

MODERN-DAY DEMOGRAPHIC PROCESSES IN CENTRAL EUROPE AND THEIR POTENTIAL INTERACTIONS WITH CLIMATE CHANGE

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ABSTRACT: The aim of this article is to evaluate the effect of contemporary transformations in the population of Central European countries on climate change, in addition to singling out the primary points of interaction between demographic processes and the climate. In analyzing the interactions between climate and demographics, we can formulate three basic hypotheses regarding the region in question: 1) as a result of current demographic trends in Central Europe, the influence of the region on its climate will probably diminish, 2) the importance of the “climatically displaced” in global migratory movements will increase, and some of those concerned will move to Central Europe, 3) the contribution of the region to global food security will increase.

In the last decade most of what comprises the region of Central Europe has reported a decline in population growth and a negative migration balance. As a process, this loss of population may have a positive effect on the environment and the climate. We can expect ongoing climate change to intensify migration processes, particularly from countries outside Europe. Interactions between climate and demographic processes can also be viewed in the context of food security. The global warming most sources foresee for the coming decades is the process most likely to result in spatial polarization of food production in agriculture. Central Europe will then face the challenge of assuring and improving food security, albeit this time on a global scale.

KEY WORDS: Central Europe, demographic changes, climate change, agriculture.

INTRODUCTION AND PRESENTATION OF RESEARCH TOPIC

The robust development of the global economy and witnessed increases in the numbers of people inhabiting our planet are leaving their mark on the environment. The footprints we leave have been noticed, and are being monitored and continuously assessed, by analysts. On a wider scale, public awareness of the links between humankind and the environment is also on the rise as societies around the world gain access to information about anthropogenic impacts on nature.

The influence of human activity on climate change has been a hot topic in recent discussions among environmental scientists, and one that has attracted significant attention on the part of researchers from other areas of study representing economics, and the social and technical sciences. Despite efforts mounted again and again in international research projects and endeavors, and notwithstanding dynamic exchanges of opinion both during international congresses and in thousands of academic publications, we are still at a loss to know what the exact nature and scale of our impact on the climate is. We can only be certain that this impact is increasing. We are equally unable to answer conclusively a question as regards the direction current climate change trends are heading in.

Climate phenomena and demographic processes have a mutual, bidirectional relationship that forms a complex system of direct and indirect connections. For instance, an increase in population has an effect on the climate, insofar as it implies a rise in the demand for energy and increased emissions of greenhouse gases (Dietz *et al.* 2007, Dyson 2006, Meyerson 1998), while changing climates stimulate global migrations (Hugo 2011), impact upon human health (McMichael *et al.* 2006), and can even contribute to armed conflict (Brauch 2002, Raleigh, Urdal 2007).

Our fears with respect to climate change are primarily a consequence of our increased consciousness of its detrimental effects and the dangerous weather occurrences associated with it (extreme droughts, floods, heatwaves, sea-level rise, excessive exposure to UV radiation, etc.). The effects of these processes extend to all categories of life and all areas of human activity, to the point of dealing significant blows to food security in some parts of the world.

In the last 200 years Earth's population has increased sixfold, while the level of CO₂ emissions has risen even more significantly, reaching figures twenty times higher than at the outset (Nakićenovič *et al.* 2007). It is estimated that a population increase of 1% is accompanied by a corresponding 1% increase in carbon emissions into the atmosphere (Rosa *et al.* 2004; Cole, Neumayer 2004). The vigorous growth in the concentration of CO₂ in the atmosphere is leading to a spatial polarization of our planet's climatic conditions, this in turn ensuring that living conditions become highly disparate (Bański 2009). The regions that have suffered most seriously from the damaging effects of climate change are expected to become tomorrow's areas of exodus, of outward migration flows comprising those who seek a safer and more stable life. In some cases, this has already begun. To follow the same line, the concentration

of people in “safe zones” can originate further transformations of the climate related to intensified land use or pockets of intense emissions of pollutants.

While it is difficult to identify all the elements that will underpin interactions between climate and humanity in the coming decades, this need not denote resort to fatalism or defeatism. Numerous additional factors have to be taken into account, including a growing global social consciousness of the effects of humanity’s actions on the environment; higher levels of education in the young generation; and technological progress in energy production. All this can coalesce to give a somewhat brighter picture of the points of contact between humankind and the climate.

Specifically, this article seeks to evaluate the effect of modern-day transformations in the population of Central European countries on climate change, as well as to single out primary points of interaction between demographic processes and the climate. The territorial extent of the investigated region has been defined in accordance with a Central Europe program funded by the European Union whose goal is the promotion of innovation, competitiveness, accessibility and environmental sustainability¹. The region comprises eight countries that are EU Member States (the Czech Republic, Poland, Slovakia, Hungary, Austria, Slovenia and selected parts of Italy and Germany), as well as one permanent observer (the eastern part of Ukraine). Central Europe can be split into two parts for research and other purposes: one made up of the original, “old” countries of the European Community, and another that comprises the new additions belonging to the Soviet Bloc until 1989 (Poland, Hungary, Slovakia, the Czech Republic and Slovenia). These last countries joined the European Union in 2004. We will focus the majority of our research efforts – and attention in this article – on the latter group.

Central Europe is one of the regions of the world exerting a considerable effect on modern-day climate changes. It is characterized by a very high output of energy derived from mining, extracted through the use of relatively dated machinery and technology. This ensures a role for the region as one of the primary emitters of carbon dioxide into the atmosphere. Furthermore, agriculture continues to play a significant role where land-use structure is concerned, this fact having important ramifications for the shaping and transformation of meteorological conditions. Overall, it is possible to venture the hypothesis that the influence of Central Europe on global climate change is greater than the detrimental effects of climate change it experiences.

The population of Central Europe is subject to many of the same demographic processes as apply in the other regions of the Old World. The phenomenon that contributes most to the demographic structure of the continent is that of ageing societies, the aftermath of a decline in birth rates and a parallel increase in life expectancy (Reiterer 2010). Another frequently indicated trend is the increased intensity of migration flows (Bijak 2007 *et al.*, Kupiszewski *et al.* 2008) and spatial polarization in terms of population density – a factor connected with the process of urbanization.

¹ <http://www.central2013.eu/>

DEMOGRAPHIC PROCESSES IN CENTRAL EUROPE

The population of Central Europe stands at around 150 million, and is associated with population densities in the range from 30 people per km² in remote, peripheral agricultural areas to 4000 people per km² in the largest urban centers. The divergent paths and phases demographic development in Western Europe and the Eastern Bloc followed after World War II were the source of marked heterogeneity in the demographic structure of the region. Over the past decade, two separate changes have been discernible where population fluctuations are concerned: an increase in population resulting from a positive migration balance and population growth in the central part of the region (Fig. 1), and a fall in population in eastern Germany, Hungary and southern and eastern regions of Poland, primarily as a result of outflows of population.

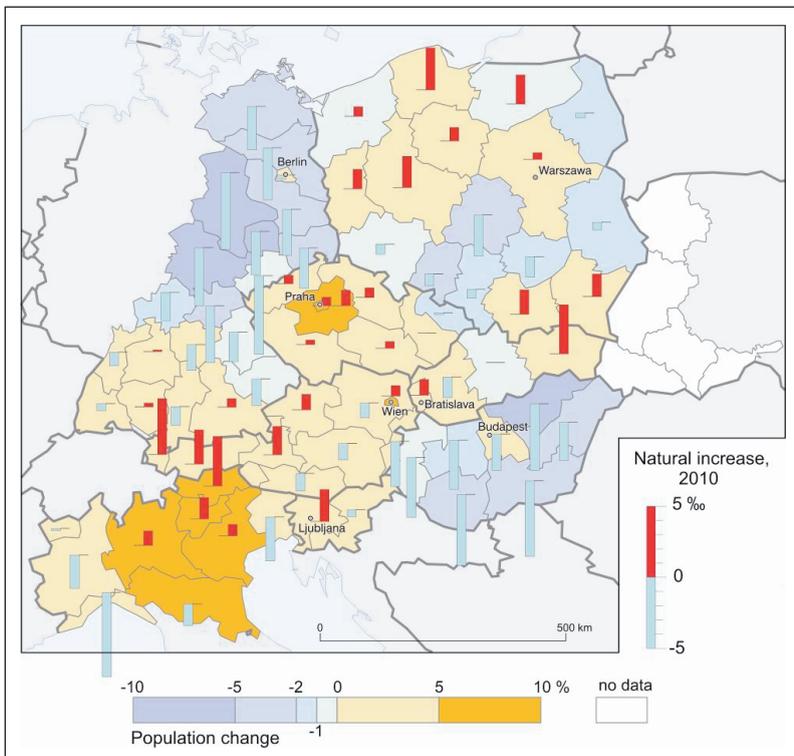


Figure 1. Population change in the 2004–2010 period and natural increase in 2010

Source: Author's own research based on Eurostat data.

The most important challenge stemming from Europe's contemporary demographic transformations is that arising from the ageing population. Societies all over Europe are ageing at an alarming rate, such that the 13.9% of the population aged over 65 in 1990 will compare with a figure as high as 24% by 2020. The age structure to the

population of the European continent (its central part included) is characterized by a gradual decline in the proportion of citizens of pre-working age, as coupled with a parallel gradual increase in the population of post-working age. This is the result of a slump in the female fertility rate, as combined with steady improvements in both the quality of healthcare and living conditions, the overall impact being to prolong the average life expectancy of the European citizen.

However, while Central Europe “is living longer with each passing year”, it is at the same time failing to secure opportunities for its population potential to be reconstructed. Young families favor the nuclear 2+1 model, often putting their professional careers first, and postponing childbirth until some point in the future. This is accompanied by changes in the cultural landscape that *inter alia* see conflicts generated between traditional and modern views of the role of women in society. This is particularly conspicuous in the eastern parts of Central Europe, and is seen most especially in terms of an urban-rural dichotomy. The overall fertility rate in the eastern part of the region fell from around 3.0 in the middle of last year to 1.2, while in other regions it ranges between 1.4 and 1.7.

One consequence of the ageing of the population will be a decline in consumption, and a parallel increase in demand for social and medical services. This will create distinct problems in the domain of financing and the economy, due to increased pressure for financing on the part of the healthcare system and welfare services. In some states of eastern Germany and peripheral areas of Poland, problems are already arising with respect to the low school attendance induced by the demographic low, as well as the inconsiderate and irrational use of the social infrastructure available. Some schools are being closed, provoking protest from local communities. Another process typical of eastern Germany is the outflow of population – mainly young women – to western regions of the same country, with the significant decrease in population that that entails.

Natural demographic changes take place but slowly, and are typically both predictable and predicted in the long run. On the other hand, changes resulting from migration are more dynamic. Generally speaking, the balance of migration in Central Europe is negative – thanks to population outflow from the relatively new Members States of the European Union to Western Europe. Those involved are commonly well-qualified individuals who fuel “areas experiencing workforce shortages” in some sectors of the Western European economy (Reiterer 2010). Migration to Central Europe, in turn, is composed by and large of individuals from non-European countries, mostly in rather small numbers. These people are in the main treating the region as just another stage in their westward “journey”. However, it is most likely that coming years will see more immigrants settling permanently in Central Europe, in line with the region’s robust socioeconomic development, and rapid improvement in living conditions.

Internal migrations are in turn characterized primarily by influxes of population in and around large urban centers (Milan, Warsaw, Prague, Budapest, etc.), these jointly constituting the most significant centers of economic development. The structure of

the incoming population is built around a core of young, highly-educated people in search of work and improved living conditions. Internal migrations shape the process whereby the population concentrates on metropolitan areas, while peripheral areas depopulate and remain depopulated – not to mention suffering seriously from the ageing of those that stay behind.

CLIMATE CHANGE IN CENTRAL EUROPE AND ITS POTENTIAL AFTERMATH

Global climate change is a corollary of the coexistence of a series of natural and anthropogenic factors. The most fundamental way in which humans further and hasten these changes is through the emission of greenhouse gases. Central Europe, and especially its easternmost sub-regions, emit an excessive amount of carbon dioxide into the atmosphere, owing to the dominant role played by conventional methods of energy production relying heavily on black and brown coal. For this reason, the diversification of energy sources is a crucial challenge for the economies of the region, with an increase in the production and use of renewable energies as its cornerstone.

Measures taken in response to changes in climate can be split into two complementary strands:

- mitigation of the detrimental effect of human activity on the climate;
- adaptation to new climatic conditions.

The European Union takes both these options into account in defining its politics in relation to climate change and the reduction of emissions of greenhouse gases by 2020². The first of these measures is to revolve around efforts to boost the production and use of renewable sources of energy and to generate clean energy. Adaptation strategies now encompass a wide range of economic sectors, including agriculture, forestry, fishing, energy, hydrology and the water industry, tourism, healthcare and insurance. Among these it is agriculture and forestry as producers of energy that play a critical role.

Current climate change processes will not have a very noticeable effect in Europe in the upcoming years. Yet even now regions of the Old World are beleaguered by extreme hydrological and weather phenomena (floods, droughts, heat waves, hurricanes and violent storms) whose intensity and scale was not quite as great in previous decades. The anomalous frequency with which these phenomena are appearing entails significant damage to the economy, as well as causing injury and loss of life in the population. Among the areas most threatened by extreme phenomena in the region are Slovenia, Hungary, Slovakia, the Czech Republic, SE and NW Poland and northern Germany (Fig. 2).

² “Europe’s Climate Change Opportunity” and “Decision No 406/2009/EC of the European Parliament and of the Council of 23 April 2009 on the effort of Member States to reduce their greenhouse gas emission to meet the Community’s greenhouse gas emission reduction commitments up to 2020”.

In Central Europe, the single greatest threat in terms of both scale and repercussions is that posed by floods. Flooding typically appears in conjunction with the spring thaw, as accompanied by intense rainfall. In 1997, for instance, Poland, Czech Republic and eastern Germany were all hit by the so-called “Flood of the Millennium”, the Oder and its tributaries throughout the basin spilling over banks, ravaging crop fields and cities alike, and destroying equipment. 56 people died in Poland alone, and damage was estimated at around \$3.5 bn (wikipedia.org/wiki/Powódź_tysiąclecia).

Flooding is *inter alia* a result of irresponsible land use. Most of the lowlands were claimed by agriculture, which meant extensive deforestation. Moreover, the areas given over for agriculture feature a marked prevalence of arable land stripped of bushes and trees. In the case of this kind of cover, the absorption of rainwater and meltwater is limited, and runoff therefore intense. The issue of flooding is of international importance because the basins of the largest rivers (e.g. the Danube and Oder) typically extend into several countries. Analysis of terrain, hydrological and weather conditions indicates that Central Europe is the most flood-prone part of the continent. This is above all true of the Danube Basin, one of Europe’s largest in association with what is also one of its largest rivers.

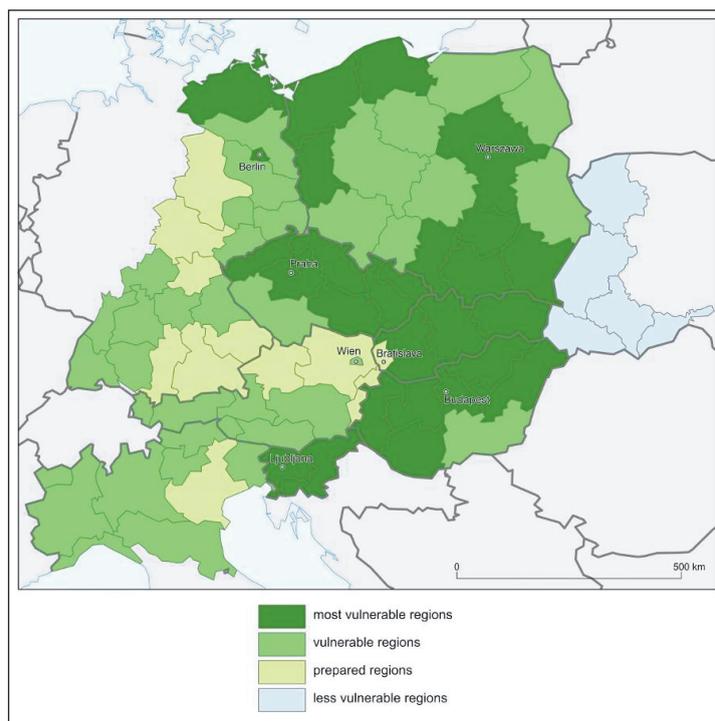


Figure 2. Vulnerability to natural hazards

Source: Author’s own research based on *Regional Challenges in the Perspective of 2020 – Phase 2: Deepening and Broadening the Analysis. Final report*, Vienna/Heisdorf/Bonn, May, 2011.

Another equally serious threat is that posed by temporary shortages of water due to summer droughts, which also degrade the quality of water. This phenomenon is a source of considerable problems in the energy sector, industry and agriculture, all of which rely on large amounts of water. The regions most vulnerable to water shortages are central and southwestern Poland and northern Italy. In addition, Poland lacks the reservoir capacity that would allow it to mitigate the adverse effects of periods of drought effectively.

Climate change can also assume a positive form. The rise in temperature and lengthening growing season in Central and Northern Europe will allow for better and more abundant harvests, and for the introduction into cultivation of new plant species. Positive results in tourism and recreation can also be expected.

DEMOGRAPHIC PROCESSES VS. CLIMATE CHANGE – A DISCUSSION

In analyzing the interactions between climate and demographics, we can formulate three basic hypotheses regarding the region in question:

- as a result of current demographic trends in Central Europe (mainly ageing and reduced population growth), the influence the region exerts on its climate will probably diminish;
- the importance of the “climatically displaced” in global migratory movements will increase, with more now migrating to Central Europe;
- the contribution of the region to the food security of the world will increase.

According to present demographic scenarios, most of the sub-regions of Central Europe will experience a decline in population and an increase in the proportion of the population that is of post-working age (Fig. 3). Average figures reported by the United Nations (2005) estimate that the period 2005–2050 will see the population of Poland fall by 17.2%; that of the Czech Republic by 17.3%; that of Austria by 1.4%; that of Germany by 4.7%; that of Italy by 12.4%; that of Slovakia by 14.6%; that of Slovenia by 17.1%; and that of Ukraine by a dramatic 43.2%. It is necessary to consider the effects of this on how the development of the climate is shaped. This is usually addressed by examining carbon emissions into the atmosphere. The first estimates of the impact of demographic changes on the level of carbon emissions was based exclusively on assessments of numbers of inhabitants and numbers of households (O’Neill *et al.* 2001). However, new models that evaluate carbon emissions are currently in development, and are based around multiple variables that include an array of economic and technological factors. The level of precision of the scales used to assess both time and space is furthermore increasing, as every successive model is fine-tuned and refined.

A tool of use in assessing the global environmental implications of demographic changes is the PET (Population-Environment-Technology) model, which takes account

of factors relating to economic growth and energy use. This framework has been used by B. C. O'Neill to investigate prospects for carbon emissions (O'Neill *et al.* 2010). Using a database comprising 34 countries that account for 61% of the world's population, possible scenarios for demographic trends defined by the UN, and two scenarios (A2 and B2) arrived at by the IPCC, the authors evaluated the impact of demographic trends on the emission of carbon. They found that levels of emissions depend, not only on population size, but also on the given region's demographic structure. It is usual for population ageing in highly-developed countries to operate in such a way that carbon emissions are reduced. In turn, in nascent economies, increased urbanization will work to drive emissions up. Thus ageing in Europe is capable of curtailing releases of CO₂ by about 20%, while intensified urbanization might increase emissions by about 5%. The equivalent figures for China and India respectively stand at -15% and +25%, and +2% and +25%.

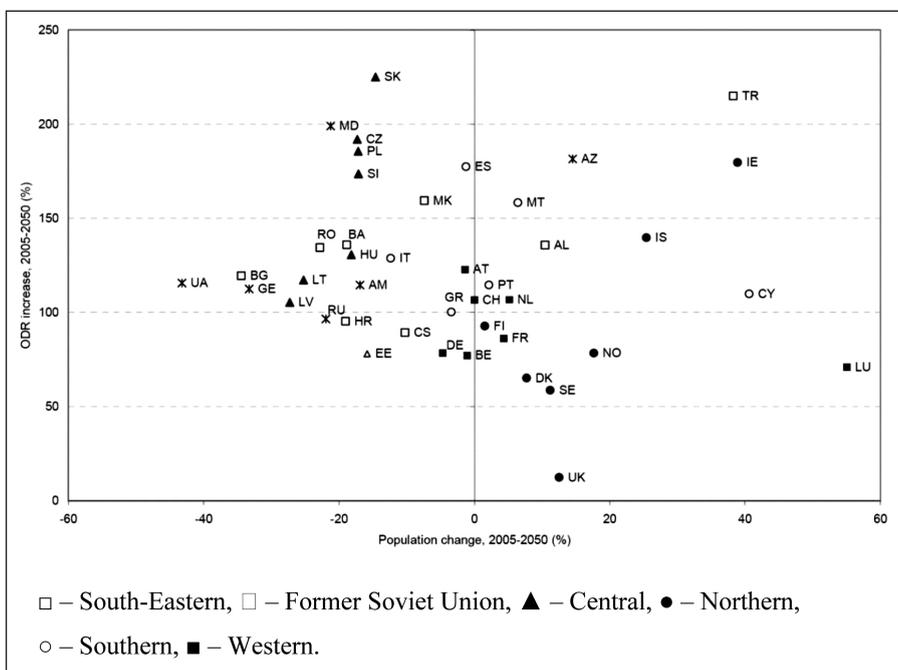


Figure 3. Population change and % growth in the Old-Age Dependency Ratio in European countries 2005–2050, according to the medium variant of the UN population projection, 2004

Source: Kupiszewski M., Bijak J., Nowok B., 2006, p. 22.

Leaving aside the social and economic impacts of demographic changes in Central Europe, the prospects for the environment can be assumed to be positive. Population decline and the phenomenon of societal ageing will play a greater role than the concentration of people in metropolitan areas. A decrease in carbon emissions is

therefore to be expected. Two strong supporting factors here will be the gradual increase in the level of education, and the introduction of energy-efficient technologies and alternative sources of energy in accordance with Directives of the European Union.

Population mobility, demographic changes and transformations in the natural environment create a so-called multidirectional interacting system. Migration processes can drive changes in the natural environment, on the one hand, while changes in the latter may just as well stimulate migration trends (Fig. 4). In eastern Poland, for example, the consequence of dynamic migration outflow and attendant population decline is for land use to become more extensive, with a resultant gradual renaturalization of the environment and the landscape ensuing (Bański 2006). These kinds of areas are often taken under the wing of the European Union's development projects, whose goal is to activate local communities through investments that are friendly to the environment (agricultural-environmental projects, the development of agritourism, biomass production and reforestation).

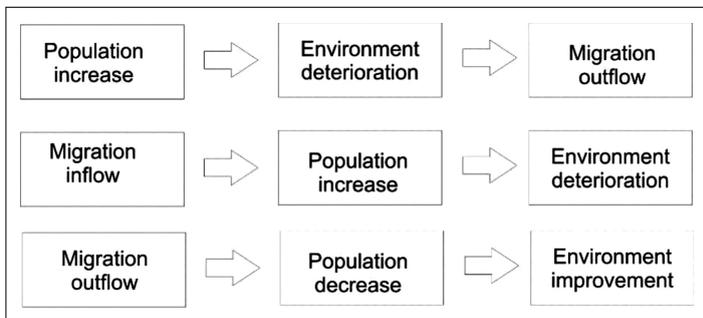


Figure 4. Selected schemes for relationships between the environment, population changes and migrations

Source: Author's own elaboration.

The increase in population on a global scale, and the concomitant transformations in the natural environment (including climate change climate) will serve to intensify migration processes. Among the areas of outflow, we can expect to see countries of southern and Southeast Asia, Africa, Latin America and the islands of the Pacific, which on the one hand are experiencing the greatest and most dynamic surges in population, and on the other are continuously plagued by droughts, floods, hurricanes and other life-threatening natural phenomena (Dilley *et al.* 2005). Here it is important to note the strong correlation between regions in which the incidence and intensity of extreme phenomena is high, and those that are affected by climate change. Hugo (2011) distinguishes five categories of area in which the influence of climate change is negative, i.e. seaside locations, river basins and deltas, low-lying islands, areas experiencing desertification and those touched by other extreme weather conditions.

Central Europe is likely to figure among the targets where inflows of migrants from the above-mentioned regions are concerned. The social and economic implications of

this are serious, and they require analysis and preparatory action at this stage. The selective influx of new citizens with a tradition of many children may also make a significant mark in the demographic structure of the “ageing” region. Examples of this include France, Norway and Spain, in which a long-established inflow of migrants from non-European nations has fed population growth. In 2002 alone there were 489 000 migrants into the European Union, of which 68% were from outside the continent, primarily Latin America (Argentina – 50 220, Ecuador – 89 249, Colombia – 34 876), Morocco – 40 520, Kazakhstan – 45 865, and Australia – 51 860 (Bijak *et al.* 2004).

The case of Central Europe has to be viewed in relation to the relatively large population outflow to the countries of Western Europe, the primary source countries being Poland and the regions of Ukraine considered in the study; as well as movement within Germany, from that country’s eastern to western states. These migrations have an economic basis and result from the liberalization of the job market in the countries of the European Union. Nonetheless, the current economic crisis has weakened East-to-West population flows across the continent, and has even encouraged some migrants to return to their home countries.

It is difficult to assess the role of climate-induced migration within the overall migration balance for Central Europe. However, as the impact of climate change in this part of the continent will be rather limited, the phenomenon of “climate-induced migration” is not likely to be induced here. In contrast, there is every reason to expect a wave of incoming migrants from parts of the world that have been hit by detrimental environmental changes. The final balance of climate-related migration in the region will thus be positive, but difficult to quantify.

Present and future interactions between climate and population processes can also be considered in the context of food security. In line with demographic forecasts, the greatest increases in population will be witnessed in countries currently affected by problems with access to food. Daily consumption over considerable parts of Central Africa is below 2000 calories per person. In order for the human body to function properly, the daily calorie intake should exceed 2400 calories. In Sub-Saharan Africa, one result of changes in climate will be extensive desertification, which will aggravate the already serious problem of malnutrition and extreme shortage of water. In turn, the effects of rising water levels will culminate in the flooding of large swathes of arable land or their intense salinization in Bangladesh (where 17 million people live between sea level and the 1m.a.s.l. contour line), Egypt, Indonesia, Mozambique, Pakistan and Senegal (Bański and Błażejczyk 2006). This brings these countries to the very edge of a population exodus.

Central Europe has agricultural and ecological conditions favorable to the development of agriculture. Global warming in the coming decades will probably entail a prolongation of the growing season likely to increase the region’s potential with respect to food production. Certain predictions are already made as regards, for instance, the geographical limits for the cultivation of crops, many of which will move

northward (Fig. 5). While today tending to limit agricultural output, Central Europe will face a challenge as regards food security that is of global significance.

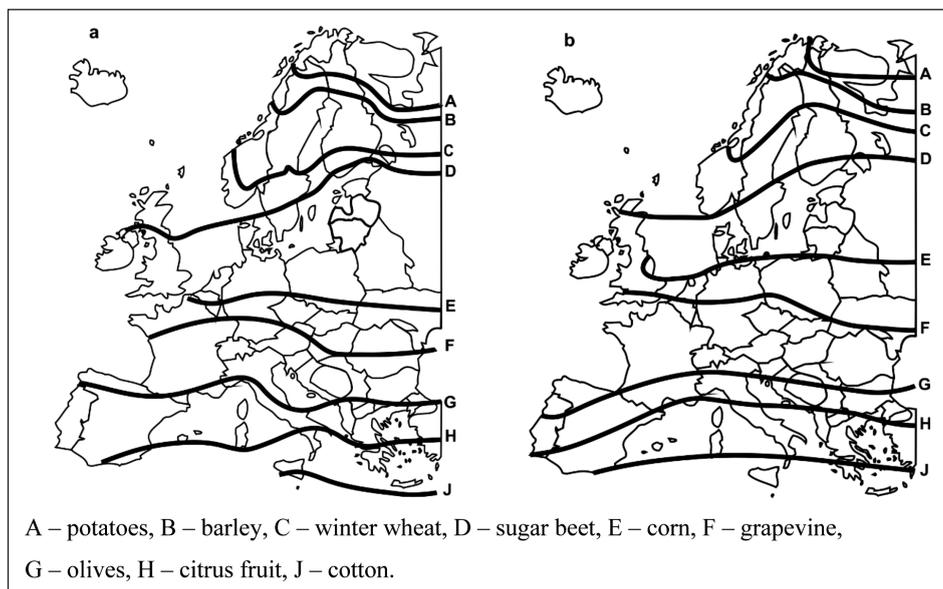


Figure 5. Northernmost limits of the geographical range of cultivation of some crops in 1975 (a) and 2075 (b)

Source: Kędziora A., 1999, p. 339.

According to Jaworowski (2008), the elevated temperature and concurrent increase in carbon dioxide emissions from oceans jointly increase net biological productivity on Earth. This particular type of fertilization by means of a natural increase in the CO₂ content of the atmosphere can be conducive to an increase in food production. For instance, in controlled experimental settings, an increase of CO₂ from 330 to 660 ppm, given optimal conditions, causes increases in production of 104% in the case of cotton, 9% for rice, 36% for barley and 4% for clover (Ryszkowski 1992). However, in natural conditions, a harvest is determined by other elements in the natural environment (e.g. water content in the soil, mineral nutrient content, fluctuations in temperature, etc.). Should these be unfavorable, they may constrain the growth of crops that reflects CO₂ concentration. For example, crop harvests depend first and foremost on day length and an optimal temperature during blooming time, as well as to a lesser extent on the concentration of CO₂ in the atmosphere. Also to be factored in is the fact that increased average temperature may leave diseases and pests more prevalent, as well as intensifying extreme weather phenomena.

In the 1939–2000 period, per capita production of barley in the world grew by 18%, while that of rice and pork grew by 35% and 200% respectively. Increased food production thus proved more robust than population growth. It is hard to determine

whether this tendency will prove durable and sustainable, or indeed what the effect of climate change on it will be. However, it would appear that, within the next several years, increases in population need not be accompanied by the problem of hunger at the global level. Equally, hunger might assume a local (or, less frequently, a regional) character, and be the result of extreme weather changes.

CONCLUSIONS

Global warming is established as the phenomenon most likely to occur in the coming decades. Paralleling this is an expected further increase in the human population. The two processes will follow markedly disparate paths in spatial terms, but it can be assumed that the most adverse effects of climate change will be felt in the regions in which population growth is most intense. Equally, it is the latter territories that may come to assume a more and more prominent role in the further determination of climate trends, primarily because of attendant increases in CO₂ emissions.

By 2050, Central Europe is expected to have experienced a population decline of at least 10% in comparison with present levels. This will be a corollary of both an ageing society and lower birth rates, while net external migration is by then foreseen to have achieved a positive balance, albeit not one large enough to play much part in shaping population in the region overall. In fact, it is anticipated that many incoming migrants will be “climate refugees”, primarily from Sub-Saharan Africa and some countries in south Asia.

Bearing the above in mind, and juxtaposing it with anticipated technological development and ongoing pursuit of EU energy policies as currently formulated, it is possible to foresee a declining influence of Central Europe on climate change – and first and foremost on amounts of CO₂ emitted. On the other hand, the impact of changes in climate will be palpable in the region, assuming the form of increased average temperature and a greater intensity and frequency of extreme weather events (floods, droughts and hurricanes).

Climate changes on the global scale will enhance the spatial polarization of food production already observable. Central Europe’s role in securing food for populations outside Europe will increase, and an extended growing season in the northern latitudes more likely to contain economically mature and developed countries will generate a visible rise in production potential. The Tropics and the area around the Equator may experience a “relative” decrease in the productivity of agriculture, only enhanced by desertification and sea-level rise. Ultimately, these changes may combine to generate surpluses of food in affluent countries and shortfalls in production in less-developed countries. This phenomenon will only be intensified by migration flows.

REFERENCES

- Bański J., 2006, *Geografia polskiej wsi, (Rural Geography of Poland)*, PWE, Warsaw.
- Bański J., 2009, *Zmiany gospodarki rolnej i zabezpieczenia żywnościowego ludności w wyniku zmian klimatycznych, (Impact of Climate Change on Agriculture and Food Security)*, [in:] M. Guty-Korycka, T. Markowski (eds), *Zrównoważone warunki życia w zmieniającym się systemie klimatycznym Ziemi, (Global Climate Change and Sustainable Conditions of Life)*, Studia KPZK PAN, 74, 64–74, Warsaw.
- Bański J., Błażejczyk K., 2006, *Globalne zmiany klimatu i ich wpływ na rolnictwo, (Impact of Global Climate Change on Agriculture)* [in:] *Przemiany środowiska geograficznego Polski Północno-Zachodniej, (Environmental change in North-West Poland)*, Ogólnopolska konferencja naukowa poświęcona pamięci Profesora Bogumiła Krygowskiego, (A tribute to Professor Bogumił Krygowski – conference), UAM, Poznań, 173–175.
- Bijak J., Kupiszewski M., Kicinger A., 2004, *International migration scenarios for 27 European countries, 2002–2052*, CEFMR Working Paper, 4, Warsaw.
- Bijak J., Kupiszewska D., Kupiszewski M., Saczuk K., Kitzinger A., 2007, *Population and labour force for 27 European countries, 2002–2052: impact of international migration on population ageing*, *European Journal of Population*, 23, 1, 1–31.
- Brauch H.G., 2002, *Climate change, environmental stress and conflicts*, [in:] *Climate change and conflict*, pp. 9–112, Federal Ministry for the Environment, Berlin.
- Cole M.A., Neumayer E., 2004, *Examining the impacts of demographic factors on air pollution*, *Population and Environment*, 26, 5–21.
- Dietz T., Rosa E.A., York R., 2007, *Driving the human ecological footprint*, *Frontiers in Ecology and the Environment*, 5, 13–18.
- Dilley M., Chen R.S., Deichmann U., Lerner-Lam A.L., Arnold M., 2005, *Natural Disaster Hotspots: A Global Risk Analysis*, The World Bank, Washington DC.
- Dyson T., 2006, *On Development, Demography and Climate Change: The End of the World as We Know it?*, *Population and Environment*, 27, 2, 117–149.
- Hugo G., 2011, *Future demographic change and its interactions with migration and climate change*, *Global Environmental Change*, doi: 10.1016/j.gloenvcha.2011.09.008, in press
- Jaworowski Z., 2008, *Idzie zimno, (Global Climate Cooling)*, *Polityka*, 15.
- Kędziora A., 1999, *Podstawy agrometeorologii, (Agrometeorology)*, PWRiL, Poznań.
- Kupiszewski M., Bijak J., Nowok B., 2006, *Impact of future demographic changes in Europe*, CEFMR Working Paper, 6, Warsaw.
- Kupiszewski M., Bijak J., Kaczmarczyk P., Kicinger A., Kloc-Nowak W., Napierała J., 2008, *Poland*, [in:] *Permanent or circular migration? Policy choices to address demographic decline and labour shortages in Europe*, E. Hoenekopp, H. Mattila (eds), Budapest: International Organization for Migration, Regional Mission for Central and South Eastern Europe, 149–181.
- McCarthy J., Canziani O., Leary N., White K., 2001, *Climate change 2001: Impacts, adaptation and vulnerability*, Geneva, Intergovernmental Panel on Climate Change.
- McMichael A., Woodruff R., Hales S., 2006, *Climate change and human health: current and future risks*, *Lancet*, 367, 859.

- Meyerson F.A.B., 1998, *Population, development and global warming: Averting the tragedy of the climate commons*, *Population and Environment*, 19, 443–463.
- Nakićenović N., Fisher B., Alfsen K., Corfee Morlot J., de la Chesnaye F., Hourcade J.C., Jiang K., Kainuma M., La Rovere E.L., Rana A., Riahi K., Richels R., vanVuuren D.P., Warren R., 2007, *Issues related to mitigation in the long-term context*, [in:] B. Meta, O. Davidson, P. Bosch, R. Dave, L. Meyer (eds), *Climate change 2007: Mitigation of climate change*. Contribution of Working Group III to the fourth assessment report of the Intergovernmental Panel on Climate Change, Cambridge, Cambridge University Press.
- O'Neill B.C., MacKellar L., Lutz W., 2001, *Population and Climate Change*, Cambridge University Press, Cambridge, UK.
- O'Neill B.C., Dalton M., Fuchs R., Jiang L., Pachauri S., Zigova K., 2010, *Global demographic trends and future carbon emissions*, *Proceedings of the National Academy of Sciences*, 107, 41, 17521–17526, New York.
- Raleigh C., Urdal H., 2007, *Climate change, environmental degradation and armed conflict*, *Political Geography*, 26, 674–694.
- Reiterer A.F., 2010, *Migration and the Demographic System in East Central Europe*, *Journal of Diplomacy and International Relations*, 11, 1, 115–128, John C. Whitehead School of Diplomacy and International Relations.
- Rosa E.A., York R., Dietz T., 2004, *Tracking the anthropogenic drivers of ecological impacts*, *Ambio*, 32, 509–512.
- Ryszkowski L., 1992, *Efekt cieplarniany a zmiany w rolnictwie, (Impact of greenhouse effect on changes in agriculture)*, [in:] *Globalne zmiany środowiska naturalnego wyzwaniem dla ludzkości, (Global environmental change as a challenge for humanity)*, Materiały konferencji, PAU Kraków, Komitet Narodowy Programu – Global Change, MOŚZNiL, PAN, Kraków, pp. 83–90.
- United Nations, 2005, *World Population Prospects: The 2004 Revision*, New York, UNDESA, Population Division.