THE DYNAMICS OF WORLD POPULATION GROWTH - CAUSES, CONSEQUENCES, NECESSARY ACTION

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SUMMARY

According to latest calculations by the department of population of the United Nations, world population will double from 5.3 billion in 1990 to at least 11 billion in the second half of the coming century. Scientific discussions of maximum possible world population reach back to the 18th century. For hundreds of years the problem of food supply was considered to be the most important; later, emphasis was placed on the problem of exhaustion of resources and finally on environmental issues. Problems of food and resources can be solved by applying well known principles. Whether this is also true for environmental problems is still a question for discussion.

HISTORY OF SCIENCE - INTRODUCTION

When Johann Peter Süßmilch carried out the first realistic projection of world population in Berlin of 1741, there were around 700 million people living on earth. On the basis of calculations of maximum capacity in nutrition science, Süßmilch came to the conclusion that our planet could feed ten times the figure of people living in his time, i.e. 7 billion /1/. From today's point of view, these figures are not only interesting because they are relatively and surprisingly correct in terms of quantitative results but also and mainly because of the reaction they caused among the scientific public. 7 billion people - this figure caused fear and dismay. Even Süßmilch's calming assurance that the whole of mankind could be assembled on land the size of Lake Constance, was not reassuring. Süßmilch had moved too far ahead of the existing optimism (as regards population) of the mercantile *zeitgeist*. Despite his great achievement he was soon forgotten. Only a few decades after the publication of Süßmilch's classic work, his optimism regarding population had turned into deep pessimism, which continues to this day. There are no signs that we can ever again escape from this pessimism. However, the decisive reason for this is not that world population in the meantime has increased to 5.5 billion and that it will most probably double to at least 11 billion because it can reach a constant state. The reason is that another of the great classic authors of population science, Thomas Robert Malthus, changed scientific thinking about population development with his "population law", published 1798, in such a way that it is not longer accessible by rational arguments anymore /2/.

The Malthus method of theorising about population left deep marks in the

history of biological, economic and social sciences. The total effect can be summed up in the statement that through Malthus' "population law" it is not the actual population increase, but the thinking about population development which has become the decisive problem, because from this kind of thinking follow greater dangers than from the population increase itself. It is true that today mankind can no longer be assembled on land the size of Lake Constance, but without any problem this is possible on land the size of Mallorca, this even after a further doubling to 11 billion. But from the point of view of Malthus' theory, empirical arguments count for little. Malthus knew Süßmilch's tables and calculations and still insisted that earth was already overpopulated with those who lived on earth in 1803, the year that his "population law" was published in an enlarged second edition.

Malthus' theory of population is a moral and philosophical theory of class, which surpasses by far the economically based class theory of K. Marx in terms of radicality. What makes the lower class into an "under" class, according to Malthus' point of view, is not the fact that it owns nothing, but its moral inferiority, especially its inability to curb the sexual urge. In the work which amounts to many hundreds of pages the fact that human beings of all ages and cultures knew and used contraceptive practices plays no part. Due to its moral inferiority the lower class is unable to refrain from sexual activity, which is why every rise of payment, every improvement of the material living conditions of the lower class brings with it a growth of population, with the necessity of nature's law. The crux is: The population number develops according to a geometrical growth line, the production of food according to arithmetic. Therefore all populations from a certain point onwards must meet their food limit. Wars, famine and disease, so-called malthusian "population checks", wipe out excess population. The population adapts to limited food capacity by increasing the death rate and an adaptation through lowering birth rates may be theoretically possible, but this remains improbable because of the moral inferiority of the lower class.

Similar "checks" to those in this population theory can be found in liberal economic theories, which were developed in England in the 18th century by close cooperation between classic economists like Ricardo and Malthus. This economy and market theory still dominates the thinking of economic science in the whole world. Population checks are analogous to the checks of the free market: The economic checks in sufficiently competitive economic groups, consumers and producers, which are not able to compete are pushed out of the market for the sake of improvement of the whole.

In theoretical biology Malthus' population checks were, according to Darwin's diaries, the paradigm for the selection processes of his selection theory. As Darwin refers to Malthus' population theory in his theoretical argumentation of his selection or evolutionary theory, the population theory has become scientifically accepted proof of the everlasting biologically guaranteed progress of mankind, although Malthus had aimed for the opposite with his theory, namely to show that progress in society is an impossibility /3/.

On the basis of this paradigm was later developed in England the eugenics of Galton and the social darwinism of Spencer, and in France Gobineau's theory of the inequality of the human races and the superiority of the arian race. In Germany, National Socialist population scientists refer clearly to Malthus' theory. The National Socalists' racial hygiene, based on population theory, cost the lives of millions of people.

In the social sciences the "population law" met with agreement, but also with negative reaction. The most vehement was the rejection by Marx and Engels /4/. I believe, that the conception of the communist theory would have been less radical and utopian if it had not been for the malthusian challenge.

Following the collapse of the eastern block, total abdication of the socialist-communist theory is to be expected. With it will disappear one of the most important intellectual bulwarks against Malthusianism and we will have to reckon with a rekindling of subliminal malthusian currents. However, a renaissance of Malthusianism is to be expected not only due to a lack of potent intellectual resistance. The decisive factor is that world wide environmental problems have given rise to a new formulation of the malthusian population law, which now seems rather more convincing than its original version in the form of the "food problem". The place of the food limit has been taken up today by the environmental limit, and the premise of the moral inferiority of the lower class has been replaced - suggested by an influential direction of thought -by a corresponding thesis about the population of the Third World, which is unable to curb its population growth. In this way it appears to be better than the original theory to explain that wars, diseases and famine are necessary in order to adapt population to its ecological maximum capacity.

To range so widely in this introduction seems necessary, because this eoclogical interpretation and development of the malthusian population theory has lead to recommendations to stop development aid and health care in developing countries. The enormous danger and thrust of this intellectual tradition becomes clear, when G. Hardin, supporter of this modern ecologically interpreted Malthusianism, refers to Malthus and claims that it is a moral duty to leave the Third World to its own devices in order that at least the developed part of mankind may survive /5/. This recommendation for action is known as "lifeboat ethics". Only few of those who use the image of a crowded lifeboat have an inkling of the intellectual history which hides behind it. As a result demography has to bear a great responsibility /6/.

CAUSES OF WORLD WIDE POPULATION GROWTH

At the time of the birth of Christ there lived approximately 200-400 million people. This estimation is, however, very uncertain. For example: Figures which are given for the Roman Empire at the time of its greatest expansion vary widely between 50 and 100 Million. It is thought certain, that world population in the first one and a half thousand years until the beginnings of industrialisation in Europe in the 17th and 18th century grew extremely slowly, with an average

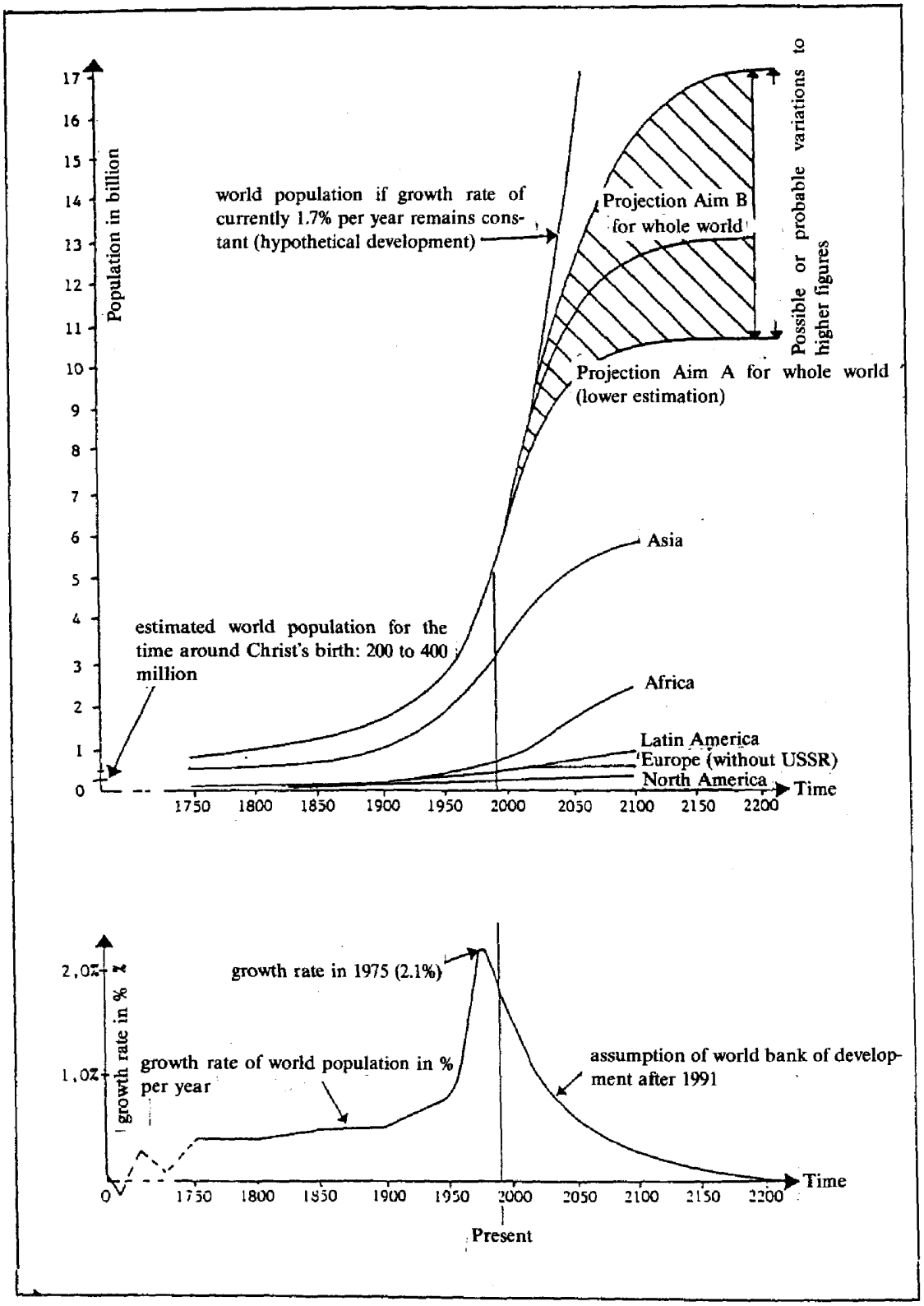

Figure 1. World population development from 1750 to the 21st century.

yearly growth rate well below one part per thousand (%). In the times of industrialisation the growth rate jumped up to 4%. In the course of the 18th and 19th century it continued to grow slowly to 5% (Figure 1, lower part).

In the 20th century the growth rate jumped up again. In 1950 it reached 8.5% and by 1960 a further 1.8%. This phase of *hypergeometrical growth* ended at a maximum of 2.1% around 1970. After this, the growth rate sank until 1985 it had reached 1.7%, since 1985 it has been constant. If world population grew further at today's rate of 1.7%, the number would be 33.8 billion in the year 2100. If, however, the growth rates of Asia (1.8%), Latin America (1.9%), North America (0.7%), Europe (not including CIS 0.2%) and Oceania (1.4%) would half themselves in each of the time spans 1990-2050, 2051-2075, 2076-2100, world population would be around 10 billion in the year 2100. This would result in the following development: 1 billion (1805), 2 billion (1926), 3 billion (1960), 4 billion (1974), 5 billion (1987), 6 billion (1998), 7 billion (2010), 8 billion (2023), 9 billion (2040), and 10 billion (2070-2100) /7/. The gaps in time from billion to billion have shrunk from 121 years between the first and second billion to 13 years between the fourth and fifth, or to 11 years between the fifth and sixth. Taking into account this development, is it probable that the gaps will rise again to 13 years (7th to 8th billion), 17 years (8th to 9th billion), or 20 and more years (9th to 10th billion)? Until recently, the population department of the United Nations was expecting a number of 10 billion in the year 2100. In their latest calculation, which is based on data for the year 1989-90, the lower limit has been set at the higher figure of 11.5 billion /8/. Can we safely assume that this is the last word of the UN's forecasters? My guess is that the figures will go up again in the next world population projection.

The reason for these constant corrections towards higher figures does not lie in incompetence of those scientists employed in the population department of the United Nations, but may, perhaps, be caused by the political pressure of lesser developed UN member countries to make relatively optimistic assumptions about the development of their birth rate. For this reason it is advisable to build our own estimate.

Figure 2 shows today's birth and death rates in the continents and large regions of the world. The *theory of demographic transformation*, which forms the basis of most population projections, changes this cross section into a longitudinal section. This plays a central part in the setting of assumptions for prognoses: A change took place in Europe from a pre-industrial population with high birth and death rates to an industrial population with low birth and death rates /9/. A similar process of change is said to be taking place in today's developing countries according to this transformation theory. The further countries lag behind in terms of industrialisation and modernisation, the longer they will need for the transformation, but all will follow eventually this development trend previously seen in Europe. On this basis UN projections have assumed that women in different developing countries, on levels responding to the state of development of the countries, will as early as 2005 not have more than 2 children per woman, who will in turn reproduce (after deduction of children dying before

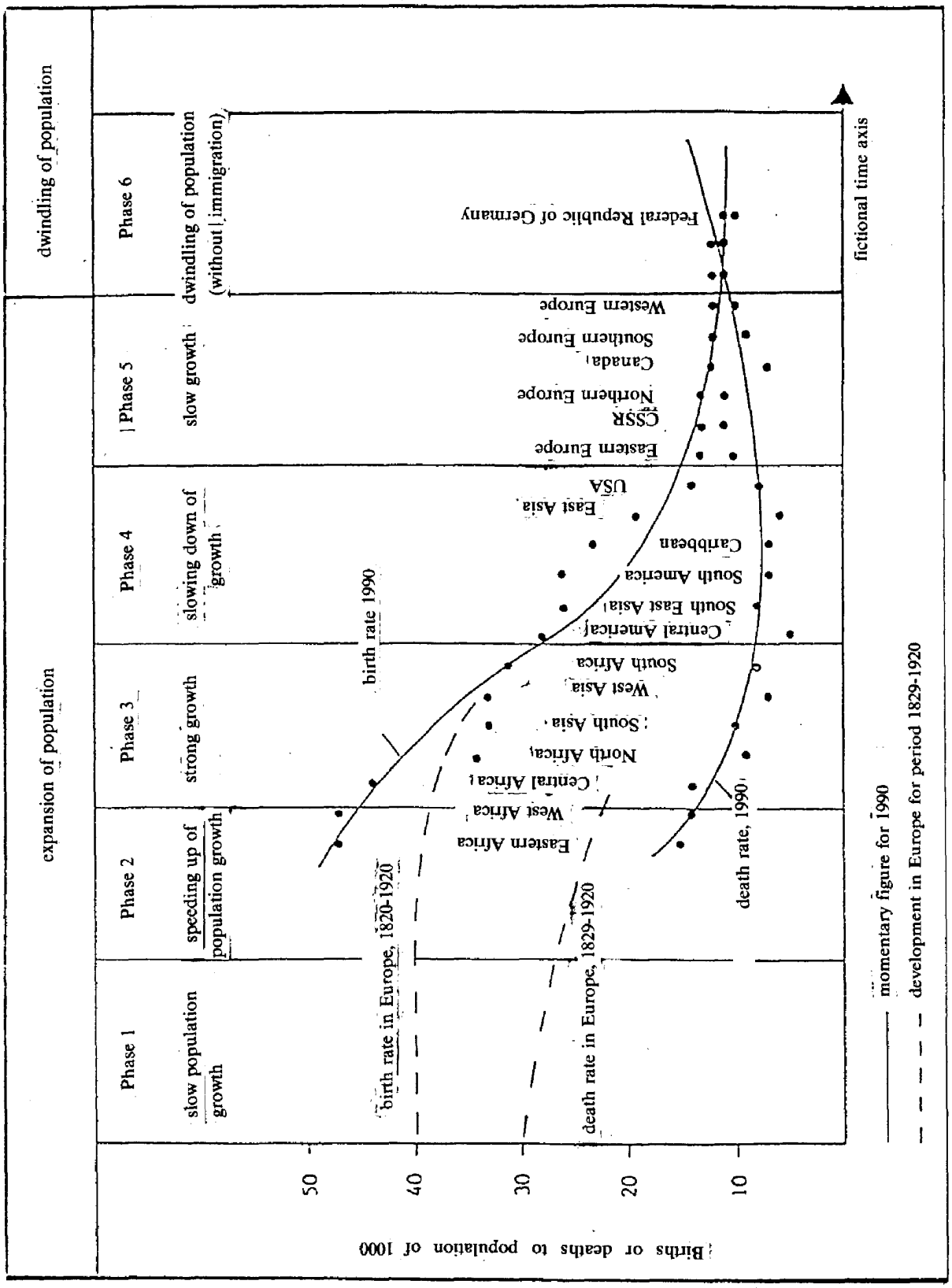

Figure 2. Phases of demographic change of countries and world regions in 1990 compared to the historical development in Europe.

reaching reproductive age). All important developing countries should have reached this target by 2020-2030, the last countries by 2060. It depends on the validity of this assumption as to whether stationary world population can be reached as early as 2100, or whether in the year 2100 11 billion people or more will be living on the earth. A delay of 20 years in reaching the norm of 2 children per woman leads to a stationary population of more than 13 billion.

This transferal of a demo-economical correlation between state of development and drop in fertility, according to the transformation theory as valid for Europe, does not work in all regions of the world. In those developing countries in which economic development has made progress, mainly in newly industrialised Asian countries, or in Mexico and Brazil, birth rates have been falling rapidly since the Eighties. However, there are countries in which the birthrate is falling only slowly or not at all. In Africa the birth rate for the period 1985-90 was 44.5 (living born to 1000 inhabitants), the death rate (deaths per 1000 inhabitants) was 14.2 and natural growth rate was 3.03%. For the period 1990-95 similar figures can be expected: Birthrate + 42.1, death rate ± 12.7, natural growth + 2.9% /8/. On the whole, there is only a small tendency is shown for falling growth rates in Africa. From a demographical point of view, India is an especially important country; here birth rate is constant (31.6) whilst the relatively low death rate (10.0) decreases. India will overtake China, today's most populated country, by the middle of the next century. In Asia alone, there will be living as many people as in the whole world today:

	China	India
population in 1990 (M)	1117	848
population in 2030 (M)	1566	1442
birth rate 1985-90	21.1	31.6
death rate 1985-90	6.7	11.0
natural growth rate 1985-90 (%)	1.43	2.06
living born per woman 1985-90 (Total Fertility Rate)	2.4	4.26

Totally independent of whether UN forecasters make realistic or unrealistic assumptions about the development of fertility, the population of developing countries, in which live 4.2 of the 5.5 billion people on earth, would rise by at least 50% over the 1985 level, even if the level of fertility were to have reached the figure of two children per woman (total fertility rate) in all countries by the year 1985. (see Table 1).

This phenomena of continued population increase over decades, even after reaching the replacement level of fertility, has been named in demography *"demographic leap"*, *"demographic inertia"* or *"momentum of population growth"*. An explanation for this phenomena lies in the young age structure of the population in developing countries: Because half the inhabitants are younger than 15-20 years, the number of already born future parents, who now form the wide base of the population pyramid, grows strongly. As a result birth rate, or popula-

Table 1. Long-term population projections and inertia factors (momentum) according to country groupings.

Region	Populations (millions) 1985	2050	2100	Stationary	Stationary ratio[a]	Population momentum	Year when population doubles	Year when NRR=1
World	4844	10035	11330	11514	2.4	1.4	2044	2060
Less developed	3666	8716	10020	10200	2.8	1.5	2028	2060
More developed	1179	1319	1310	1314	1.1	1.1	-[b]	2030
Africa	559	2275	2962	3049	5.5	1.6	2009	2060
America[c]	667	1146	1192	1201	1.8	1.4	-[b]	2030
Asia	2823	5728	6288	6375	2.3	1.5	2047	2055
Europe and USSR	771	843	842	846	1.1	1.1	-[b]	2030
Oceania	25	42	44	45	1.8	1.3	-[b]	2030

Notes: "More developed" comprises Europe, USSR, Northern America (United States and Canada), Australia, New Zealand, and Japan. "Less developed" comprises the rest of the world.

a Stationary population + 1985 population.

b Population will not double with projected rates.

c America comprises both North and South America.

Source: Rodolfo A. Bulato, Eduard Bos, Patience W. Stephens, and My T. Wu; World Population Projections 1989-90 Edition, Baltimore 1990.

tion, rises by at least a further 50% (over 1985), even if generative behaviour had changed abruptly as early as 1985, so that for every girl there will not be more than one daughter, surviving the phase of newborn and child mortality (a net production rate of 1.0). On average one daughter per woman equals two children per woman (Figure 3).

If one investigates the causes of population development until the present day and the likely development trends of the future, more exact theories regarding fertility, mortality and migration than those found in the transformation theory have to be utilized. Due to space and time limitations only an outline can be given here. Fertility factors can be grouped together as follows: (1) age and settlement structure and population density, (2) level of education, training, role of women, tradition, religion and culture, (3) direct and indirect costs of children, especially the cost of opportunities for children, as well as risks of long term determination of curriculum vitae /11/, (4) social structural factors like insurance against life's risks in sickness and old age through collective insurance systems and (5) general state of development, economic structure and spread of income.

In developing countries it is mainly a young age structure and general lack of social security systems which hinder a drop of fertility to the level of two children per woman. The tragedy of these countries is that the introduction of age and sickness insurance systems is so expensive that they can only be introduced after a certain minimum level of income per head on a wide spectrum has been reached. Reaching this minimum level, in turn, demands a slowing down of population growth. At the present time only a few developing countries have broken through this "poverty circle" (newly industrialised countries in Asia, Mexico). For this reason it has to be feared that the decrease of birth rate in developing countries will weaken and that the total fertility rate will remain above 2.0 until the 22nd century. In this case world population would grow even more in the 22nd century, even if one takes into account the worst assumptions regarding increasing death rate as a result of AIDS. It remains totally open when a stationary population could be reached.

CONSEQUENCES

In analogy to the circle of poverty in developing countries we could talk about a circle of wealth in developed countries: The higher the state of development and income per head, the higher the personal freedom to design individual lives. But the bigger, too, are the risks of long-term determination of curriculum vitae and the costs of opportunities for children, and the lower is the birth rate. This correlation, present in all industrial countries, can be reduced to the following formula: economic success reduces the demographic base of society and the long-term decrease of population is faster the greater is economic prosperity. In the Federal Republic of Germany this is already the case: Net production rates has sunk to 0.65 (1990) and population has been decreasing since 1973. Only in years with especially high immigration from foreign countries is this deficit of

births compensated or over-compensated. Because non-born children do not reproduce, a contractive demographic momentum develops, which becomes the negative image of the expansive demographic surge of developing countries (momentum, see Table 1). The result is a decline in labour potential (more than 200,000 per year), which in turn results in increasing demographically determined international movements, to which are added more refugees and asylum seekers, the more population growth occurs in the third world. Although the world forms a unit from an ecological point of view, demographically speaking it is divided into expansive and stagnating or contractive groups of countries. Population in the Federal Republic, without immigration and if the current rates of fertility and mortality remain constant, would sink from 80 million to 60-65 million (2030).

Considering on the one hand the effects of demographic development on the use of environmental resources and on the other the growing pollution of the environment, three classes of demographically determined factors can be distinguished: *structural effects, behavioural effects and quantitative effects.*

To the *structural effects* belong the trend to urbanisation, combined with a tendency to reduce the size of the average household in the wake of decreasing birth rate and job creation outside agriculture. Reduction in size of households combined with increase in population, raises the demand for household related products, particularly housing and energy. To the *behavioural factors* belong the increasing *per capita* consumption of industrially produced goods because of a rise of mass income following economic growth. The increase of *per-capita* consumption of consumer goods is accompanied by an increase in energy use *per capita* in developing countries. Only from a relatively high gross domestic product per head, energy consumption per head becomes stable. *Quantitative effects* refer to structural and behavioural impacts arising from changes in absolute population levels. Because of world wide population growth negative impacts multiply, arising from structural, behavioural and quantitative effects on the consumption of environmental resources and on formation of environmental pollution.

Environmental pollution can be divided into *reversible* and *irreversible*. The latter include species extinction and effects on climate. However, the divisions are not clear-cut. For example the destruction of rain forests can be considered reversible, if the growth of secondary forests is seen as a more or less sufficient compensation.

My main concern is to show that the quantitative effects of population growth can lead to dramatic strains on the environment, if they occur in combination with structural and behavioural effects. An illustrative calculation for emissions of carbon dioxide and sulphur dioxide in developing countries for the year 2020 shows that the combined effect of the increase in population according to the population projections of the United Nations (quantitative effect) with the rise in per-head emissions (behavioural or structural effect) is higher by the factor 8.5 than a mere quantitative effect of population growth in case of constant per-head emissions (Table 2). Combination of quantitative and behavioural

effect is normal because, according to contemporary expert opinion on developing countries, a temporary increase in per capita emission has to be allowed in developing countries. Otherwise the change to a self-sufficient economic growth with increasingly environmentally friendly ways of production could not be achieved.

The level of risk to the environment in developing countries will be determined by the level of increase in *per capita* emissions during the growth phase and by how long this phase will last. In the case of a - fictitious - growth of *per capita* emissions until the year 2020 to a level which equals that reached in industrial countries in the 1980s, *per capita* emission in the year 2020 - even if population is constant - would be higher by the factor 5.3 than in the case of rising population with *per capita* emission remaining constant as it did in the 1980s (Table 2).

Table 2. Growth of carbon dioxide and sulphur dioxide emissions in developing countries in case of alternative assumptions.

		Emission in developing countries in 2020 (in million tonnes)	
		carbon dioxide CO_2	sulphur dioxide SO_2
1.	Quantitative Effect: Population increasing, constant per-head emission as in the eighties	2344	52
2.	Qualitative Effect: Population (supposedly constant, per-head emission increasing to the level reached in industrial countries	12478	279
3.	Combined Effect: Population and per-head emission increasing	19909	446

Energy requirement (ER) by definition equals the product of total population (POP), gross national product per head (GNP) and energy intensity (energy consumption per unit of gross national product, EI). From this interrelation we can deduce that the growth rate of energy requirement is the sum of growth rate of population (G_{POP}), of gross national product per head (G_{GNP}) and of (negative) growth rate of intensity of energy (G_{EI}).

$$G_{ER} = G_{POP} + G_{GNP} + G_{EI}$$

Assuming - for example - a population growth rate of 1.2%, a growth rate of national product per head of 4% and a rate of decreasing energy intensity of −0.5%, the result is a growth rate of energy requirement of 4.7%. Given this assumption, energy requirement would increase by the factor 3.97 from 1990 until 2020, or by 2025 by the factor 4.99.

Around three quarters of global industrial emissions of carbon and sulphur dioxides today are apportioned to industrial countries, although they make up only a quarter of world population. But this situation is changing. If *per capita* emissions in developing countries in 2020 increase to the level reached in developing countries by the 1980s, the effect of population growth, which intensifies the problem, will lead to global carbon dioxide emissions increasing by five times (from 4783 million tons beginning of the 1980s to 24000 million tons in 2020), even if *per capita* emissions in industrial countries remain constant. One objection to this example calculation is that today's developing countries will never reach the *per capita* energy consumption or emissions reached by industrial countries in the 1980s. This will probably be correct simply because effects on climate alone would prevent this development. However, we must remain conscious of the fact that today's industrial countries are aiming for what in effect means realisation of this scenario. In my estimation, increase of emissions in developing countries will be so large that it cannot be made up for completely by measures taken in industrial countries.

The final conclusion drawn from these reflections is that we are in a race against time, a race for more and better technologies on the one hand and for environmentally orientated changes of consumer behaviour and production methods on the other. Crucial pre-requisites for winning this race are a stepping up of efforts for technological innovation, for international aid projects and for improvement of understanding by citizens and politicians of the limited possibilities of manipulation due to the momentum of demo-economic processes.

CONSEQUENCES FOR ACTION

If a discussion about possibilities for manipulating worldwide developmental and civilisation processes takes place from an isolated point of view, either economical or ecological, it is easy to over-estimate possibilities for action. In order to curb expectations of ability to influence processes, the totally different demographically determined problems of industrial and developing countries have to be kept apart, so that they can consequently be analysed in their reciprocal, problem intensifying effect (Table 3).

Table 3. Demographically determined chain of problems in industrial and development countries.

Industrial countries	Developing countries	Supra-national
1. Threatening population decline	1. Population explosion	worldwide population growth
2. Demographic increase in the percentage of old population	2. Mass unemployment of young generations	Increasing international disparities between rich and poor countries. Growing supra-national need for action. Population development is cause and multiplier of environmental problems
3. Precarious situation of welfare state institutions (pension and sickness insurance)	3. Extensive lack of state of help for old age on today's young generation	
4. Polarisation of society in reproductive and non-reproductive parts	4. Extreme difference of class regarding living standards	
5. Shortage of labour and mass immigration	5. Poverty refugees, environmental refugees, asylum seekers	
6 Ethnic and intercultural tensions and conflicts		
7. Increase in demand for state control	7. Conflicts moving to the outside and war danger	
8. Environmental problems across the borders.		

A symptom of the international demographically determined chain of problems is the current debate about changing article 16 of the German constitution (*Grundgesetz*). Following a loss of interest in the debate about asylum, problems of immigration and nationality will dominate the agenda. It will become commonly understood that immigration of younger people from foreign countries can only moderate, but not stop the inevitable increase of percentage of old people, because the - on average younger - immigrants age as do the locals. The old age quota (= relation between the number of inhabitants 65 and above to the number of 15-65 year olds) rises without migration from 0.23 to 0.50, but even if there is immigration in millions an increase to 0.40 is certain.

Table 3 includes an outline of the different demographically determined problems of industrial and developing countries. The common factor in both problem groups is that in demography, in contrast to economy, there exists few independent self-interactive variables. For example there is in the economy a supply and a demand for labour which meet in the job market, but (thanks to God) there is no supply and no demand for living born and no market for living born, on whose number, however, will depend 15 to 20 years later the supply of labour. Wages as cost of labour cannot sufficiently make up for demographically determined discrepancies between supply and demand for labour 15 years later. Therefore instability in the job market or unemployment cannot be blamed merely on failures of economic policy. Unemployment or shortage of labour are thus normal, and full employment is the exception. Demographically determined instability reaches new dimensions in developing countries with future large generations and with unemployment rates of 50% and more which can lead to social and political destabilisation and so brings down to zero the chance to actively manage those processes. The dramatic consequences of a non-directed environmentally unfriendly development, in combination with rapid population growth, need to be thought through in a similar way to the carefully balanced scenarios of the United Nations, for example regarding energy development, which always suppose that processes can be manipulated /12/. Global consequences also impair the possibilities of action in industrial countries; the effect is the greater, the more pressures increase as a result of international conflicts and civil wars.

Political control of problems is made more difficult by the fact that developing countries demand to have a *right to demographic self-determination*. They see their sovereignity restricted by international efforts in population policy. In addition, there is a right to sovereign use of environmental resources, newly propagated at the international conference "Environment and Development" (Rio de Janeiro, June 1992). As reported by the Frankfurter Allgemeine Zeitung, the Indonesian secretary for forestry threatened the deforestation of all Indonesian tropical forests - the second bigest after Brazil - should there be no end to criticism of precious wood consumption. However, Indonesia will, in all probability, not avoid deforestation of more and more tropical forest for the gain of agriculturally usable land, due to demographic reasons, because the surge of population growth surpasses by far the undisputable success of their family policy. For example, the population of the island of Java, which today has a population density of 825 inhabitant per km^2, will grow from 109 million to 191 million in 2050. The government is trying to defuse the problem through mass resetlement to the islands Borneo, Sumatra, Celebes and New Guinea, which are still largely covered by tropical rain forests. /"Transmigration Policy". p.13/

The world could be turned into a paradise even if world population doubles: laws of nature do not stand in the way. But a range of social, political and not least demographic problems could prevent us from changing the world in such a way that a symbiosis of nature, technology and culture is possible. Malthus' pro-

gnosis was that human beings are morally too inferior to solve demographically determined problems. He did not think it possible that food production could grow faster than population. In this and in many other points, which can be empirically tested, he has been proven wrong. However, the most important ideological and political parts of his "population law", which cannot be empirically tested, still take hold sway.

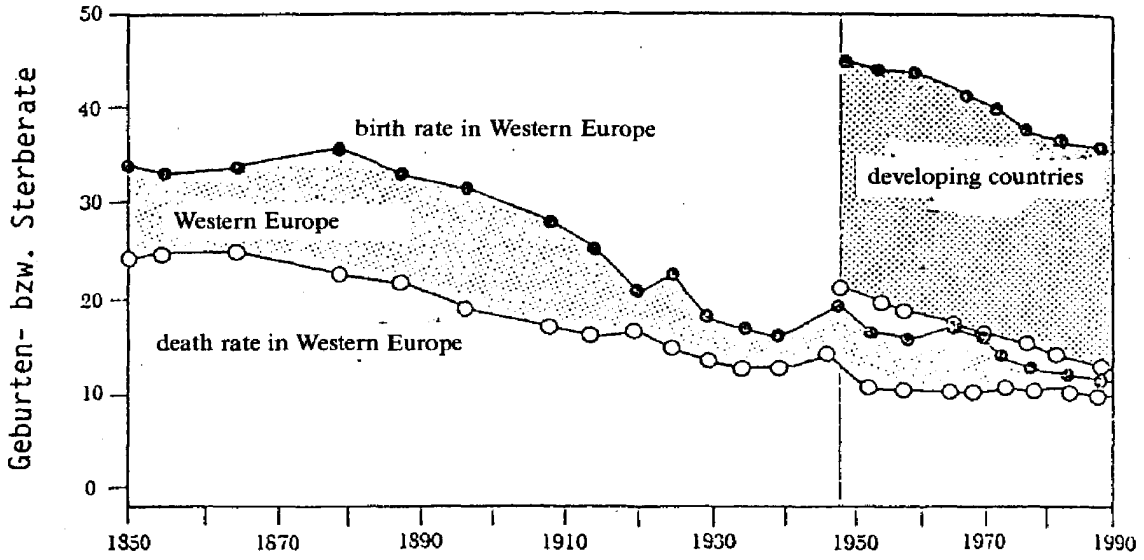

Figure 3. Historial development of birth and death rates in Western Europe and in developing countries.

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