Pergamon

S0959-3780(96)00014-3

Global Environmental Change, Vol. 6, No. 3, pp. 187–192, 1996

0959-3780/96 $15.00 + 0.00

Viewpoint

Security risks of global environmental changes

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Today's world is characterized by rapid changes. Socio-economic changes are accompanied by increasing environmental pressures on natural resources. Decrease in quality and quantity of resources, rapid population growth and unequal access to resources are the main three factors that determine – through increased scarcity of resources – decreasing environmental security, and consequently risks of population displacement, social instability and possibly even violent conflict. In a 'Conventional Development' scenario world, rapid growth of population and economy, and the associated demands for food, water, energy and raw materials lead to increased environmental pressures and associated scarcity of resources, and thus, to increased security risks. Most important for the majority of conflicts, those within countries or regions, is the increasing scarcity and inequitable distribution of renewable resources, notably fresh water resources and arable land. These risks are exacerbated by large-scale environmental changes, such as climate change. Risk of conflicts between countries can be increased by the scarcity and

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While skeptics claim that environmental degradation only forms a minor factor in bringing about civil strife, recent analysis suggests that the environment is very important in addition to political, social and economic factors. According to Homer-Dixon,[1] the decrease in quantity and quality of resources, rapid population growth, and unequal resource access are the basic drivers behind increasing environment related security risks. Notably renewable resources like water and land are crucial factors in security issues, especially with respect to instability and migration *within* countries or regions. The vast majority of post second World War conflicts has been of a domestic rather than of an international kind.[2] In addition, it should be noted that scarcity of non-renewable resources may contribute to instability: especially in the international context the struggle for resources has been a principal reason for conflicts *between* countries (take oil as example). The question arises as to how such environmental stresses and the associated risks will evolve. In the following, I consider possible future developments of the environment related underlying causes of social instability and conflict.[3]

A 'Conventional Development' scenario and its potential implications for environmental security

Let us take a comprehensive, imaginary but plausible 'business-as-usual' scenario for world development. The 'Conventional Development' scenario of the Stockholm Environment Institute (SEI) describes a set of assumptions for the basic driving forces population and economy and the derived demands for energy, land and food, and water.[4] By 2050, these assumptions lead to approximately a doubling of the world population and more than a quadrupling of the economic output as expressed in GDP. These developments lead to derived demands of energy, food and water that are growing along with population and economy, but tempered by efficiency improvements.

Energy

As to energy, while global demand increases by a factor of 1.7 by 2015 and 2.7 by 2050, supply remains dominated by fossil energy resources in the scenario. Global average per capita consumption increases by 17% by 2015 and 40% by 2050. What could be the implications of this scenario for environmental resources and environ-

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unequal distribution of renewable resources too, but also by scarcity of non-renewable resources. An example is the increased concentration of fossil energy supply (notably oil and gas) in a limited number of politically unstable world regions.

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[1]T F Homer-Dixon, J H Boutwell and G W Ratjens: 'Environmental change and violent conflict', *Scientific American*, 1993
[2]C Thomas, 'The Environment in International Relations', The Royal Institute for International Affairs, London, 1992
[3]UNEP has commissioned RIVM to perform a global, model-based assessment of the environmental consequences of projected socio-economic developments as a contribution to the planned Global Environmental Outlook that will be published in late 1996 to support the comprehensive 1997 review of the achievements towards implementing Agenda 21, 5 years post-Rio. This 'viewpoint' offers some of the preliminary results of this study, but the views expressed are those of the author only. The environmental implications of the assumed socio-economic developments have been analysed with a set of models available at RIVM, primarily the IMAGE-model for climate and land use, J Alcamo (ed) *IMAGE 2.0: Integrated Modelling of Global Climate Change*, Kluwer Academic, 1994
[4]P Raskin, M Chadwick, T Jackson and G Leach 'The Sustainability Transition: Beyond Conventional Development', Stockholm Environment Institute, Boston, 1995a; P Raskin, E Hansen and R Margolis 'Water and Sustainability: a Global Outlook', Stockholm Environment Institute, Boston, 1995b; P Raskin, and R Margolis 'Global Energy in the 21st Century: Patterns, Projections, and Problems', Stockholm Environment Institute, Boston, 1995; G Leach, 'Global Land and Food in the 21st Century: Trends and Issues for Sustainability', Stockholm Environment Institute, Boston, 1995
[5]R J Swart *Climate Change: Managing the Risks*, dissertation, Free University, Amsterdam, 1994
[6]*Ibid*
[7]R Engelman, and P LeRoy: 'Conserving Land: Population and Sustainable Food Production', *Population Action International*, Washington, DC, 1995

mental security? While global energy demand grows by a factor of 2.7 by 2050, intensity only decreases by a factor of 1.7, leading to increasing energy demand and – while the energy system remains to be based primarily on fossil fuels – associated emissions. First, under the scenario, the development of energy supply will increasingly disturb the geo-biochemical cycles including, but not limited to, those of carbon (climate change) and sulphur (acidification). With the emissions of carbon and other greenhouse gases rising throughout the scenario period, the goal of the Framework Convention on Climate Change – stabilization of concentrations – is not in sight in the scenario. Therefore, the risks of impacts of climate change for agriculture, ecosystems and other systems are very real. As to acidification, while in Europe and North America progress in being made towards internationally co-ordinated control of emissions, many developing regions are now increasingly satisfying the two conditions for acidification problems: vulnerable soils and high emissions of acidifying compounds. Similarly, global and regional cycles of nitrogen and phosphorus are increasingly affected by human activities. The disturbance of large-scale cycles is increasingly having negative impacts on renewable resources like water and land, and thus on associated environmental security.

A second risk factor may result from the expected significant changes in the composition of the energy industry and fuel trade patterns. After the oil crises in the seventies, additional sources were identified and exploited world-wide, decreasing the dependence on Middle East oil. These sources were often smaller and less accessible than those in the Middle East. In the 1990 IPCC Business-as-Usual and the 1992 IPCC IS92a scenarios (very much similar to the CD scenario) world energy production (notably oil and gas) is (re-)concentrating in the Middle East:[5] in the scenarios, the contribution of this region to the world's oil supply more than doubles from 18% to 40% between 1985 and 2025. The self-sufficiency ratio of the OECD countries decreases from 50% to 30% during that same period.[6] Concentration of fuel supply in politically not very stable regions may have serious security implications as the Gulf War has demonstrated.

Land

As to food, the scenario assumes a convergence of dietary patterns towards current western standards. This implies, in addition to overall nutritional improvements, a shift towards more luxury food, such as animal products. While the fraction of animal products in the developed regions remains relatively stable at 30%, in the developing countries it is assumed to increased from 10% now to 17% by 2050. Total global agricultural demand increases by a factor of 1.6 by 2015 and 2.0 by 2050 in the scenario.

Food demand can theoretically be met by a combination of (1) increased productivity, (2) additional extension of agricultural lands and (3) increased trade. But even under the assumptions that (1) global productivity will continue to increase (up to a factor of 1.7 by 2050) by increased cropping intensity and increasing yields and (2) local and regional deficits will be supplemented by increasing imports, considerable natural lands would have to be converted, especially in Africa and Asia. Agricultural lands (including pasture and marginal agricultural lands) will increase from one-third to one-half of the earth's land mass. Erosion and other forms of land degradation may further exacerbate these trends. What remains is predominantly mountainous, boreal/subpolar, arid or semi-arid areas which are in general not very suitable for agricultural development (the 'last frontier'). With only limited options for expansion of agricultural land, a doubling of population (more in many regions) and increasing food demands, it is evident that the amount of arable land available per person is declining rapidly, exacerbated by loss of arable land to urban expansion and land degradation.[7] According to Engelman and LeRoy, between 1 and 3 billion people could live in conditions of arable land scarcity by 2025 in the low

and high UN population projections, respectively. Arable land scarcity is defined here as 0.07 ha/capita, below which self-sufficiency would only be achievable by intensive modern inputs or imports. Clearly, these last two options are not impossible and theoretically technologies and methods are available today to meet increasing demands. For example, amongst the countries with less than 0.07 ha per person, the Netherlands, Switzerland and Japan demonstrate that 'doing more with less' land is quite possible. However, poor countries in North and sub-Saharan Africa, the Middle East and South and Central Asia are or will soon be below this threshold. For these countries, it is questionable as to whether they can afford to intensify or import the necessary food supplements.

Self-sufficiency may not improve in large regions in Africa and Asia, including the Middle East. Rapidly industrializing countries, such as China, may increasingly import grains to supplement their own production, including feed needed for livestock to satisfy increased demand for meat and dairy products. The consequences of the possibly resulting increasing market prices for poorer regions are uncertain. They may well lead to hunger and migration in certain areas, eg in sub-Saharan Africa. Theoretically, higher prices may also boost local agricultural production, but it is uncertain if the necessarily resources to do this can be deployed rapidly enough to avoid malnutrition problems. In fact, increased legal or illegal migration from overpopulated areas in China or Central Asia to Siberia where climate change may make conditions more favourable for agricultural production is not beyond the imagination and may have important security implications.

Water

The main increases in water withdrawals will be determined by industry and the domestic sector as a result of economic development. In contrast, the prospects for increased irrigation – in most countries the main water consumer – are considered bleak in the scenario, leading to a global increase in water withdrawals by only a factor 1.4 by 2015 and 1.7 by 2050. According to Engelman and Leroy,[8] between 1990 and 2025 the number of people living in water scarce regions will rise from 131 million to around 1 billion.[9] In the late 1980s, nine countries in the Middle East withdrew more water than the sustainable supply.[10] At the sub-national or local level, this mining of fresh water resources is occurring even more frequently, including in the USA. Recent analysis (RIVM, in preparation) at the level of more than 110 catchment basins suggests that in large areas in West and Central Asia, in East and North Africa, and in the southern and western United States withdrawals are already exceeding sustainable long-term supplies. Almost half of the total world land area lies in international river basins, varying from 40% in North and Central America to 65% in Asia. In Africa, 23 countries have more than 75% of their area in international river basins. The political risks of water scarcity, especially in the Middle East have been analysed regularly.[11] Already, tensions about water in the Jordan and Tigris-Euphrates basin are severe. The same applies to the Ganges and Indus basins in South Asia[12] and the Nile basin.[13] According to model calculations by Morita *et al*,[14] water supply in many catchments can significantly change under a changed climate, varying from a doubling of annual water discharge to less than half for a doubling of atmospheric carbon dioxide concentrations, which is expected some time in the next century. The place and size of these precipitation changes are particularly uncertain.

Biodiversity

The consequences for biodiversity are significant. In the scenario, natural area decreases globally, but especially in the developing regions in Africa and Asia: from around two-thirds to about half. Ecosystems in the tropical and subtropical areas are especially affected. The areas at risk increasingly include nature reserves and the regions where the original varieties of the

[8] R Engelman and P Leroy: 'Sustaining water: population and the future of renewable water supplies', *Population Action International*, Washington, DC, 1993

[9] Engelman and LeRoy use a benchmark of 1000 m^3 per person per year to define water scarcity

[10] P H Gleick, (ed) *Water in Crisis*, Oxford University Press, 1993

[11] S C McCaffrey, 'Water, International Politics and Law', in P H Gleick, (ed) *Water in Crisis*, Oxford University Press, 1993

[12] *Ibid*

[13] T F Homer-Dixon, 'Environmental Scarcity and Violent Conflict', *International Security*, Vol 19, No 1, 1994, 5–40

[14] T Morita, M Kainuma, H Harasawa, K Kai and Y Matsuoka 'Long-term Global Scenarios based on the AIM Model', National Institute for Environmental Studies, Tsukuba, Japan, 1995

world's main staple crops are found. In addition, the remaining areas are increasingly fragmented, further weakening the flexibility of ecosystems to adapt, for instance to an altering climate. The quality of remaining ecosystems and their associated biodiversity is also increasingly at risk due to the increasing pressure from anthropogenic activities, directly as in exploitation (wood and other products) but also indirectly as through climate change.

Health

The consequences of the economic assumptions for health and population on the short- to medium-term appear quite promising, but on the longer-term they are more ominous. The positive developments for human health – as expressed in (disease-adjusted) life expectancy – of the last decades are assessed to continue in most regions. In the scenario, an epidemiological transition takes place from communicable to chronic diseases in all regions, with associated decreases in child mortality. Also, increasing incomes offer the possibility of increasing education and availability of reproductive health care. The continuation or acceleration of declining fertility rates that can be observed in most developing countries today may therefore well lead to stabilizing population levels within the next century. However, on the longer-term the environmental changes referred to above may well limit further advances in human health. Maybe more importantly, in the shorter-term there are important exceptions to the general positive trends, notably in Africa, South and West Asia, and in urban areas around the world, particularly in developing countries. These serious problems are closely related to inequitable distribution of resources and associated poverty, and thus to the risk of environmental insecurity.

Discussion: uncertainties and alternative futures

The 'Conventional Wisdom' scenario summarized above sketches a world that is on average wealthier, healthier and better educated than today. Unfortunately, this positive development of economic and human 'capital' seems to go at the expense of unmanaged natural 'capital'. Also, there are very significant regional and sub-regional variations to these global trends. Evidently, the scenario is not necessarily the most likely or desirable future. At a first glance, the positive socio-economic developments in the scenario may suggest that potential environment related security risks may decrease: population growth decreases, incomes increase and resource demands are increasingly met. Here, three aspects are particularly important.

First, the summary at the globally and regionally averaged level masks important sub-regional, national and local exceptions to the general trends. This is especially relevant for renewable resources like land and fresh water. Also, the increasing income levels hide the remaining income gap between and within regions. In fact, over the scenario period the income inequality between regions increases up to 2015 before slowly declining. Differences within regions are likely to remain or increase similarly.

Second, as in all scenario analysis the findings are dependent on the validity of the assumptions underlying the scenario. In the period considered (more than half a century) the rapid developments in the world today defies any serious attempt to 'predict' or even 'project' future developments. The scenario is only used to structure the basis for analysing the issues. For population, demography can be expected to develop between relatively narrow bounds for the coming 20–30 years due to the built-up momentum in the population system. However, on the longer-term, large variations are possible. The decline of fertility towards 2.1 as assumed in typical 'medium' population scenarios is by no means certain. If the decline did not take place as rapidly or as much as assumed, a considerably larger and younger population would result. Similarly, economic development and its distribution may develop more or less positively than in our scenario. Strengthening of the economic growth

in important areas with environmental security risks, such as Africa, the Middle East, South Asia and the republics of the former Soviet Union may decrease poverty and social tension. Alternatively, failure to achieve the assumed economic growth or failure to distribute its benefits equitably may lead to higher security risks. The eventual pressure on the environment is also dependent on resource use efficiency that is largely determined by technology. In the scenario continuing, but declining, efficiency increases in the use of energy, land and water have been assumed. This factor is particularly uncertain. The development and implementation of new innovative technologies may enable stable or even accelerating efficiency improvements that would lead to lower environmental pressures. On the other hand, lack of incentives may lead to lower efficiency increases than assumed in the scenario or the failure to distribute existing technologies adequately. This would lead to higher environmental pressures.

Third, not all environmental problems have been mentioned. Examples are the spreading of persistent toxic chemicals and hazardous wastes, unsustainable fisheries, the depletion of the ozone layer, eutrophication of fresh water resources, pollution of oceans and coastal zones, land degradation and others. Therefore, at a second glance, it becomes clear that the three indirect causes of conflict mentioned above – population growth, quantity and quality of resources, and unequal access to resources – all point in the direction of higher rather than lower security risks.

Futures fundamentally different from the 'conventional development' paradigm are certainly possible or maybe even likely. As indicated above, it is uncertain if the assumed developments in the CD scenario can be achieved. If social, political environmental or economic developments turn out to be less beneficial, the world may well fall back into chaos and despair. As Homer-Dixon *et al.*[15] note, dwindling natural resources can weaken administrative capacity and authority of government, which may create opportunities for violent changes to the state by political and military opponents. In what can be called a 'Barbarization' future,[16] pockets of wealth behind barbed wire survive in a world where the majority of people are poor and desperately trying to secure shelter, food and water. Alternatively, dependent on one's optimism or pessimism, brighter futures are possible. A future where qualitative changes for the better address inequality and reverse environmental degradation is fortunately not beyond imagination. Wealth may increase further but may saturate at a certain point in time. Sharp declines in fertility could lead to a relatively small population size. In terms of resource use, transitions in the use of water, land, energy and materials would then lead to sustainable supplies. In such a future security risks related to environmental degradation and resource scarcity are likely to decrease.

Conclusions

What can we conclude from the above from the viewpoint of environmental security? Thinking along the lines of the 'conventional development' paradigm we may infer that all three proximate causes of conflict listed at the beginning of this viewpoint tend to increase in importance: population, decrease in quality and quantity of resources and unequal access to these resources. Population growth continues, albeit at a lower rate, renewable resources show a marked increase in depletion, and remaining resources are inequitably distributed. It can be concluded that environment related security risks in a 'conventional development' world are likely to increase. It may even be argued that, if negative developments – which we can discern in some of the poorest regions of today's world – would persist and spread, a spiralling excalation of environmental degradation and social instability may ensue. On the other hand, in that same world of today we can also discern many positive developments towards higher efficiencies in resources use and the

[15]Homer-Dixon, *op cit*, Ref 1
[16]P Raskin, G Gallopin, A Hammond and R J Swart 'Global Scenarios and Sustainability', Stockholm Environment Institute, in preparation

mitigation of poverty in many developing regions. Technologies and methodologies that are known today can significantly increase productivity in the use of energy, land and water alike and reduce environmental pressures. If these developments prevailed, risk reduction could be the result.

It is impossible from the rough analysis in this viewpoint to derive impending security risks. A fuller analysis of the social, economic, political, and institutional conditions and their environmental consequences would be needed. The analysis, however, does confirm that the areas where environmental factors play an important role in determining security are characterized by a combination of high population growth, scarcity and unequal distribution of (renewable) resources. This poverty related combination occurs especially in Africa, the Middle East, South and East Asia (China). Also, it is evident that affluence related global and regional environmental problems, such as acidification and climate change, could exacerbate sub-regional and local degradation of renewable resources such as land and water. Interdisciplinary research is needed to investigate these issues related to environmental security and sustainable development and consequently assist in the development of early warning and evaluations of options to reduce environment related security risks. Politically, it may be time to give environmental degradation its proper attention as one of the core threats to domestic and international security.