



# GLOBAL ENVIRONMENTAL CHANGE AND FOOD SYSTEMS

## A HUMAN DIMENSIONS PERSPECTIVE



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## AN INTRODUCTION TO THE IHDP

Research on the human dimensions of global environmental change (GEC) addresses the coupled human-nature system and investigates how individuals and societal groups contribute to, are influenced by, and mitigate and respond to changes that take place on a local, regional and global level. The human dimensions of global environmental change, thus, comprise the causes and consequences of people's individual and collective actions, including the changes, which lead to modifications of the earth's physical and biological systems and affect the human quality of life and sustainable development in different parts of the world. The central questions to be addressed in the human dimensions of global environmental change research are:

- ❑ How do human actions contribute to local, regional and global environmental change?
- ❑ Why are these actions taken?
- ❑ How does global environmental change feed back into people's lives?
- ❑ What actions can be taken by whom to reduce and mitigate the adverse effects of global environmental change?

IHDP is an international, interdisciplinary, and non-governmental science programme. Its key activities are the promotion, support and co-ordination of research, the facilitation of capacity building and scientific networking. The research is primarily carried out in four core projects:

- ❑ Land Use and Land Cover Change (LUCC- Cosponsored with IGBP)
- ❑ Institutional Dimensions of Global Environmental Change (IDGEC)
- ❑ Global Environmental Change and Human Security (GECHS)
- ❑ Industrial Transformation (IT)

These projects facilitate the efforts to produce new knowledge and priorities for improved policy and action at all levels of decision-making, by promoting, supporting and co-ordinating scientific research, capacity-building, and international scientific networks. Increasingly these activities are carried out in collaboration with the international partner programmes on global environmental change<sup>1</sup>. So far, three joint projects have evolved out of this partnership (on the global carbon cycle, food systems and water systems).

When the research programmes on global environmental change began to develop joint projects on important issues concerning sustainability science, IHDP felt that it would be important to define the particular human dimensions research elements that could contribute to the broader international, interdisciplinary agenda. This paper aims to summarize this particular contribution to the research agenda on the topic of food consumption and production systems and raise research questions from a human dimensions perspective.

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<sup>1</sup> IHDP's main partner organisations are the other three global environmental change programmes in the Earth System Science Partnership (ESSP): International Geosphere-Biosphere Programme (IGBP), World Climate Research Programme (WCRP) and the international programme on biodiversity DIVERSITAS.

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### THE HUMAN DIMENSIONS OF FOOD CONSUMPTION AND PRODUCTION SYSTEMS

A series of teleconferences, meetings and written contributions led to this framework document considering the human dimensions perspectives on the interactions between food systems and global environmental change. It concentrates on institutions, scenarios, vulnerability and adaptation, and on scale issues.

Food systems are the focus of the joint project on "Global Environmental Change and Food Systems" (GECAFS)<sup>2</sup>. They can be broadly defined as systems of provision (i.e., production, supply, availability, access to food and related, essential resources) and consumption of food. Each of the IHDP core projects has ongoing research that could make a central contribution:

- ❑ Institutions are a major factor in determining the production and consumption of food;
- ❑ The IHDP core project on "Industrial Transformation" focuses on trends and transitions in food consumption and production systems; the development and use of scenarios is essential in this area of research.
- ❑ Both the projects on "Land-Use and Land-Cover Change" and "Global Environmental Change and Human Security" have a focus on "vulnerability".

The relevance of vulnerability in relation to food systems becomes particularly clear when the capacities of individuals and societal groups to deal with perturbations in food supply are considered. Finally, the attentiveness towards temporal and spatial scales of the interactions between the human and environmental systems is extremely important when considering global environmental change and food systems.

### THE INSTITUTIONAL DIMENSIONS OF FOOD SYSTEMS

Institutions, which are defined in a broad sense in the IHDP core project on "Institutional Dimensions on Global Environmental Change" are a major factor in determining the consumption and production of food, influencing a variety of factors including labour relations, access to resources, gender issues with regard to food systems, livelihoods, property rights, trade relations, etc.. However, it is important for our understanding of the roles of institutions in food consumption and production systems to be clear about what we mean by the word "institutions". For IHDP, institutions are systems of rules, decision-making procedures, and programmes that give rise to social practices, assign roles to the participants in these practices, and guide interactions among the occupants of the relevant roles (IHDP, 1999).

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<sup>2</sup> GECAFS is jointly sponsored by the IGBP, the WCRP and the IHDP. It has been developed in formal collaboration with the Food and Agriculture Organisation of the United Nations (FAO), the World Meteorological Organisation and the Consultative Group on International Agricultural Research (CGIAR). See <http://www.gecafs.org>

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When the factor of global environmental change is taken into account, the importance of institutions is amplified. Institutions act both as driving factors of change and as mediators in the response of individuals and societal groups and countries to changes in food consumption and production systems. Institutions play a major role in determining whether and how social groups and individuals are able to cope with global environmental change and with the impacts of transformations in the food production and consumption sector.

Local, regional, national and global institutions interact with food consumption and production systems in influencing entitlements, setting them within a complex and dynamic context. The literature on entitlements shows that not only is the access to resources of critical importance to food consumption and production systems, but also the availability of resources and the ability to make effective use of resources.

Institutions, however, are not static, but change as a result of social development. Two major processes of institutional transformation that profoundly influence the global environment and food systems are globalisation, especially international trade, and decentralisation of structures. These changes are transforming the contexts within which the relationship between global environmental change and food systems must be studied.

Applying these perspectives on institutions to food systems, the following science questions have been developed:

### **OVERARCHING QUESTION:**

What role do institutions play in determining the impacts on and responses of food production and consumption systems to global environmental change?

### Sub-questions:

- ❑ How much of the variance in the changes in food systems may be attributed to institutions, and which institutions and associated systems of decision-making and rules (for example, land tenure, access to credits, and markets) are of importance?
- ❑ To what extent and in what ways does integration in the global economy (i.e., globalisation, trade regimes) affect food provision and consumption?
- ❑ How do formal / informal institutions influence the effectiveness of environmental policies in sustaining or enhancing food provision?
- ❑ How can environmental and trade regimes be rearranged to reduce social vulnerability to global environmental change, and enhance adaptive capacity of food systems in different societies or regions?

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### **TRENDS IN, AND SCENARIOS FOR, FOOD CONSUMPTION AND PRODUCTION SYSTEMS (FCPS)**

The environmental context of agricultural production is undergoing transformations as a result of changes at the global level (such as climatic change) and at the local level (such as water pollution). Furthermore, economic developments are leading to changes in food consumption patterns. Wider international trading of food has environmental effects at the national, regional and local levels. Household consumption patterns are also changing, although the changes differ from region to region. Technological developments, especially biotechnologies, present new opportunities for agricultural practices (including new foods), but there are also associated problems and controversies.

The human dimensions research community can have significant input in mapping these trends and in identifying potential policies to deal with them. Scenario development offers one fruitful method of identifying a range of possibilities. Such scenarios can be developed using a number of approaches, including both forecasting and back-casting techniques. There is a considerable interest in producing scenarios that include multiple stresses, including both environmental and socio-economic stresses. IHDP could contribute to the discussion by developing such scenarios complemented by "place-based" approaches that encompass the particular areas of expertise of the programme. Policy exercises provide the opportunity for developing and analysing scenarios that incorporate the various dimensions of food consumption and production systems, and account for global environmental change.

#### **OVERARCHING QUESTION:**

What are the likely interactions between changes in food consumption and production systems and changes in the global environment over the next twenty years?

#### Sub-questions:

- ❑ How will changes in FCPS affect GEC? How will GEC affect FCPS? What will be the regional differences in these changes, and what are the most significant factors underlying these differences?
- ❑ What are the implications of changes in food preferences due to such processes as urbanisation and economic development for GEC? What constraints and opportunities are imposed on food consumption and production systems by processes such as globalisation and trade liberalisation?
- ❑ What are the implications of a switch from extensive agricultural production to intensive agricultural production in developing countries? What role will such developments as biotechnology and organic systems of food production play in the next 20 years, in developed and developing countries?

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- What role can scenario methods - both back-casting and forecasting - play in the development of policies with respect to FCPS? How can scenarios incorporating human dimensions concerns be connected to biophysical and climate scenarios?

### **VULNERABILITY AND ADAPTATION**

Vulnerability, in particular social vulnerability, is an overarching concept encompassing the capacity of individuals and communities (e.g. rural and urban) to anticipate, resist, cope with, recover from, and adapt to perturbations such as global environmental change (GEC). Coping usually refers to shorter-term adjustments that are undertaken within the context of the prevailing social system (e.g. temporary relief measures). Adaptation includes longer-term modifications in practices (e.g. land management, diversification) and structures (e.g. institutions regulating access to credit, emergency response measures) that are made in an attempt to reduce social vulnerability in such ways that the risk of negative impacts stemming from GEC would be moderated.

Vulnerability is a property of a system (e.g. the food system), and not a residual of GEC. Vulnerability is also inherently dynamic and responds to socio-economic factors (e.g. economic restructuring, globalisation) that can alter exposure levels to threats such as GEC as well as the ability and capacity to cope with, recover from and adapt to the changes.

A holistic approach is essential in vulnerability assessments of food systems. Providing sufficient amounts of food and ensuring adequate access to food are some of the largest challenges facing food production systems. On the one hand, more intensive production systems supported by adequate access to inputs are a likely means for increasing food production. On the other hand, increasing access to food will in all likelihood also hinge upon enhancing incomes and improving human security. New theoretical models and frameworks will be required to capture the spatial and temporal dimensions that influence a more dynamic and holistic approach to vulnerability.

Vulnerability of the food system to GEC has been examined through a number of vulnerability and adaptation assessments. Social and economic vulnerability and adaptive capacity are highly variable both in space and time. Furthermore, vulnerability is not limited to specific concerns such as food security, but includes broader production and consumption components. A key concern is determining the most appropriate and promising strategies for reducing social and economic vulnerability to GEC. This will depend on obtaining answers to some of the following questions:

#### **OVERARCHING QUESTION:**

How can vulnerability best be identified and measured so that some of the dynamic processes and changes in the environmental system can be captured?

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### Sub-questions:

- ❑ What lessons can be learnt from existing vulnerability assessments of food systems?
- ❑ How is social vulnerability of food systems to GEC affected by other stresses on the system (e.g. economic globalisation, institutional changes, urbanisation, etc)?
- ❑ What is impeding the further understanding of social vulnerability to GEC? (i.e. inadequate theory, inadequate methods, inadequate case studies or inadequate data)?
- ❑ How do factors such as genetic engineering and alternative food production systems reduce or amplify the vulnerability of food systems to GEC?

## FOOD SYSTEMS AND SCALE

The interactions between food systems and global environmental change are inherently scale-dependent. The issue of scale cuts across all discussions of food production and consumption systems and their interactions with global environmental change: institutions are not only scale-dependent but also challenged by scale interactions; vulnerability and adaptation are also scale-dependent. It is important to distinguish at the outset between spatial and temporal scales. While there has been considerable work on food systems and particular spatial scales, there has been little work investigating the interactions between food systems and global environmental change on the short- vs. long-time scales.

Particular communities or livelihood systems have a different degree of vulnerability than a national economy and dealing with such questions at the global scale is extremely difficult. It is not possible to "sum up" local vulnerabilities to give meaningful national or global estimates. Community-level concerns about the impacts of global environmental change might focus on the risks of experiencing hunger, while national concerns might focus on impacts on the gross domestic product or on import requirements.

While vulnerability of food systems to GEC differs across scales, it is also important to recognize that other global change processes are simultaneously interacting across scales, with feedbacks that influence the vulnerability of food systems. Global economic changes have impacts on regional, national, local, and household vulnerability. For example, national trade liberalisation policies affect local market prices, which in turn influence the profitability of agriculture or fisheries. Changing market prices may have a positive or negative effect on vulnerability, depending on the context and scale of analysis. Likewise, changes at the local scale (e.g., rural HIV infection rates) can also influence national agricultural vulnerability to global environmental change by reducing local food production and increasing national food insecurity.

In summary, the discussion of food systems and GEC requires a deeper understanding of the temporal and spatial scales at which interactions between environment and society are critical. The

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linkages among processes occurring at different scales must be addressed through research and methodological developments.

### **OVERARCHING QUESTION:**

How do the interactions between food consumption and production systems and global environmental change vary across different temporal and spatial scales?

Sub-questions:

- ❑ At which spatial and temporal scales and in which ways are food consumption and production systems vulnerable to global environmental change?
- ❑ At which spatial and temporal scales and in which ways are food consumption and production systems causal factors of global environmental change?
- ❑ How do the interactions between the different spatial scales (global, regional, national, local, household) and temporal scales (month, year, decade, multi-decade) influence the relationships between food systems and global environmental change?

### **CONCLUDING COMMENTS**

This document has traced some of the interactions between food consumption and production systems and GEC. Several questions have been suggested that will hopefully encourage the engagement of those involved in the science of food systems. More importantly, however, the human dimensions of such interactions clearly emerge. Understanding the human causes and consequences of global environmental change and the implications for food systems remains a key challenge for the future. The involvement of scientists in research addressing the questions posed here should improve the understanding of these complex systems and assist in adaptation to and mitigation of global environmental change.

## PART II

### FOOD SYSTEMS RESEARCH IN IHDP CORE SCIENCE PROJECTS

#### LAND USE AND LAND COVER CHANGE (LUCC)<sup>3</sup>

Land-use and land-cover change are important for a range of issues central to the study of global environmental change. The alterations in the surface of the earth have major implications for sustainable development and livelihood systems and also contribute to changes in the biogeochemical cycles of the earth. The LUCC project analyses the sources of change in patterns of land use and the impact of those changes on patterns of land cover over time. Therefore, identification and quantification of the environmental consequences of increasing food, fibre and fuel supply is a LUCC research task, as well as the explanation of physical and social circumstances that lead to a change in land use patterns.

Focus 1 of LUCC links local land use decisions to regional and global processes. It helps understanding how land managers in particular situations respond to key driving forces and how they produce particular land-cover consequences. It explores the role of land tenure security, the nature of private versus common property systems, the development of infrastructure such as roads and irrigation works or the expansion and evolution of commercial agricultural systems.

Furthermore, empirical observations and diagnostic models of land-use change are necessary for predicting future production areas. Research activities under Focus 2 address this issue by answering the following questions:

- ❑ What are the rates and spatial patterns of land-cover change, and how will they likely progress?
- ❑ Where is land-cover change presently occurring, and where will it likely occur in the future?
- ❑ Which natural and cultural landscape attributes contribute the most to the explanation of land-cover change?

A priority for LUCC is the development of a monitoring system through direct collaboration with the space agencies and the Committee on Earth Observing Systems, international observing systems through the International Global Observing Strategy of GTOS/GCOS/GOOS, and through collaboration with selected international agencies that can provide land-cover and socio-economic data.

Direct measurements and empirical analyses alone, however, will not provide enough understanding to analyse the driving forces of land-use and land-cover change. Thus, moving from empirical models, which just highlight spatial and temporal associations between variables, to system models that represent causal relationships, LUCC follows a comprehensive approach to understanding these changes and, at the same time, provides important inputs to policy.

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<sup>3</sup> <http://www.geo.ucl.ac.be/LUCC/>

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### **INSTITUTIONAL DIMENSIONS OF GLOBAL ENVIRONMENTAL CHANGE (IDGEC)<sup>4</sup>**

The core of the project is an analysis of the roles that social institutions play as determinants of the course of human /environment interactions. Institutions are systems of rules, decision-making procedures, and programs that give rise to social practices, assign roles to participants in these practices, and guide interactions among the occupants of the relevant roles.

Changes in both natural and managed terrestrial ecosystems manifest themselves directly as changes in land use or indirectly as atmospheric changes. They are driven in part by the actions of human agents operating under the influence of a variety of institutional arrangements.

For that reason IDGEC's Research Focus 1 looks at

- The role of environmental and resource regimes in causing /confronting GEC
- The role of other institutions (e.g. trade and investment regimes) in causing / confronting GEC

Example: Depletion of fish and animal stocks often results from the operation of access rules that produce few if any incentives for users to harvest stocks selectively as a means of ensuring a steady supply of these living resources over time.

There is considerable overlap between Focus 1 and the objectives of the LUCC project, since studies of the role of environmental and resource regimes as causes of global environmental change include a consideration of institutional forces leading to changes in land use. A particular area of interest in this regard is the interaction of property rights regimes and macro-economic institutions as a source of change in patterns of land use.

### **GLOBAL ENVIRONMENTAL CHANGE AND HUMAN SECURITY (GECHS)<sup>5</sup>**

The project operates from a concept of security that encompasses economic, food, health, environmental, personal, community and social security, seeks to determine how environmental changes affect a multi-dimensional spectrum of security concerns. It focuses on a crosscutting issue in the sense that there is a security aspect to most problems of global environmental change.

The primary research question of the GECHS project is: "What are the relationships between global environmental change and human security?" The project considers human security as achieved when and where individuals and communities:

- Have the options necessary to end, mitigate, or to adapt to threats to their human, environmental, and social rights;

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<sup>4</sup> <http://fiesta.bren.ucsb.edu/~idgrec/>

<sup>5</sup> <http://www.gechs.org>

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- Have the capacity and freedom to exercise these options; and
- Actively participate in attaining these options.

The pace of human-induced forms of environmental degradation and resource depletion has increased in many regions due to a combination of increasing demand for agricultural products, improving technological means of exploitation, and the lagging pace of conservation and control. Meanwhile, the ability and perhaps also the inclination of people to adapt to environmental stress is increasingly challenged, particularly where resources and environment provide the principal basis of their livelihood, as is the case in much of the South.

Security is closely related to the concept of vulnerability, which is defined both by characteristics of the natural and physical environment, as well as by the social, political, and economic processes that impose upon people and which define the capacity to cope in the face of change. Pressures to achieve improved economic performance have contributed to widespread resource harvesting with an associated degradation of natural environments.

In this sense, Focus 2 GECHS explores environmental change, resource use, and human security in terms of (i) water and human security, (ii) food security, (iii) energy security, (iv) atmospheric change and human security, (v) land-use change and human security, and (vi) environment and conflict/cooperation.

The fundamental question is, how environmental change does affect resource availability and, in turn, human security? Resource dilemmas are the result of scarcity of resources, related particularly to fresh water, energy, food, and land, where environmental factors play an important role. Key factors relate to the degradation of resource quality and quantity, population growth and distribution, unequal access to resources, conflicting demands for resources, and negative effects of overuse. Scarcity or inadequate distribution may give rise to institutional instability, conflict or other threats to human security.

The dilemmas addressed in this focus area are transnational in nature, either because they occur in more than one country or, because they spill over national borders. These kinds of problems raise crucial questions as to the kind of international responses, policies, and institutions required and the actors involved; these questions directly link GECHS to the research areas of IDGEC and LUCC.

### **INDUSTRIAL TRANSFORMATION (IT)<sup>6</sup>**

Industrial Transformation research has the challenging goal of understanding the ways in which society could combine economic and social development with the reduction of pressure on the environment. This project seeks to understand the social forces that could lead to major changes in

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<sup>6</sup> <http://www.vu.nl/ivm/research/ihdp-it/>

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large-scale economic systems. It is based on the assumption that important changes in production and consumption systems will be required in order to meet the needs and aspirations of a growing world population while putting a significantly smaller burden on the environment on a global scale. IT is about system innovation to decouple economic and social development from its negative consequences for natural resources. These innovations need to be both technological and institutional in nature, as disparities between regions that supply natural resources and those that use them for industrial purposes typically arise from institutional arrangements.

In this sense, the ways in which activities are organized in food consumption and production systems (FCPS) are of great importance for sustainability in all parts of the world. The industrial transformation of FCPS requires an understanding of how social, economic and cultural drivers of change both influence and are influenced by the drivers of the biogeochemical cycles on which food production depends. The IT research focus “Food” reflects this perspective by promoting research to increase the understanding of the social mechanisms and human driving forces that lead to the transformation of the FCPS.

In particular the proposal for a research project “Food consumption and production systems: towards sustainability” comprises some fundamental objectives with local, regional and international dimensions:

- ❑ To provide the necessary data and framework to assess the impact of the food consumption and production systems (FCPS) on global environmental change;
- ❑ To explore alternative incentive structures at the local, regional and global levels that may induce FCPS transformation leading to sustainable production and consumption patterns;
- ❑ To generate knowledge to support the design of local, regional and global policies with a view to meeting development needs that are sustainable with respect to global environmental change.

The feasibility of “decoupling” in FCPS depends on whether it is possible to meet growing needs and changing preferences for foods, while simultaneously reducing their environmental impacts. Therefore, IT aims to understand the global trends of FCPS and develop tools to measure progress in the sustainability of the systems. Regional differences and the role FCPS play in local and regional development are taken into account as well as local and regional policies, which affect the contribution of the FPCS to global environmental change.

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## **GLOSSARY**

### **Human Dimensions**

“Human Dimensions” of global environmental change comprise the causes and consequences of people’s individual and collective actions, including the changes, which lead to modifications of the Earth’s physical and biological systems and affect the human quality of life and sustainable development in different parts of the world.

### **Human Security**

“Human Security” is achieved when and where individuals and communities have the options necessary to end, mitigate, or adapt to threats to their human, environmental, and social rights; have the capacity and freedom to exercise these options; and actively participate in attaining these options. Moreover, human security will be achieved through challenging the structures and processes that contribute to insecurity (IHDP Report 11, 1999, p.29).

## **Industrial Transformation**

“Industrial Transformation” research deals with the relationship between societal, technological, and environmental change. It focuses on systems and system changes that are relevant in view of the Global Environmental Change. Industrial Transformation research relates producer and consumer perspectives, including the incentives and institutions that help in shaping these perspectives. This implies that the research aims to increase understanding of the relations of, and interdependencies between, the macro-level (governance and institutions at local, national, and international level), the meso-level (sectors, companies, and communities) and the micro-level (consumers and households) (IHDP Report 12, 1999, p. 2).

## **Institutions**

“Institutions” are systems of rules, decision-making procedures, and programmes that give rise to social practices, assign roles to the participants in these practices, and guide interactions among the occupants of the relevant roles. Institutions arise in all areas of human endeavour (IHDP Report 9, 1999, p. 14).

## **Land-use and land-cover changes**

“Land Cover” is the biophysical state of the earth’s surface and immediate subsurface. Changes in land cover include changes in biotic diversity, actual and potential primary productivity, soil quality, and run-off and sedimentation rates. Land-cover change involves processes of conversion and modification. “Land use” involves both the manner in which the biophysical attributes of the land are manipulated and the intent underlying that manipulation – the purpose for which the land is used (IGBP Report 35 / IHDP Report 7, 1995, p.17, 20).

## **Vulnerability**

Vulnerability to global environmental change has been conceptualized as the risk of adverse outcomes to receptors or exposure units (human groups, ecosystems, and communities) in the face of relevant changes in climate, other environmental variables, and social conditions. Vulnerability is emerging as a multidimensional concept involving at least exposure – the degree to which a human group or ecosystem comes into contact with particular stresses; sensitivity – the degree to which an exposure unit is affected by exposure to any set of stresses; and resilience – the ability of the exposure unit to resist or recover from the damage associated with the convergence of multiple stresses. The concepts of preparedness, coping reserve, and adaptive capacity are clearly important.