.3% in 2045/50. In the developed world the population will begin to decrease from 2030. The most prominent reduce in population growth will took place in the less developed countries where the figures will fall from 1.4% in 2000/05 to 0.4% in 2045/50. In the least developed countries the population growth will be half the number of 2000/05, about 1.2% in 2045/50. Africa will remain the fastest growing region in the world with about 1% per year (Table 4). As a result of the population growth the population density per km^2 will increase accordingly, from 45 in 2000 to 66 in 2050 at a global scale. The population densities of the least developed countries will nearly threefold until 2050 and reach 81 in 2050. In Africa the population density will double until 60 in 2050 and the highest number will be reached in Asia with 164. Europe is the only region with a declining population density; in 2050, 27 people are expected to live on one km^2 (Table 5).

Table 4: Population growth in %: DCs, LDCs, LLDCs, and regions, 1970-2050*.

Region	1970	1975	1980	1985	1990	1995	2000	2005	2010	2015	2020	2025	2030	2035	2040	2045	2050
World	27	30	33	36	39	42	45	48	50	53	56	58	60	62	63	65	66
DC	19	20	20	21	22	22	23	23	23	23	23	23	23	23	23	23	23
LDC	32	36	40	45	50	54	59	63	68	72	76	80	83	86	89	91	93
LLDC	15	17	19	22	25	29	32	37	41	46	51	56	61	66	72	77	81
Africa	12	13	15	18	21	23	26	29	32	36	39	43	46	50	53	56	60
Asia	67	75	83	91	100	108	116	123	131	138	144	149	154	158	161	163	164
Europe	29	29	30	31	31	32	32	32	31	31	31	30	30	29	29	28	27
Latin America	14	16	18	20	22	23	25	27	29	31	32	33	35	36	36	37	37
Northern America	11	11	12	13	13	14	15	15	16	17	18	18	19	19	20	20	21
Oceania	2	3	3	3	3	3	4	4	4	4	4	5	5	5	5	5	5

Source: World Population Prospects 2002, medium variant [http://esa.un.org/unpp/]

Table 5: Population density per sq. Km: DCs, LDCs, LLDCs, and regions, 1970-2050.

Region	1970-1975	1975-1980	1980-1985	1985-1990	1990-1995	1995-2000	2000-2005	2005-2010	2010-2015	2015-2020	2020-2025	2025-2030	2030-2035	2035-2040	2040-2045	2045-2050
World	1.94	1.73	1.71	1.72	1.50	1.35	1.22	1.13	1.05	0.93	0.81	0.70	0.60	0.51	0.42	0.33
DC	0.78	0.67	0.59	0.60	0.43	0.34	0.25	0.20	0.16	0.11	0.06	0.02	-0.03	-0.08	-0.12	-0.14
LDC	2.36	2.08	2.06	2.04	1.79	1.61	1.46	1.34	1.24	1.10	0.95	0.82	0.71	0.61	0.50	0.40
LLDC	2.46	2.47	2.52	2.60	2.69	2.43	2.41	2.31	2.16	2.05	1.93	1.80	1.65	1.50	1.36	1.23
Africa	2.66	2.81	2.86	2.78	2.56	2.35	2.20	2.06	1.94	1.82	1.69	1.58	1.46	1.34	1.21	1.08
Asia	2.24	1.87	1.85	1.85	1.59	1.41	1.25	1.15	1.04	0.89	0.74	0.60	0.49	0.38	0.28	0.18
Europe	0.59	0.49	0.39	0.44	0.16	0.02	-0.09	-0.14	-0.18	-0.23	-0.27	-0.31	-0.35	-0.39	-0.43	-0.46
Latin America	2.45	2.32	2.10	1.90	1.72	1.56	1.41	1.26	1.11	0.96	0.82	0.69	0.57	0.44	0.32	0.20
Northern America	0.97	1.01	1.02	1.02	1.09	1.07	1.00	0.94	0.89	0.84	0.76	0.66	0.57	0.49	0.44	0.40
Oceania	2.07	1.14	1.56	1.57	1.61	1.41	1.22	1.08	0.98	0.91	0.85	0.76	0.63	0.52	0.45	0.39

* Average for period of 5 years

Source: World Population Prospects 2002, medium variant [http://esa.un.org/unpp/]

Ageing

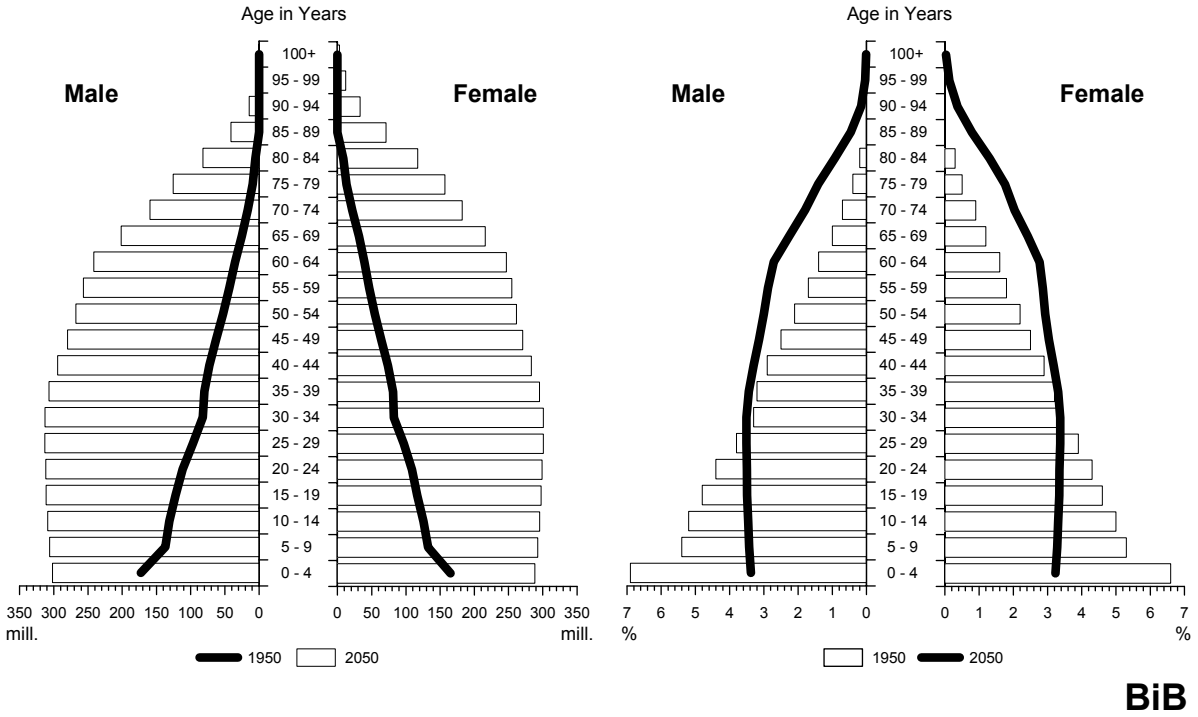
As shown in Figure 2 (left side) the age composition of the world population will change considerably in 2050 compared to 1950. In 1950 the age composition was characterized by large age groups of children and – due to high mortality – a declining number of elder people. In 2050 the age structure will show a maximum of people in the age groups between 20 and 34 years. The younger age groups will show declining numbers, indicating the start of a general population decline, while rough numbers will be far beyond the figures of 1950. The elder groups – due to increased life expectancy – will make up for a growing share of the population in 2050 compared to 1950 (right side), indicating the ageing process of the population.

For the world population the growth of the median age was only moderate in the past, from 21.7 years in 1950 to 26.4 years in 2000. Till 2050 the median age will increase to 36.8 years. In the developed countries, where today the median age is already 37.3 years, ageing will continue and will reach 45.2 years in 2050. In the least developed countries ageing will take place faster than in the industrialized countries during the next 50 years, the median age will grow from 24.1 to 35.7 years in 2050, nearly the present level of developed countries. As a result of the high fertility in the least developed countries they will still have a relatively young population in 2050 with a median age of about 27 years.

In China the one-child population policy has increased ageing. In 1970 the median age of India and China was nearly the same, 19.9 and 19.7 years respectively. Since the 1970th the population of China started to age faster than that of India. In 2000 the difference was about six and a half year. In

2050 the median age of China will reach 43.8 years, nearly the average of developed countries. The Chinese population's median age will then be approximately two and a half years higher than the average in Northern America. In India the increase of the median age is much slower, in 2050 the figure will be only about 38 years, which is slightly below the average of all Asian countries and only a little below the average of the less developed countries.

Figure 2: World population by sex and age in millions and percentage, 1950 and 2050



Source: World Population Prospects 2002 [http://esa.un.org/unpp/], own calculation.

Urbanization

Most of the future population growth will took place in the urbanized areas of the world. From 2000 to 2050 the global population in the rural areas will remain stable at around 3.2 billion people. In the developed countries there will be a slight decrease, whereas in the less developed countries a slight increase will occur. Only in the least developed countries the rural population will grow by about 200 million people till 2050, three quarter of that in Africa alone (Table 6).

Table 6: Rural population (in 1,000), DCs, LDCs, LLDCs, and regions, 1950-2030

Region	1950	1960	1970	1980	1990	2000	2005	2010	2015	2020	2025	2030
World	1,785,900	2,028,721	2,362,944	2,697,838	2,990,352	3,213,654	3,281,638	3,324,936	3,341,377	3,324,840	3,272,264	3,185,470
DC	386,097	379,113	355,180	333,927	323,672	311,407	303,259	292,223	278,809	263,170	245,925	227,505
LDC	1,399,803	1,649,609	2,007,764	2,363,911	2,666,680	2,902,247	2,978,379	3,032,713	3,062,569	3,061,670	3,026,339	2,957,965
LLDC	185,545	222,647	272,173	331,011	409,068	499,800	544,939	588,088	627,252	662,300	691,153	712,511
Africa	188,320	225,841	274,450	340,646	423,649	500,323	535,037	567,040	595,415	619,385	637,347	649,846
Asia	1,166,330	1,363,764	1,657,367	1,939,553	2,156,070	2,312,757	2,355,378	2,378,454	2,380,376	2,355,767	2,302,761	2,222,364
Europe	267,079	261,559	243,202	217,350	205,359	198,928	193,540	185,906	176,486	165,342	153,025	140,070
Latin America	97,157	110,701	121,443	126,942	127,647	127,247	125,098	122,728	119,998	116,856	113,280	109,332
Northern America	61,967	61,438	60,765	66,757	69,660	65,920	63,786	61,660	59,594	57,621	55,650	53,451
Oceania	5,047	5,418	5,717	6,590	7,967	8,479	8,799	9,148	9,508	9,869	10,200	10,405

Source: World Urbanization Prospects 2003, medium variant [http://esa.un.org/unup/]

While the rural population will be stable, the urban population will show a large growth, from 2.9 billion in 2000 (less than the rural population) to 4.9 billion in 2050. The growth in the developed regions will be about 132 million, in the less developed regions around 1.955 billion and even in the least developed regions approximately 377 million people. A total of 1.3 billions out of the 2 billions growth of urban population is accounted for by Asia and 450 million by Africa (Table 7).

Table 7: Urban population (in 1,000), DCs, LDCs, LLDCs, and regions, 1950-2030.

Region	1950	1960	1970	1980	1990	2000	2005	2010	2015	2020	2025	2030
World	732,729	992,753	1,329,548	1,736,844	2,273,241	2,856,927	3,171,990	3,505,347	3,855,870	4,215,397	4,579,192	4,944,679
DC	426,674	536,185	652,298	749,061	825,245	882,465	905,558	928,632	951,690	974,228	995,452	1,014,773
LDC	306,055	456,569	677,249	987,783	1,447,996	1,974,462	2,266,432	2,576,716	2,904,180	3,241,169	3,583,740	3,929,906
LLDC	14,835	23,498	40,541	69,153	107,839	167,957	208,375	257,330	314,641	381,129	457,688	544,304
Africa	32,894	51,557	82,833	128,972	198,794	295,348	352,927	417,186	489,125	568,199	654,738	748,158
Asia	232,158	337,572	485,751	692,783	1,011,737	1,366,980	1,562,130	1,770,494	1,990,146	2,214,364	2,439,471	2,664,282
Europe	280,324	342,842	412,654	475,081	516,223	529,058	531,182	533,808	536,917	540,068	543,011	545,369
Latin America	69,940	107,599	163,413	234,460	313,879	392,982	433,183	471,708	508,263	542,392	573,577	601,726
Northern America	109,649	142,714	171,172	189,312	213,889	249,995	268,371	286,479	304,359	321,968	338,662	354,081
Oceania	7,765	10,469	13,725	16,237	18,720	22,564	24,199	25,673	27,061	28,405	29,733	31,063

Source: World Urbanization Prospects 2003, medium variant [http://esa.un.org/unup/]

The urban population will grow with a rate of more than 1.5% per year at the end of the 2020th, with the highest growth in the least developed regions (3.47% 2025/30). In Asia, the region with the highest absolute growth rates, the growth rate has already begun to slow down and will fall below 2% per year from 2020. In Africa the urbanization rate is currently still above 3.5% per year and the slow down of this process is less prominent than in Asia. The annual urban growth rate of Africa will remain above 2.5% in 2025/30. The urbanization rate of Europe is by far the lowest in the world and it will stay stable at around 0.1% per year until 2030 (Table 8). In 2030 the share of urban population will be highest in Northern and Latin America (about 85%), followed by Europe (about 80%). The urbanization ration of Africa and Asia, now both at 37.1% will increase considerably to around 54% in 2030.

Table 8: Urbanization on rate in %, DCs, LDCs, LLDCs, and regions, 1950-2030*.

Region	1950-1955	1955-1960	1960-1965	1965-1970	1970-1975	1975-1980	1980-1985	1985-1990	1990-1995	1995-2000	2000-2005	2005-2010	2010-2015	2015-2020	2020-2025	2025-2030
World	3.02	3.06	3.08	2.76	2.63	2.72	2.67	2.72	2.35	2.22	2.09	2.00	1.91	1.78	1.66	1.54
DC	2.31	2.26	2.12	1.80	1.51	1.25	0.97	0.97	0.75	0.60	0.52	0.50	0.49	0.47	0.43	0.38
LDC	3.96	4.04	4.15	3.74	3.65	3.90	3.87	3.78	3.21	2.99	2.76	2.57	2.39	2.20	2.01	1.84
LLDC	4.49	4.71	5.36	5.55	5.03	5.66	4.39	4.49	4.61	4.25	4.31	4.22	4.02	3.83	3.66	3.47
Africa	4.38	4.61	4.83	4.66	4.40	4.46	4.37	4.28	4.15	3.76	3.56	3.35	3.18	3.00	2.84	2.67
Asia	3.74	3.74	3.84	3.44	3.37	3.73	3.77	3.81	3.11	2.90	2.67	2.50	2.34	2.14	1.94	1.76
Europe	2.02	2.01	2.05	1.66	1.55	1.26	0.85	0.81	0.34	0.15	0.08	0.10	0.12	0.12	0.11	0.09
Latin America	4.34	4.28	4.32	4.04	3.75	3.47	3.07	2.77	2.33	2.16	1.95	1.70	1.49	1.30	1.12	0.96
Northern America	2.65	2.62	2.04	1.60	0.98	1.04	1.22	1.22	1.58	1.54	1.42	1.31	1.21	1.12	1.01	0.89
Oceania	3.01	2.96	2.83	2.58	2.38	0.98	1.39	1.46	1.97	1.77	1.40	1.18	1.05	0.97	0.91	0.88

* Average for period of 5 years

Source: World Urbanization Prospects 2003, medium variant [http://esa.un.org/unup/]

Summary

From the results of the world and urban Population Prospects one can expect a declining population growth around the world as well as a convergence of the TFR and other demographic parameters. In 2050 Africa will still have the highest population growth and the lowest median age, Asia the highest population density. The population growth in the less and least developed countries will took place mostly in urban areas with high urbanization rates in Asia and especially in Africa. Both continents will then reach an urbanization ratio of slightly more than 50%.

The demographic situation in Europe will be the most extreme in terms of low fertility, high median age and population decline. In 2050 Europe will have the lowest TFR in the world and a population decline of 0.4% per year in the 2040th according to the medium variant of the UN projection (and most national statistical offices expect even lower figures). The population density will then be slightly below the average of developed countries. The ageing will further increase and the median age will reach a value of 47.7 years, far beyond the other regions and slightly above the whole figure for developed countries. The rural population will decline by about 60 million people till 2050 while the urban population will increase by only 15 million. The urbanization rate will allow a slow growth of the urban population by 0.09%, with cities in all other regions growing with 1% at the mid of the century, and the urbanization ratio will reach 80%.

Conclusions

At the end of this paper three conclusions related to the EcoPop project design can be made:

1. The conceptualization of the relationship of demographic and environmental processes must deal with the micro-macro problem of social research. While the demand of environmental services can only be conceptualized based on human decisions made by individuals, demographic research is only possibly based on available aggregate macro-data. Future demographic processes as stressors of the environment can only be forecasted by combining demographic projections with survey data on individual preferences and decisions related to the demand of environmental services. An elaborated conceptual model and the definition of a set of suitable variables remain a desideratum of research.
2. The demographic data available by international organizations like the UN Population Division or the Population Commission of the Council of Europe (see also Swiaczny 2005) are not sufficient for analysing ecosystem relevant demographic processes because of their small scale spatial resolution. For research on the environmental change in the EU Eurostat data on the NUTS 3 and NUTS 5 levels can be used and population projections have to be calculated at a regional level.
3. The most dynamic demographic processes will take place in less and least developed regions. Their impact on the global environment will exceed the demographic effects on the environment in more developed regions like the EU, where the population development is characterized by declining and ageing population and a slow down of urbanization and suburbanization. As a result, the global environmental linkages between developing regions and developed countries will likely modify environmental processes in the EU and should therefore be accounted for.

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