

ECOLOGICAL-ECONOMIC ANALYSIS OF CLIMATE CHANGE ON FOOD SYSTEM AND AGRICULTURAL VULNERABILITY: A BRIEF OVERVIEW

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Introduction

The agricultural sector is critical to social and economic progress, particularly with regard to the eradication of hunger and poverty, the creation of employment and livelihood-earning opportunities, and the generation of trade and foreign exchange earnings. Agriculture is also at the core of environmental concerns over the management of natural resources – land degradation, water scarcity, deforestation, and the threat to biodiversity. And yet agriculture has been marginalized, at both national and international levels. Agriculture essentially concerns the relationship between the natural environment and human society. With rapid population growth, securing the inherent vulnerability of this relationship, whether social, economic, or environmental, has to be central to efforts to achieving sustainable development. The focus on people – their scope, rights, capabilities, limitations, and opportunities – has multiple benefits for individuals and society; yet it is the rural population that has to be central in agricultural development efforts (FAO, 2001).

Land-use and land-cover change are significant to a range of themes and issues central to global environmental change. Alterations in the earth's surface hold major implications for the global radiation balance and energy fluxes, contribute to changes in biogeochemical cycles, alter hydrological cycles, and influence ecological balances and complexity. Through these environmental impacts at local, regional, and global levels, land-use and land-cover changes driven by human activity have the potential to significantly affect food security, renewable fresh-water resources, and the ecological sustainability of the agricultural supply systems. Increases in the concentration of atmospheric greenhouse gases are leading to future climate change. A consensus has emerged that developing countries are more vulnerable to climate change than developed countries, because of the predominance of agriculture in the economies of these countries, the scarcity of capital for adaptation measures, their warmer baseline climates, and their exposure to extreme events. Agricultural vulnerability divided into three major parts e.g. social vulnerability, economic vulnerability, environmental vulnerability.

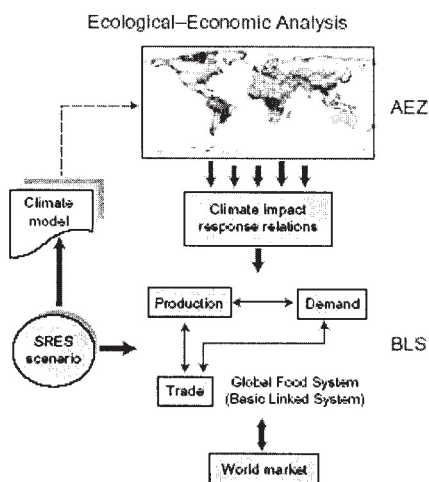


Figure 1. Integrated ecological-economic analysis of the impact of climate change on food and agricultural systems (Fischer et al, 2002)

Social Vulnerability

Many factors contribute to social vulnerability, including rapid population growth, poverty and hunger, poor health, low levels of education, gender inequality, fragile and hazardous location, and lack of access to resources and services, including knowledge and technological means. And when people are socially disadvantaged or lack political voice, this vulnerability is exacerbated further. Over the next 50 years, the world population is projected to increase by some 3 billion, primarily in the developing countries. This increase in population, mainly in sub-Saharan Africa, South Asia, and the Middle East, is expected to be larger than during the period of rapid growth over the last quarter-century (IPCC, 2000). This high rate of growth and agriculture's crucial role in overall rural development mean that in the initial stages this sector will have to absorb many of the new entrants into the rural labor force.

Economic Vulnerability

The economic vulnerability of agriculture is related to a number of interacting elements, including its importance in the overall national economy, trade and foreign-exchange earnings, aid and investments, international prices of agricultural commodities and inputs, and production and consumption patterns. All of these factors intensify economic vulnerability, particularly in countries that are poor and have agriculture-based economies. At the world level, the share of agriculture in total gross domestic product (GDP) in developing countries is about 13%, in contrast to 2% in developed countries. (IPCC, 2001, Farkas et al, 1997, 2003a,b).

Environmental Vulnerability

In the 21st century, we now face another, perhaps more devastating, environmental threat, namely global warming and climate change, which could cause irreversible damage to land and water ecosystems and loss of production potential. We cannot be complacent, not when the foundation of human survival, that is, the need for food, may be at risk due to the global-change-induced environmental vulnerability of natural ecosystems. Combating climate change is vital to the pursuit of sustainable development;

equally, the pursuit of sustainable development is integral to lasting climate-change mitigation. And the most pressing challenge is to strengthen the social, economic, and environmental resilience of the poorest and the most vulnerable against climate change and variability (CIESIN, 2002).

Effects of Global Climate Change and Land Use Practices (Socio-economic tendencies) on Agriculturally Used Ecosystems

The ecological effects of land use and its changes can not be understood mechanistically. We consider some examples from Hungary. From the point of view of carbon uptake the comparison of different management shows that there was a great difference between the extensively and intensively managed grassland sites and that the land use practice itself directly influences the greenhouse gas balances (Tuba et al., 2004). The intensive treatments (meadow fertilized and irrigated sites) had higher carbon sink activity, but higher source activity in the drought period of the year (Czóbel et al., 2005). The extensively grazed grassland site had a drought tolerant character; this grassland was less sensitive to the summer drought stress than the not grazed meadow. This pattern is more complex if we consider the effects of inter-annual climatic variability on the carbon balance of the ecosystems. e.g. the grasslands (Campbell et al., 2000). The intensively managed (fertilized and irrigated) grasslands have extremely increased carbon sink capacity which can modify the rate of air CO₂ accumulation trend. This latter is also important from the direct ecological consequences of the increased air CO₂ concentrations alone (Tuba et al., 1994; Tuba, 2005), regardless from the effects of global climate change and land use practice (Campbell et al., 2000). As a consequence of the above the land use practice and changing climate together with the increasing air CO₂ concentrations do influence interactively the ecosystem functions which are modifying and forming the social and economic processes involved in the processes of Kyoto protocol (Tuba et al., 2004; Tuba 2005).

Conclusions

This review describes that due to rapid globalization, vulnerability in different areas affects human life. With rapid population growth, securing the inherent vulnerability of this relationship, whether social, economic, or environmental, has to be central to efforts to achieving sustainable development. The vulnerability of agricultural systems varies with geographic location, time, socioeconomic conditions, and environmental resources. The capacity to mitigate and to adapt to climate-change impacts is strongly related to the future development paths. The socioeconomic and, even more so, the technological characteristics of different futures strongly affect emissions, hence the extent and pace of the impacts of climate change, as well as the capability of societies to adapt to and mitigate climate change. The presented review gives a brief idea about ecological-economical analysis of climate change and agricultural vulnerability and how it affects human life.

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References

- Center for International Earth Science Information Network (CIESIN), Columbia University, 2002, Country-level Population and Downscaled Projections for the SRES B2 Scenario, 1990–2100, beta version. CIESIN, Columbia University, Palisades, NY, available at <http://sres.ciesin.columbia.edu/tgcia/>.
Campbell, B. D., Stafford Smith, D. M., Ash, A. J., Fuhrer, J., Gifford, R. M., Hiernaux, P., Howden, S. M., Jones, M. B., Ludwig, J. A., Manderscheid, R., Morgan, J. A., Newton, P. C.

- D., Nösberger, J., Owensby, C. E., Soussana, J. F., Tuba, Z., ZouZhong, C. (2000): A synthesis of recent global change research on pasture and rangeland production: reduced uncertainties and their management implications. *Agriculture, Ecosystems and Environment*, 82: 39-55.
- Czóbel, Sz., Fóti, Sz., Balogh, J., Nagy, Z., Bartha, S., Tuba, Z. (2005): Chamber series and space-scale analysis in grassland vegetation. A novel approach. *Photosynthetica* 43. (2). 267-272
- FAO, 2001, *The State of Food Insecurity in the World, 2001*, Food and Agriculture Organization of the United Nations, Rome, Italy [ISBN 92-5-104628-X].
- Fischer, G., Shah, M., and Velthuizen, H. V., 2002, *Climate Change and Agricultural Vulnerability*, World Summit on Sustainable Development, Johannesburg
- IPCC, 2000, *Summary for Policymakers, Emissions Scenarios*, Special Report of IPCC Working Group III, Intergovernmental Panel on Climate Change, Cambridge, University Press, Cambridge, UK [ISBN 92-9169-113-5].
- IPCC, 2001, *Climate Change 2001: The Scientific Basis*, Contribution of Working Group I to the Third Assessment Report of the Intergovernmental Panel on Climate Change [ISBN 0521-014-95-6].
- Tuba, Z., Raschi, A., Lannini, G.M., Nagy, Z., Helyes, L., Vodnik, D., di Toppi, L.S. (2003): Vegetations with various environmental constraints under elevated atmospheric CO₂ concentrations, In: *Abiotic Stresses in Plants*, Eds.: Luigi Sanità di Toppi and Barbara Pawlik-Skowronska, Kluwer Academic Publishers, Dordrecht. pp. 157-204.
- Tuba, Z., Bakonyi, G. and Singh, M.K. (2004): Impacts on Biodiversity. In: *Pollution processes in agri-environment. A new approach*, Eds.: Láng, I., Kőmives, T., Jolánkai, M., Akaprint Publishers, Budapest p235-254.
- Tuba, Z. (ed.) (2005): *Ecological Responses and Adaptations of Crops to Rising Atmospheric Carbon Dioxide*. Haworth Press Inc, New York, USA, p 414.
- Fekete-Farkas, M. and -Audsley, E. (1997). Relationship between farm income and pattern of land use in the Eastern Counties of England, *Journal of Hungarian Agricultural Economics*, (Gazdálkodás), No.6. pp. 53-65.
- Fekete-Farkas, M., Kamphorst, E., Rounsevell, M., Audsley, E. (2003a) The role of policy in scenarios concerning European agricultural land use change in the coming century, 80th EAAE Seminar, Gent, Belgium, *New Policies and Institutions for European Agriculture*
- Fekete-Farkas, M., Molnar, J., Szucs, I. (2003b) Socio-economic scenarios of Central and Eastern European agriculture. ACCELCEEC Workshop SZIE, Gödöllő, 9-11 October.