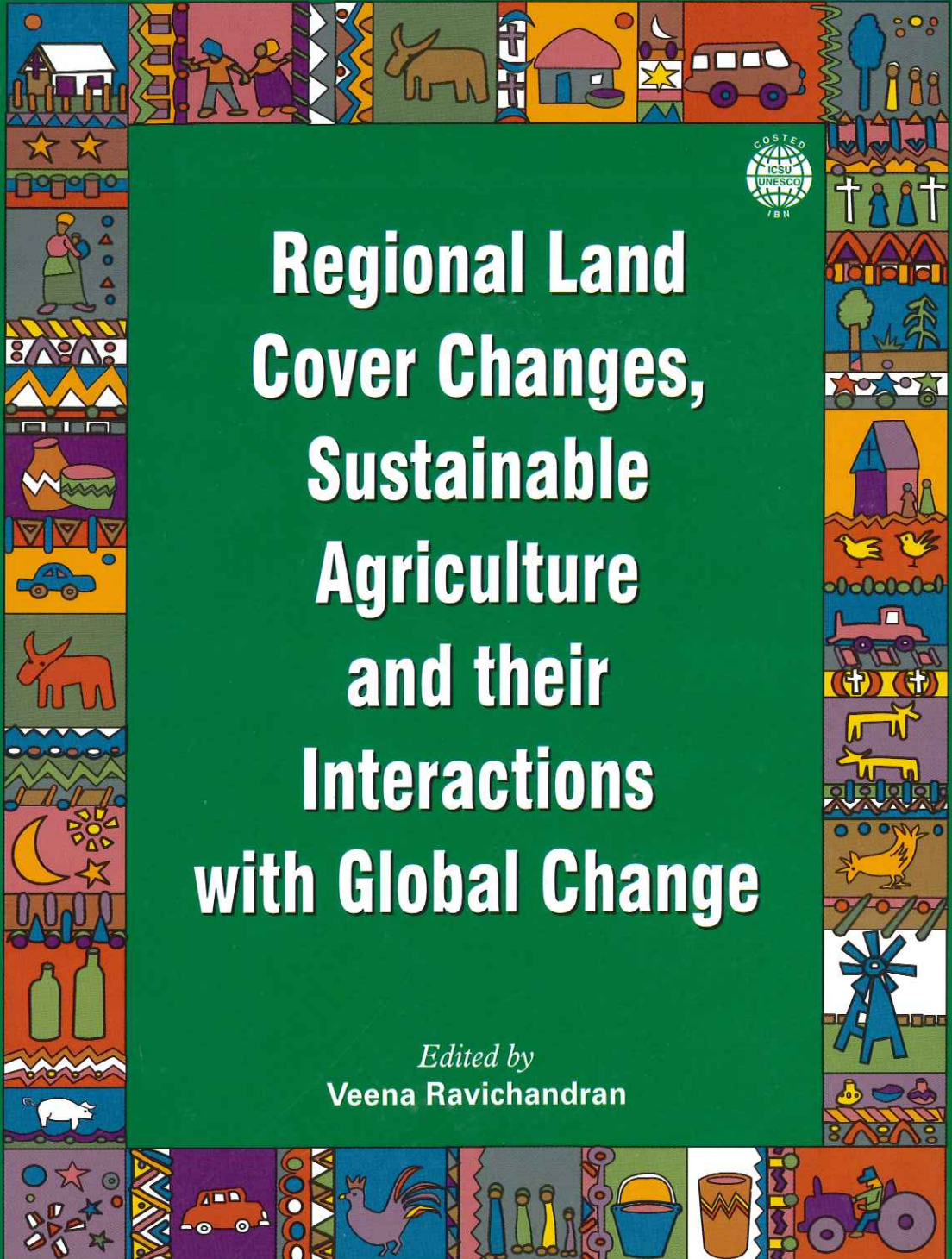




Regional Land Cover Changes, Sustainable Agriculture and their Interactions with Global Change

Edited by
Veena Ravichandran



Land is a valuable resource and land use continues to be driven by varied, competing and often conflicting interests. This book captures the deliberations of an expert meeting of officials, scientists, geographers, environmentalists, policy makers, planners and agriculture experts working in the Southern African region. It addresses the present scenario and the challenges of identifying and recognizing the dominant forces influencing land use and land cover changes, and proposes guidelines for policy and land managers.

Environmental degradation and sustainable agriculture to cope with global population growth and ensure food security, are the most important concerns in understanding the changes in land use and land cover. How does environmentalism engage development without being seen as opposed to development? This book presents well-directed recommendations for the academic, decision-making and donor communities. It strongly advocates a regional approach, underpinned by an interdisciplinary and multi-institutional cooperation, in seeking the way forward for the most rational use of precious land resources.

Dr Veena Ravichandran, a doctorate in Biophysics from Madras University, is a senior professional staff at COSTED which is an interdisciplinary constituent of an international NGO, the International Council for Science (ICSU) based in Paris. She has been coordinating a wide range of projects relating to sustainable use of natural resources, an integrated approach for understanding land use and land cover changes. She has coordinated activities on the Land Use and Land Cover Change (LUCC) project in South Asia, southern Africa and India. She is an associate of the programme of Leadership for Environment and Development (LEAD) funded by the Rockefeller Foundation and the International Development Research Centre in Canada.



Universities Press

Veena Ravichandran: Regional Land Cover Changes, Sustainable Agriculture and their Interactions with Global Change

ISBN 81 7371 269 7



9 788173 712692

Universities Press (India) Limited

Registered Office

3-5-819 Hyderguda, Hyderabad 500 029 (A.P.), India

Distributed by

Orient Longman Limited

Registered Office

3-6-272 Himayatnagar, Hyderabad 500 029 (A.P.), India

Other Offices

Bangalore/Bhopal/Bhubaneshwar/Calcutta/Chandigarh

Chennai/Ernakulam/Guwahati/Hyderabad/Jaipur

Lucknow/Mumbai/New Delhi/Patna

© Universities Press (India) Limited 1999

First published 1999

ISBN 81 7371 269 7

Typeset by

OSDATA, Hyderabad 500 029

Printed in India at

Orion Printers, Hyderabad 500 004

Published by

Universities Press (India) Limited

3-5-819 Hyderguda, Hyderabad 500 029

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Welcome Address

Honourable Minister for Coordination of Environmental Affairs, Scientific Secretary of COSTED, Coordinators of the Conference, Directors of the wise institutions present here, ladies and gentlemen:

It is an honour for me to pass some words to you on behalf of the Prime Minister of Mozambique. Since the conference at Stockholm on Man and Environment up to the conference at Rio de Janeiro on UNCED, it has been observed that environmental issues have gained particular importance with specific considerations to global change.

At a more detailed level, one element of preoccupation in relation to the environmental issues during the past years that has been an issue of international dialogue is the problem of global change. In 1992, about 30 million inhabitants of Southern Africa, that constitute about a quarter of the total population of the region have been heavily depending on food aid due to drought. The production of cereals in Southern Africa decreased by about 50 per cent of the annual needs. It is important to mention that more alarming situations resulting from the severity of this drought have hit areas of Zimbabwe and Mozambique as well as areas of our neighbour South Africa. As it is obvious, the impact of drought were even further exaggerated due to socio-economic conditions related to the political factors, such as the war in Mozambique, the problems of refugees in Zimbabwe and the reduction of cereal reserves within the region.

This turns the impact on climatic instability over the African eco-systems and the impact on the socio-economic conditions are usually interpreted in a more explicit manner. As an integrated part of the Southern African country strategy for the implementation of Agenda 21, it was mandated to the Secretariat for Environment and Land Management to concentrate the efforts on the aspects related to environment within the region. These factors integrate two important programmes, namely, the programme on land management and the programme on environmental management. The objective, specific to this last programme, is to achieve sustainable development within the Southern African region that is necessary to integrate three major components:

1. Economic sustainability,
2. Social sustainability, and
3. Environmental sustainability.

It is important to stress that within the region, agriculture represents the main land use and as such it is the most important socio-economic activity which involves about 70 per cent of the total rural population according to the statistics of 1992. In the context of sustainable development of natural resources and the preservation of the environment, the agriculture activity has to be under special attention within all national organisations, regional institutions and international research institutions making available the information and technology adapted to the relevant parts of the areas in the region.

The government of Mozambique, which is quite clear about the duality within development and the sustainable use of natural resources, has been very much engaged in the elaboration of policies and the implementation of programmes for the reconstruction and the development of the post-war period in Mozambique.

With respect to land use, the Government policy is now under consideration within the Parliament for the final approval.

Honourable Minister, dear participants, considering the number of debates on such topics that have already taken place the challenge that we are facing now as participants of this event is to transform

those debates to real objectives of the conference. In this way we can contribute to the definition of the strategies and actions that in the near future can be used for the establishment of the appropriate mechanisms for the management of natural resources, ensuring the sustainability of natural eco-systems, while at the same time, we satisfy the basic needs of society.

Finally, on behalf of the Prime Minister of the Government of Mozambique, I wish all the participants a good work and good stay in our beautiful city of Maputo.

Mr. Carlos Agostinho do Rosario
Hon'ble Minister for Agriculture
and Fisheries, Mozambique

A note from the Editor

This book is a recapitulation of the deliberations of the COSTED workshop on "Regional Land Cover Changes, Sustainable Agriculture and their interactions with Global Change", held in Maputo, Mozambique during 28–30 July, 1997. The book has been compiled using the manuscripts provided by the invited speakers and audio recordings, where manuscripts were not available.

The workshop brought together about 65 senior experts, government officials and policy makers and representatives of NGOs dealing with agriculture, land use policy and global change issues. Participants represented 23 countries of which 13 were African countries. The participating countries were Angola, Belgium, France, Germany, Ghana, Greece, India, Italy, Kenya, Lesotho, Malawi, Mozambique, The Netherlands, Namibia, Portugal, South Africa, Spain, Sweden, Tanzania, Uganda, U.K., Zambia and Zimbabwe.

The workshop was supported by the Govt. of Mozambique. Two Ministries of the Government namely the Ministry for Agriculture and Fisheries and the Ministry for the Co-ordination of Environmental Affairs actively participated in the deliberations. The workshop included participants from a variety of regional, national and international organisations. The participating organisations were the IUCN, Maputo, IGBP Secretariat, Sweden and IGBP-START Secretariat, Washington, the Association for African Universities, Accra, the LUCC International Project Office, Barcelona, the International Centre for Research in Agroforestry (ICRAF), Zomba, the Southern African Development Community-Environment and the Land Management Sector (SADC-ELMS), Maseru and International Centre for Insect Physiology and Ecology, Nairobi and several National Universities and Research Institutes in the regions. The deliberations included country papers which revealed the complexity and diversity of the issues within the region, presentation on the various driving forces of land use/cover changes, development of integrated assessment models to understand these changes, the threat of desertification, human dimensions of land use dynamics and assessment of climate change implications. A panel discussion at the end of the two-day session led the way forward to formulate a set of comprehensive recommendations which are included in the last section of this book.

The workshop offered a unique opportunity for interaction among European Union and African experts, to pave the way for future collaborative efforts. The deliberations were fruitful and helped focus on ground realities that confront the region.

The generous funding support by the European Commission for organising the workshop and ensuring European Union participation is gratefully acknowledged. The active participation and enthusiastic contribution by the participants have indeed formed the basis for this publication, which I hope will be a useful resource book for policy makers, research institutions and development agencies alike.

Veena Ravichandran
Senior Scientific Officer
COSTED

Foreword

The twentieth century's developments in science and technology have advanced the quality of human life everywhere. Technological progress continues to be the engine for economic growth, the source of dramatic improvements in health, and the base for robust increases in agricultural productivity. But the results of technological change also lead to enormous stress on people in the workplace and on the basic life support systems of land, water, forests and the living environment.

One central concern is global population growth. Ensuring food security in populous developing countries is a challenge, especially for that half of the world's poor living in South Asia and Africa. Some estimate that 7 billion out of the 8.5 billion population projected in 2025 will be in developing countries. At that time, however, given present rates of economic growth, many "developing countries" (such as China and India) will have higher per capita income and lower rates of population increases. But in Africa alone, the current 500 million population may be 1.2 billion by the year 2025, and food gaps there could increase, unless the economy continues its recent upward trend and the quality of governance improves.

Heightened pressure on natural resources will probably arise from the imperatives to increase economic incentives for farmers, raise productivity per unit area of land, and put more land under cropping. The necessary interventions would have consequences on the land cover as well as on hydrological and geochemical cycles. Global climatic changes, whether severe or moderate, would also have an impact on agricultural productivity; some areas may benefit, some may be hurt. To address this complex cluster of issues, new economic policies and prudent science-based field management must improve agricultural yields by enabling the incorporation of both new technology and traditional knowledge.

A rich literature, developed over many decades, covers global trends and projections for population and food. In re-evaluating the gloomy predictions of Malthus, for example, demographer Joel E Cohen assesses recent estimates and options in his magisterial volume, *How Many People Can the Earth Support?* (Norton, 1995). His quantitative skill and conceptual insight will help frame constructive strategies. Along the same lines and with comparable analytical rigor, agronomist Paul E Waggoner avoids both glib doomsaying and triumphant complacency in his report, *How Much Land Can Ten Billion People Spare for Nature?* (CAST, 1994). On balance, there are grounds for optimism. Higher economic growth, together with broader opportunities and rewards for women, correlate strongly with reduced rates of population increase. Shaping the best technological paths in education and economic development is a unifying perspective that will improve the prospects for meeting goals in agriculture as well as in health, energy, and job-creation. Accordingly, the New York Academy of Sciences has taken up this urgent task with conferences and publications, such as *Science-based Economic Development: Case Studies Around the World* (NYAS, 1996). Similarly, the Committee on Science and Technology for Development (COSTED) of the International Council for Science (ICSU) accords high priority to the broad issues in development.

COSTED is particularly dedicated to fostering regional and international cooperation in tackling the issues. So we were delighted that the European Commission generously funded this workshop on **Regional Land Cover Changes, Sustainable Agriculture and their Interactions with Global Change**, held in 28–30 July 1997 at Maputo, Mozambique. The workshop focussed on the Southern African region where the problem has special relevance to rural development and food security. It brought together stakeholders from many sectors, from the science and technology community, and from the government and policy units in the region; the private sector will be more fully represented in future exchanges.

These proceedings offer valuable recommendations relating to:

- a) Improving data and information systems
- b) Undertaking the causes and consequences of land cover change
- c) Setting priorities for regional research efforts
- d) Building capacity and establishing an evaluating policy framework
- e) Disseminating information to promote environmentally sound resource management.

The recommendations must be pursued at the national, regional and international levels. Their implementation calls for both North-South and South-South co-operation, because the projected impacts of change will transcend national boundaries.

COSTED expresses its deep gratitude to the European Commission and the Government of Mozambique for extending wholehearted support and co-operation in ensuring the success of the workshop and colleagues from the senior staff of the COSTED Secretariat in Madras - especially Drs. G. Thyagarajan and Veena Ravichandran.

I hope these proceedings will stimulate new debate, fresh analysis, and substantial action. Governments, policy planners, science and technology institutions, private agribusiness firms, individual farmers, and development agencies must focus in depth on agriculture in order to accelerate renewal of development in Africa.

May 1999

Rodney W Nichols
President and CEO
New York Academy of Sciences

Preface

Following the successful conduction of the International Workshop on Regional Land Cover Changes, Sustainable Agriculture and their Interaction with Global Change, in Chennai India 16–19 December, 1996, the European Commission commissioned COSTED to plan and organize a similar workshop in Africa with a focus on the southern African region. This was indeed very flattering to COSTED and a demonstration of the trust the EC's Directorate General XII reposed in us.

While in a broad sense the issues of the fast disappearances of land cover and environmental degradation vis-à-vis increasing demands for foods and food security apply as importantly and vehemently in the Southern African region as in the South Asian region, there are specific problems and stresses the Southern African region struggles to cope with. These matters were vividly and forcefully brought up and discussed at the workshop COSTED organized in Maputo, Mozambique during 28–30 July 1997, participated in by over sixty scientists, policy makers and experts in global change and allied subjects. The importance of the subject of the workshop and its deep relevance to Mozambique was exemplified by the presence of two senior members of the cabinet, The Hon'ble Dr Bernardo Ferraz, Minister for the Co-ordination of Environmental Affairs, and the Hon'ble Mr Carlos Agostinho do Rozario, Minister for Agriculture and Fisheries, at the opening and closing sessions.

The workshop has generated a number of valuable recommendations pertaining to data and informatics, causes and consequences of land use/land cover change, research opportunities and priorities, capacity building, policy support and sound resource management. COSTED hopes that this publication, carrying the subject presentations and the workshop recommendations, will be widely read and consulted by all those who are concerned with the issues of food security as well as scientific and sustainable land and water use.

A vast proportion of the world's poor live in the Southern African region, and in assessing and determining the options for development and the priorities identified by this EC-funded workshop would, COSTED hopes, receive recognition.

It is with much pleasure that I record COSTED's gratitude to the EC for commissioning us to plan and organize the workshop in Maputo.

I would particularly like to thank Prof Tilak Viegas, of the Directorate General XII and his colleagues Mr. Pierre Mathy and Dr. Mario Cattizone for their wholehearted co-operation and encouragement.

I am pleased to present this publication to the European Commission, national governments in the Southern African region, professional scientists active in this subject, and to the wider international community concerned with sustainable development.

May 1999

G. Thyagarajan
Scientific Secretary
COSTED

Monitoring and Managing Land Use Methodology

Understanding the interactions between Nature/
Society for land use management in rural areas.

Nelson Lourenço,
Teresa Pinto Correia, Rosário Jorge and Carlos Russo Machado

Introduction

Today, the Social Sciences still face the absence of an appropriate conceptual framework which could make for the understanding of the complex interactions between society and the environment. In fact, the majority of studies tend to concentrate on the effect and impact of man's actions on the environment, paying little attention to the consequences of those changes on human activity.

As mentioned by Mesarovic, McGinnis and West (1996), studies on the role which humanity plays in global change are often carried out within the concept of an *analysis of the human dimension*; thus, they lose the systemic perspective which considers society as a subsystem interacting with the natural subsystem within the far-reaching and integrated framework which is the global change system.

The use of this systemic perspective allows the complexity of the interactions defined by the social systems / natural systems to be incorporated in the analysis and obliges the development of a different view on the relationship of these two systems. This view shows that they interact through a logic of reflexivity, in other words, the social systems are changed at the same time as they modify the natural system, or, the impact of human activity on the environment and the consequences of the latter's deterioration on human activity cannot be considered separately since they are related in real time (these two views are graphically represented in Figs. 1 and 2).

The methodology proposed in this article for the monitoring and management of land use specifically aims to assume an integrated and systemic vision of the social system / biophysical system relationship. Thus, the study of the changes in land use aims at understanding the environmental changes and, further to identifying them, makes for understanding the motivations and strategies of man's interventions in the environment and his reactions in the light of global change. So, the interactions between natural and social, political and economic factors should be present in the studies on changes in land use.

Therefore, the land use study "...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..." (Turner, Skole, Sanderson, Fisher, Fresco and Leemans, 1995).

Generally speaking, the effects of the change in land use on global change are still little known in much the same way as the factors which are behind those processes are not fully understood. There are, therefore, difficulties in defining methods of intervention in the regions and in obtaining support instruments for decision making which are fundamental to managing, understanding, accompanying and assessing the changes (environmental and social) resulting from modifications in land use.

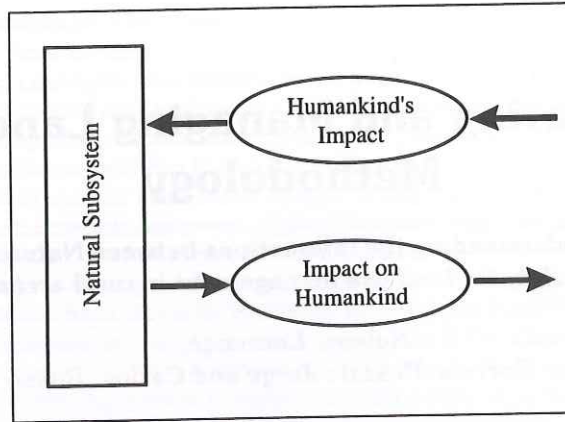


Fig. 1 *The human dimension view of Global Change*
 Adapted from: Mesarovic, McGinnis, West; 1996

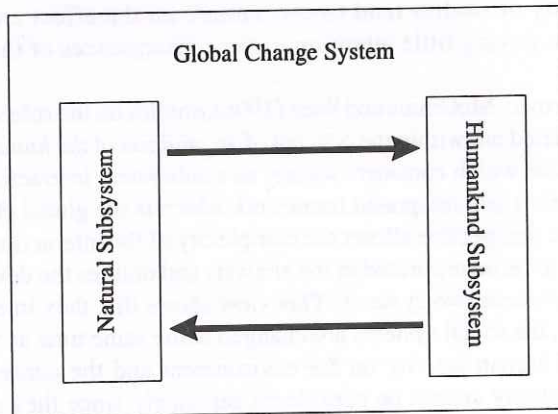


Fig. 2 *The Reflexivity view of Global Change*
 Adapted from: Mesarovic, McGinnis, West; 1996

The development of a methodology for monitoring and managing land use therefore implies understanding the Nature/Society relationship; in other words, the interaction processes between the natural system and the social system. From this point of view, and within the framework of global change whose factors are of natural and anthropocentric origins, it is possible to construct reliable and efficient instruments for supporting technical and political decision making.

The reflexivity of the relationship of these two systems implies an element of uncertainty given that very complex interactions are involved, whose consequences are felt on a global level and for long periods of time. Thus, the uncertainty constitutes a limit to the objective and full understanding of the relationships between the two systems; this makes it difficult to forecast its evolution.

The construction of support instruments for decision making should, therefore, take into consideration the social participants involved at different levels of social reality, the uncertainties, various possibilities for action, different consequences of a decision, situations of conflict or competition, etc.

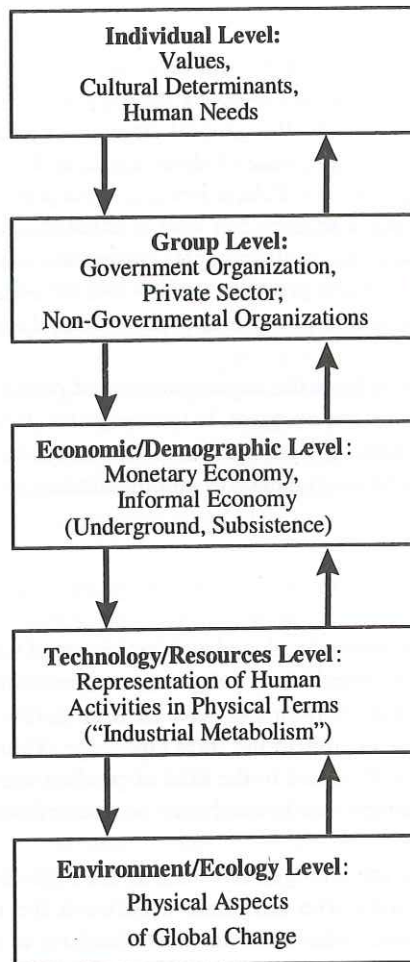


Fig. 3 *Conceptual level framework*
Adapted from: Mesarovic, McGinnis, West; 1996

The conceptual framework presented in Figure 3 allows these questions to be situated and considered within the framework of the working of complex systems. The higher level shows the individual perspective; in other words the needs, values, socio-cultural conditioning factors of the participants involved in the change in land use, such as farmers and their actions at farm level. The next level shows the way in which the participants who intervene directly and indirectly in land use (farmers, farming specialists, official services) are organized. The socio-economic framework, expressed by demography and by the different methods of economic organisation, is dealt with in the next analysis. For example, at this level, the implications of the population exodus from the regions studied can be analyzed in terms of the implications on the decrease in labour force. The different technologies applied in land use and the resources available should also not be forgotten. Lastly, the environmental level should approach the different processes of environmental change which can be seen in the natural system, and which have implications in terms of land use, within a framework of global changes whose factors are of a natural and anthropocentric nature.

As farmers are the main users of the land (in fact, they decide how to use the land), it is assumed that their reactions will largely determine the impact of agricultural policies in terms of constraints and opportunities for development. Thus, this conceptual approach should take into consideration the external driving forces; in other words, the general framework of measures which direct and rule society's intervention in nature. An example of these kinds of forces is, in the European case, the European Union's Common Agricultural Policy. Here, it is not possible to forget the restrictive measures on production (which in some regions can lead to extensification or even the abandonment of the land for agricultural purposes) and environmental conservation which were established due to the existence of very intensive agricultural practices (which had far-reaching consequences in deterioration of the environment) implemented in the countries of Central and Northern Europe over the last few decades.

Thus, change in land use results from the implementation of political measures which aim to reduce environmental damage and agricultural excesses. In the meantime, these guidelines often contradict the farmers' interests because they entail a drop in income. Therefore, the success of this type of intervention is dependent on the implementation measures complementary to agricultural incomes.

Methodology

The methodology presented below was developed and implemented within the scope of the study *Monitoring and Managing Changes in Rural Marginal Areas: a comparative research*¹.

The research was based on the study of the head farmers' activity, in other words, activity as an agricultural farmer and agent for change in the rural landscape. Thus, on one hand, it is important to analyze what their options are with regard to the kind of product and production quantity and, on the other hand, to understand the farming trends which may be diversification, maintenance, extensification or intensification.

The aim was to understand the changes in land use through the analysis of the impact of the human and biophysical dynamics. The articulation between the human and biophysical factors which is at the root of land use, contributes in understanding of the complexity of the regional dynamics through the comparative analysis of local case studies.

In fact, the analysis of the processes of change in the rural areas and their articulation with external driving forces, such as the Common Agricultural Policy, stressed that in the face of different contexts the same cause provokes different effects (Jorge, 1997; Lourenço *et al.*, 1997). The study carried out allowed us to identify and highlight four fundamental dimensions which define a systemic articulation that structures the processes of change in rural areas: the change in farms' structure and land availability; the change in soil use; the process of innovation and modernization; and the regional and local dynamics.

The first step of this study led to the identification of Territorial Units where a characterization of the farmers and of the natural framework in which they are located was carried out. Thus, a detailed survey was effected on current land use, by land use plots of the farms studied as well as on the landscape's elements which give most structure to the farming activities (hedges, fencing, lines of trees, etc.). The analysis of the farmers' strategies resulted in the carrying out of a detailed survey which allowed for the development of their socio-economic characterisation and for the assessment of the main changes they introduced in land use on their farms.

¹ This project was financed by the European Commission (DG VI) and carried out by multi-disciplinary research teams from Portugal, Belgium and Denmark. These teams studied the main processes in land use changes in rural and marginal areas in some regions of their countries.

The presence of different biophysical and socio-economic contexts, head farmers with different socio-cultural characteristics, and diverse land uses, result in very different situations which, in order to be duly analyzed, had to be grouped into a typology of farms and head farmers.

In this study, it was more relevant to be able to characterize the farmers and the conditioning factors in their choice of soil use and the environmental pressure on the agricultural land. It was necessary, therefore, to create a typology which was dynamic, useful for forecasting and directed at choice in terms of soil use and environment. On account of this, it needed to incorporate some conditioning factors (namely non-economic factors such as the age of the farmer, his heirs, etc.) related to decision making, restrictions and specific objectives.

The typology proposed combines a characterization of the farms linked to structural aspects of production (type of production, kind of techniques employed, buildings) and a characterization of the farmers' dynamism (investments, changes in production of animal or vegetal kind, search for land).

Finally, the typologies were formulated step by step, articulating quantitative and qualitative information, aiming to function as a comprehensive analysis tool for the dynamics of agriculture and the farmers' behaviour. Thus, the aim was obviously not to generalize the typologies but to consolidate an approach for the formulation of typologies considered as auxiliary instruments to the understanding of the dynamics of change.

The process of constructing the typology implied the use of the Factorial Analysis of Correspondences and made for the initial identification of a typology of production systems. The Factorial Analysis of Correspondences is the technique which can best ensure the simultaneous analysis of all the variables, given that their inter-relationship and weight are dependent on the group. The concept of the farming system is understood as an operational concept; in other words, it is an idea which allows for the description of the group of products of a plant or animal kind which are present on the farm and contribute, directly or indirectly, to the creation of income.

The second step of the statistical treatment consisted of another Factorial Analysis of Correspondences which gave rise to the farms' and head farmers' typology. These kinds of tools permit an analysis of the categories most associated with change and with the different farming systems and which are, simultaneously, most important for the farming systems and trends for change.

The aim of this comprehensive typology of change was to make a synthesis which answers the initial question: How do the individual characteristics and the farms' characteristics condition the head farmers' different practices in terms of overturning or reinforcing the trends of the process of change in rural areas?

Although the changes in land use were considered in the Factorial Analysis, the resulting typology is not a typology of changes in land use. In truth, the great diversity of land uses present in each farm doesn't allow for a characterization according to a differentiated types of land use. However, it is possible to define the main trends of change: intensification, extensification, diversification or abandonment of land use. These are the main trends which were identified through the dynamics expressed in the typology presented.

The importance attributed to the study of the dynamics of the farm lies in the fact that it is there that the interaction of the socio-economic and biophysical aspects is most intense, allowing for the analysis and understanding of the change of trends in land use.

For example, Figure 4 shows the typology of the farms and head farmers obtained for the regions studied in the South of Portugal. On account of the great diversity of biophysical and socio-economic contexts, the aim was not to obtain a common typology for all the regions studied, in the three countries. However, the construction of the typologies in the three countries followed the same methodology which aimed, in essence, at obtaining instruments adapted to the each situation studied, in order to construct support instruments for the decision making process. Thus, the resulting groups show the conjugation of the socio-economic factors, practices and attitudes of the farmers with regard to intervention in the land.

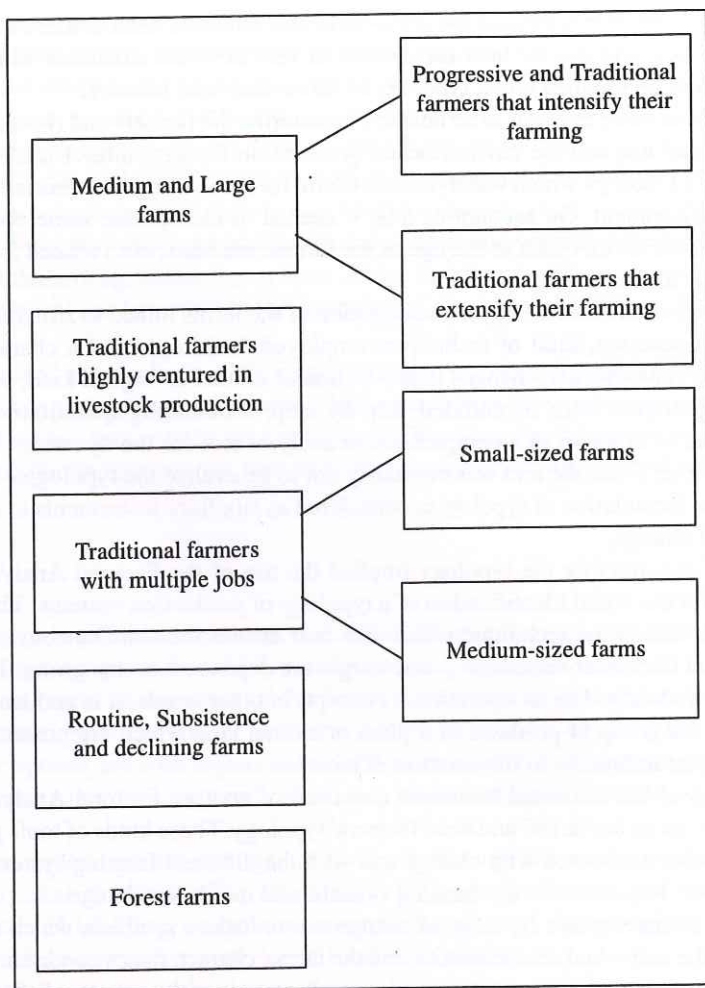


Fig. 4 *Typology of farmers and farm units in South Portugal*
 Source: Lourenço et al., 1997

As previously mentioned, this methodology was developed for the study of the dynamics of the farms in regions of Portugal, Belgium and Denmark, countries with different biophysical, social, economic and legal contexts, with farmers who are different in terms of type, level of development and integration in the market (Lourenço *et al.*, 1997; Pinto Correia, 1993). Typologies of the farms and head farmers in the regions studied were realized in these three countries.

Given the need to characterize and group head farmers, it was necessary to carry out detailed surveys of the farmers as the only way of obtaining the necessary information.

This need for information obtained at a local level is one of the main points of this methodology since it is this information, articulated with that obtained at a regional level from official statistics, which allows for its generalization to wider areas, thus making it possible to formulate change scenarios which are an important support instrument for the decision making process.

The incorporation of this typology of the farms and of the information related to current land use, passed through a Geographical Information System, allows for the identification of the main trends of

change in land use and of landscape patterns. Given the characteristics of these kinds of data processing tools, which allow for the rapid and frequent update of the data, it is possible to keep the changed scenarios updated.

Application of the methodology to the regional analysis

The application of this methodology to the monitoring and managing of changes in rural areas has made it possible to understand the main dynamics and processes of the farmers' intervention on the land at a local level. This type of analysis is very difficult to apply to more extensive areas, given that the scale used does not make it possible to include the regional dynamics which would explain tendencies for change in larger areas.

It's possible, nevertheless, to apply this methodology on a regional scale. To do this, it is necessary to adapt the approach of this type of study in some ways.

One of the project's contributions was precisely to formulate a methodology which is capable of articulating demographic, economic and social information with information of a physical nature (soils and soil use). These two groups of data were introduced into the Geographic Information System, making for a spatial reading of the information. The GIS software made other analysis possible, for example, the sensitivity factors of the land to abandonment; but above all, the GIS allowed very different kinds of information to be inter-associated as well the quick adaptation of the analysis to the questions which were raised during the course of the research.

Although it is important that the reach of the information is restricted to the areas studied, this database is set up as an instrument for supporting decision making, monitoring and management of the area and its dynamics. The constant update of these databases and their expansion to other areas shall permit the construction of precious support instruments for decision making and the definition of regional policies.

Obviously, the generalization of the databases to large regions with the detail used in this study may give rise to financial and operational problems. However, it is possible to conceive the construction of databases with different levels of detail, inter-articulated, based on GIS supports, serving the same objectives as those incorporated in this study at a local level. In the last instance, it is a question of making the analysis of the local dynamics compatible with the dynamics at a regional level. This procedure would require the characterization of the region based on indicators of a secondary nature (censuses, annual statistics, instruments for remote sensing) with the realization of case-studies which are representative of the regional situation, making the study of the dynamics of social changes and their effects on soil use viable.

At a regional level the analysis should, therefore, be based on information obtained with instruments for remote detection (satellite pictures and aerial photographs) which permit the extensive collection of information on land use in this region. These instruments also make it possible to obtain data for different periods and to carry out an evaluative analysis of the main changes in land use. On this level, official statistics can also be analyzed to collect socio-economic information which is fundamental for describing the region's general framework. These two types of information are complementary and fundamental for the identification of the main problems which affect the region studied.

It is also necessary to study the main participants in the land's use at local level. It should be emphasized, however, that, due to the growth of other economic activities in rural areas (such as tourism, services, industries, etc.); in the European context the traditional participants, i.e. the farmers, are dwindling rapidly in number, their importance being made secondary by the intervention of other agents (new residents, farming experts, local planners, local associations, etc.). This level is, therefore, important for understanding the motivation of these agents when they use the land. A group of farmers should

be chosen who represent the questions identified at regional level which make it possible to understand them. A typology will be constructed based on this group of farmers, following the methodology referred to above, which will make it possible to understand the main factors for changes in land use.

The articulation of these two levels of analysis will be used for constructing support instruments for decision-making processes, mainly based on the construction of scenarios of change which will indicate the main tendencies for changes in land use.

In this way, the study is carried out on two levels of analysis. On a regional scale, it is possible to describe the region, and use official statistics and remote detection to identify the main problems to be dealt with and the main changes in land use. At local level, a study is made of the farmers, and of the factors for change identified at a regional level.

In addition to permitting the construction of instruments for monitoring, managing and supporting decision-making, this type of approach makes it possible to work with larger areas, extracting information from the analysis which is more detailed, but also more specific and localized, possibly facilitating its application to regions where less information is available.

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