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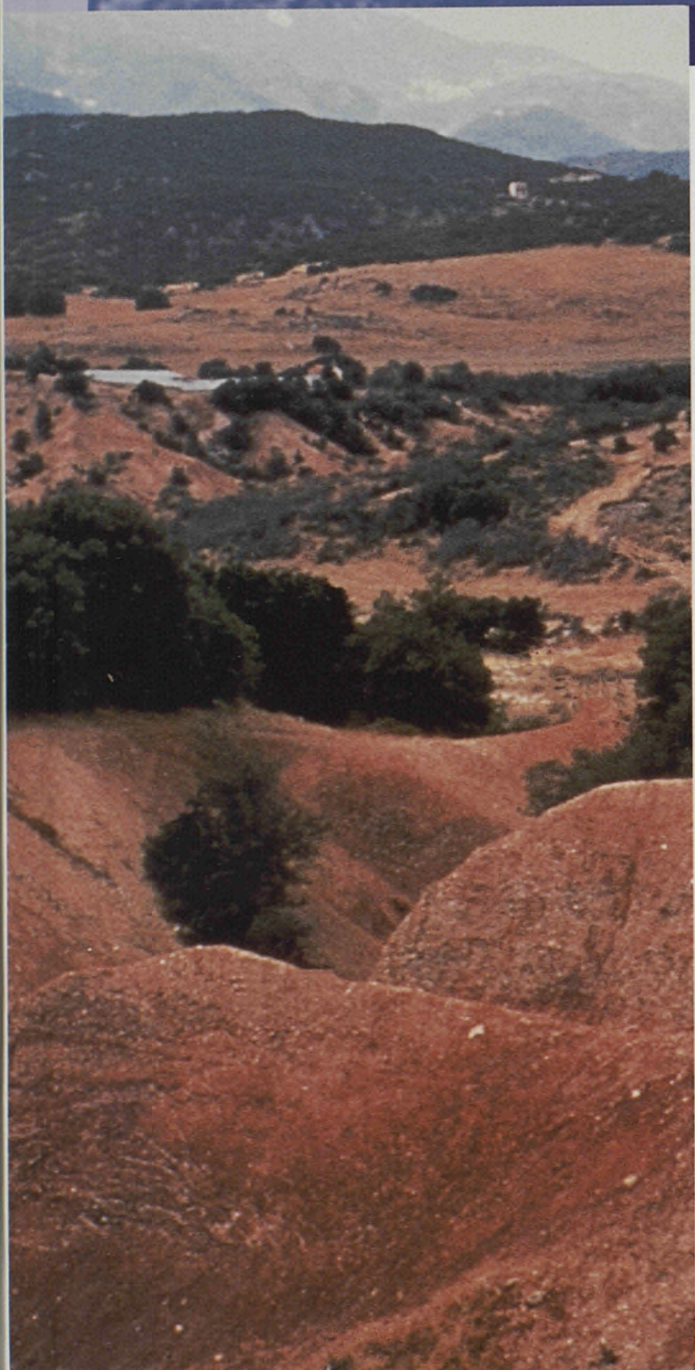

Environment and climate programme

CHAPTERS
1 Introduction overview of whole study
2 Multidisciplinarity and Integration

The Archaeomedes project

Understanding the natural and anthropogenic causes of land degradation and desertification in the Mediterranean basin

period: 20,000 years ago to present day

Research results

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UNDERSTANDING THE NATURAL AND ANTHROPOGENIC CAUSES OF LAND DEGRADATION AND DESERTIFICATION IN THE MEDITERRANEAN BASIN

Edited by S.E. van der Leeuw
(University of Cambridge)

VOLUME : SYNTHESIS

THE ARCHAEOMEDES PROJECT

coordinated by

University of Cambridge

for

Agricultural University of Athens
Universitat Autonoma de Barcelona
International Ecotechnology Research Centre
P.A.R.I.S. (C.N.R.S.)
Centre de Recherches Archéologiques
Institut National Agronomique
R.A.A.P. (University of Amsterdam)

for the

Directorate General XII of the European Commission

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Preface

S.E. van der Leeuw

It is my privilege to present here, for all the many members of the team, the synthesis of the ARCHAEOMEDES Project which, between 1.7.1992 and 1.10.1994 investigated the natural and anthropogenic causes of land degradation and desertification in the Mediterranean. I have little to add to the scientific chapters which follow, but I cannot let the occasion go by without adding a few personal words to the team, and to the many others who assisted us in realising one part or another of the daunting task which we set ourselves.

First and foremost of these are the three members of the section 'Climate and Natural Hazards' of DG XII, without whom we would not even have begun. Dr. R. Fantecchi, whose personal commitment to desertification has been an inspiration and an example; Dr. P. Balabanis, whose open door and aptitude to listen, as well as his commitment to collaborative research in Europe, have steered the project smoothly through Brussels' waters; and Dr. D. Peter whose always constructive and interesting comments pointed my thoughts in new directions.

Peter Allen, Roel Brandt, James McGlade, Denise Pumain and Roger Seaton contributed their time and energy from the first preliminary discussions all the way through to the end of the project (and beyond), but what I remember most vividly are the discussions we had in 1990-91, and the many hours we all spent writing the proposal.

In searching for people who were interested in participating, it quickly became clear that there were many who were willing to go beyond the call of duty. Sometimes after brief discussions, like at 7 AM on a cold morning in Paris with GiGi, or without knowing each other at all, they trusted me enough to respond and give me of their valuable time and energy. For opening many doors, I owe much to Françoise Audouze and to Jean-Luc Fiches, as well as to my Cambridge colleagues Geoff Bailey and Martin Jones.

In Cambridge, the whole Department of Archaeology must at times have wondered what I was up to, whether I wasn't having martinis on the beach in Marbella or skiing in the Alps rather than assisting at Departmental Meetings. But, under the direction of Martin Jones and Jane Woods, they supported the project in true Cambridge spirit and enabled me to devote all my attention to it; in so doing they contributed greatly to the result.

Once we were installed in Janus House, 'ARCHAEOMEDES' consisted of a coffee machine, a phone, a fax, and a photocopier, all brought to life by Anne Lilensztein. She was the soul of our team; she kept in touch with everyone, she loved them and cajoled them, fronted for me and protected the photocopier from my wrath. A few weeks ago, someone asked me how, on top of all that, she managed to keep up with all the typing. The place was permanently buzzing, but Charlie, Nick and Geoff kept cool and helped create a pleasant atmosphere no matter what the latest panic was.

As in any project there were surrealist moments, for example when the Queen of Spain unexpectedly came to lunch in the building in Barcelona where we were meeting. Or seeing James McGlade walking over the platform at Alicante Airport when I awoke and stared through the porthole of our plane. He was waving his arms in a discussion with a colleague, unaware of the fact that we were not quite in Almeria yet. Or hearing a farmer near the Greek-Albanian border shout something incomprehensible as he came running after Geoff King and myself with a gun. We were both bearded and strange-looking, so he thought we were Albanians who had kidnapped his father.

Some of the most rewarding moments were spent travelling or in the field with the different teams. Arriving the day after the project had started in Aristi, way up in the Epirus mountains, I was honoured with a new nickname, 'The Godfather', member of 'The Cambridge Mafia'. A couple of months later, my first visit to the Vera basin was a real acid test - but everyday my hosts allowed me to discover more interesting sites, dishes and people. In Mycenae it snowed on Atreus' tomb, but the same evening in Argos and Nafplio, Nenia and Nikos thawed me out with retsina and shared some of their warmth and Greek wisdom. And a long car ride with brother François, from Valbonne to Besançon, was the occasion for one of the most interesting discussions of recent years.

Then there were the workshops at which we confronted our different ideas - and in so doing slowly became a team. From the puzzled faces in Paris to the winks and jokes at Grignon, all those involved gave their time freely and gladly even if it meant another weekend away from the family.

For that fascinating voyage along many paths I had never had time to explore, I owe much to all the members of the ARCHAEOMEDES team. The last few years have easily been the most rewarding of my academic existence so far, with their mosaic of academic and national cultures and interests, fierce discussions and debates, and occasions to test my potential in 'conflict resolution'. But above all with their many instances of collegiality, hospitality and friendship. It is significant that, during all my trips for the project, I hardly ever stayed in a hotel and had many memorable evenings in out of the way places.

Thank you.

Table of Contents

Chapter 1: Introduction **2**
Aims of the research 2
Context of the project 2
Definition of degradation and desertification 3
What is degradation? 4
What is desertification? 5
What is desertion? 6
Where, when, how and why? 6
Where? 6
When? 6
How? 6
Why? 7
Our approach 7
The long term 7
Multidisciplinarity: the social and the environmental aspects jointly investigated 8
A co-evolutionary perspective 8
The role of perception 9
Social dynamics and natural dynamics 10
Many socio-environmental systems are nonlinear and metastable 10
The interaction between different spatiotemporal scales 11
Sustainability and resilience 13
The rolke of modelling 13
Description of the subprojects 14
The Vera basin 15
The role of perception in degrading the water table in the Argolid 17
Epirus and the case for disturbance-dependency 17
Urbanisation and the environment: the southern Rhône valley 18
Conclusions 19
Methodological issues 19
Substantive insights 20
Lessons for the future 21

Chapter 2: Multi-disciplinarity, policy-relevant research and the non-linear paradigm **25**
Introduction 25
History, Nature, Culture, Environment, Society, Science and ... degradation 26
The present dilemma 30
A bee's eye view of multidisciplinarity and degradation studies 33
Le milieu et l'environnement 33
Past and present 34
The temporal dimension 35

The spatial dimension 35
Experience and reason 36
Multi-disciplinarity and policy-relevant research 37
Multi-disciplinary research and the adoption of a 'creative' perspective 39
Conclusion 40

Chapter 3: Main building blocks of our approach **43**
Introduction 43
Human ecodynamics: the co-evolution of Nature and Society 43
Dynamical systems 44
The change in outlook: 'From Being to Becoming' 44
The role of instability and fluctuation 46
Diversity and self-reinforcing mechanisms 46
Deterministic chaos 46
Resilience and emergent behaviour 47
Attractors 47
Scales, hierarchies and heterarchies 49
Some epistemological implications 50
Conclusion: towards 'human ecodynamics' 52
Our perspective on the environment is necessarily social 52
Societies as communications structures 53
Communication: the spread of knowledge 54
Social systems as open, self-organising systems 55
Group structure and its impact on perception 56
Processing under universal control 56
Processing under partial control 56
Processing without central control 57
Dynamics of communications structures 57
The Epirus example 57
Perspective and information distortion 58
Conclusion 59
The 'Multiscalar Modelling Framework' 59
Modelling epistemology 59
Modelling socio-natural interaction 60
Models as partners in dialogue 62
Policy-oriented research 65
The attribute-set approach 65
Conclusion 68

Chapter 4: Northwestern Epirus in the Palaeolithic **71**
Introduction 71
Parameters of the research 72
Aims 72
The geological background 74
Tectonic structuring 76
Climate and vegetation 82
Fauna and human land use 89
Landscape and animals 89
Human occupation 92
Scenarios of land use 97
Forms of exploitation 100

Modelling the spatial behaviour of animals	101
Conclusions	109
Chapter 5: Environmental dynamics in the Vera basin	**115**
Introduction	115
Stratigraphy and lithology	115
Tectonics and neotectonics	116
Sea level fluctuations	116
Hydrogeology	116
Geomorphology	116
Soils and land use	116
Modern vegetation	116
Palaeobotany	117
Archaeology and history	118
Aims and objectives of the research	118
Mapping the natural environment	119
Diachronic research strategy and selection of studied sites	121
Analytical procedure and systems of interpretation of soil structuration	124
Establishing the chronological framework	127
Geodynamic and erosional processes as a long-term trend	127
The Holocene model of soil system structuration	127
Effects of human intervention	129
Human ecodynamics and the long-term structuring of social space	131
Ecosocial dynamics	137
Ecohistorical period 1: 4000 BC - 3000 BC	137
Eco-social formation 1	137
Ecohistorical period 2: 3000 BC - 700BC	138
Eco-social formation 2	138
Ecohistorical period 3: 700 BC - AD 718	138
Eco-social formation 3	139
Ecohistorical period 4: AD 718 - AD 1500	139
Eco-social formation 4	140
Ecohistorical period 5: AD 1500 - AD 1960	140
Ecosocial formation 5	140
Ecohistorical period 6: AD 1960 - AD 1994	140
Ecohistorical formation 6	141
Conclusion	141
The modelling contribution	141
Modelling soil erosion sensitivity	142
Microscale	147
Mesoscale	148
Macroscale	159
Discussion	160
Degradation contexts and temporalities: the importance of scale	162
Long-term rhythms	162
Medium-term rhythms	163
Short-term rhythms	163
Conclusion	164
Sustainable futures for the Vera basin: reality or myth?	164
Sustainable agriculture: the lessons from the past	165
Resource management and land-use competition	167

Land-use competition and conflict: a dialogic solution 168
Model architecture 168
Operationalising the dialogic framework 169
Research implications and policy recommendations 170
Land-degradation as socio-natural impoverishment 170
Policy recommendations 171

Chapter 6: Land use, settlement pattern and degradation in the Ancient Rhône Valley 175
Introduction 175
Part I: The diachronic study of past erosion and settlement patterns 177
The dynamics of settlement pattern and land use 178
Land use and settlement in the Alpilles 181
Morphogenesis, pedogenesis and time-lags in the study of erosion 187
Diachronic overview of degradation in the Valdaine 191
A tentative overview of land use and degradation in SE France 192
Conclusions 199
Part II: Settlement location and environmental perception 200
Methodology 201
Roman perception of the soil 203
Analysis of the rural settlement pattern in the roman period 208
Colonisation and spatial organisation 208
Desertion and reorganisation 211
One ditch too far 212
Conclusions 217

Chapter 7: Urban and rural settlement in the middle and lower Rhône valley in modern times 223
Introduction 223
The setting 223
Human pressure: the unequal impact of resident population 227
Size of communes and spatial distribution 227
The role of spatial coherence in the settlement system 230
Dynamics governing the urban pattern and its environmental pressure 238
Resilience of individual towns and relative environmental pressure 239
The spatial diffusion of environmental pressure around urban nodes 239
Social composition and spatial dynamics 240
Human pressure: differentiation and resilience of agricultural systems 244
Human pressure in rural areas 252
Three case studies and a comparison 259
Deforestation 260
Water management and land use dynamics in the Camargue 261
The Comtat 267
French agricultural policy 271
Some prognoses for the future 274
Recommendations and conclusion 274

Chapter 8: Agricultural production and water quality in theArgolid Valley, Greece 281
Developing the relevant framework 282
The recent history of the Argolid agricultural system 283
Identification of the extent of water shortage 287
The present social and economic context in the Argolid 291

Spatial structure of the Argolid valley 293
The agricultural system, perception and farming 294
Perceived uncertainty and farming 297
Perceived futures 299
Decision making and the dimensions of change for agricultural production 299
Policy issues 301
Conclusion 303
Modelling 303
Introduction 303
Policy instruments 304
Farmers' attributes on crop decision-making 306
Crop choice model 307
The model of water flow 314
Simulating the history and future of the degradation process 321
Policy imperatives 323
Towards a better understanding of the 'problem' 324
Discussion and conclusions 324

Chapter 9: Landscape perception in Epirus in the late 20th century 329
Introduction 329
Description of Epirus 330
Research design 333
Pilot study 333
Regional quantitative study 333
Kasidiares case study 333
Thesprotia case study 336
Katarraktes and Ktismata 336
A brief history of Epirus 337
1913-1939 337
The second world war 337
The Greek civil war 337
The 1960's 'economic revolution' 338
The Papadopoulos military regime (1967-1974) 338
Summary 338
Transformations 339
Economic use of the physical environment 339
Settlement patterns 341
Land ownership 343
Relations between regions 345
The role of transhumance 347
Perceptions of landscape 349
The creation of the landscape: the Aristi-Doliana Horse Trail, Lake and Nature Reserve 352
Introduction 352
Background to the project 353
Controversies 354
Conclusions and policy recommendations 357

Chapter 10: Concusions (I): aspects of method and theory 361
Introduction 361
Degradation 361

What is an 'environmental crisis'? 364
The individual level: the role of perception in generating crises 365
The group level: the role of social organisation in generating crises 366
The feedback cycle between organisation and its environment 367
Some implications for our modelling of past processes 367
Long-term processes: cultural evolution 369
The middle level: transition between organisational modes 370
The third level: oscillations within an organisational stage 370
Degradability, resilience and specificity of land use 372
Temporal scales 375
Natural temporal scales 376
Social scales 377
Scalar perception 381
What can people do about degradation? 382
Exchange 382
Techniques and technology 382
Disturbance 383
Rehabilitation 384
Spatial displacement 384
Conclusions 385
The spatial dimension: landscapes and the social organisation of space 386
The role of community structure 387
Landscape sensitivity matrices 389
Mapping the socio-natural dynamics of degradation 390
The long-term tendency towards reduction of diversity 392

Chapter 11: Conclusions (II): Substantive aspects and recommendations 397
Introduction 397
Part I: The individual regions 397
Epirus 398
The Vera basin 401
The southern Rhone valley 404
The Argolid 412
Part II: Recommendations 415
Science policy 415
Degradation policy 419
A few last words 424

Chapter 1

Introduction

S.E. van der Leeuw

It is only recently, under the impact notably of research programmes on global environmental change, that the topic of degradation and desertification in (Southern) Europe has become the focus of a major, concerted research effort. Partly as a result of this, and partly due to the normal, relatively fragmented and uncontrolled development of most research disciplines, our knowledge of land degradation in Southern Europe is rich in some ways, and completely insufficient in others. The focus has been on the role of climate, and subsequently on the role of the natural environment (*i.e.* soils and vegetation), while the role of man (other than in changing the global climate) has not been researched with the same intensity. The research has often been undertaken in relatively small 'sample' areas, and has sometimes focused on detail to the detriment of the overall picture. An area of investigation that is sorely missing, for example, is the comparison between manifestations of degradation and desertification in different areas, which occur under different circumstances. Because the research has begun only recently, there often is very little, if any, time-depth to the observations.

The present project explores the depth and shape of some of these holes in our knowledge, and intends to develop a different research philosophy on the issue. As such, the project will raise more questions, at least initially, than it will try to answer.

The full report on the project consists of six parts, of which this last volume serves to introduce and summarise it. The five others are each devoted to a particular area and period, and discuss the phenomenon of degradation from a different angle. The case studies involved are devoted to, respectively, (1) Palaeolithic Epirus (20.000-10.000 BP), (2) the Vera Basin during the last six millennia, (3) the Rhone Valley during a similar period, but with a particular focus on the six centuries from 100 BC to AD 500, (4) the Rhone Valley during the last two centuries, (5) the Argolid during the last forty years, and (6) Epirus during the same period. Another research area, the island of Brac off the dalmatian coast, was the subject of a separate but related research contract, and has been reported on elsewhere (Stancic 1995).

In the present chapter, which serves as an introduction to the synthesis, I have chosen to present a sort of sketch map to the whole project, a very brief summary of a number of the issues to be dealt with in the following chapters and, in more detail, in the other parts of this report - which were compiled by the different teams involved in the case studies. In order of appearance, we will (1) discuss the context of the project, (2) try to describe what we have understood 'degradation' and 'desertification' to mean, (3) outline some of the basic assumptions we have made concerning the nature of these phenomena and concerning the best ways to investigate them, (4) provide a summary of the methodology and contents of each case study, and (5) draw some conclusions which might serve as threads through the remainder of this report.

Taking a 'concentric' approach, the next chapters will go into each of these topics in more detail. Chapter 2 deals with issues of multidisciplinarity and integration, while chapter 3 discusses the methodology chosen, and summarise the present state of the 'Integrated Evolutionary Framework' which we set out to develop. Then follows a series of chapters presenting a summary of the data, fleshing out the arguments, and presenting the conclusions of each case study. The final two chapters of this part will be devoted to comparisons and recommendations.

Aims of the research

In the original proposal the aims of the research have been defined at two levels - the level of the project as a whole, and the level of the various case studies involved. In an order which differs in some respects from that which was originally proposed by us, I would argue that at the general level, our aim was to develop a Complex Systems framework for the evolution and understanding of the social, political and environmental factors contributing to environmental degradation and potential desertification. This framework would be used to produce 'policy-relevant' methods of diagnosis and analysis of imminent and potential threats to the environment, involving loss of sustainability through land degradation and desertification, and notably to:

- develop indicators, based on physical, socioeconomic and policy processes, which can be used to give warning prior to more obvious symptoms of 'desertification' and contribute to preventative policies.
- identify, among a range of landscapes and occupation regimes, those that will be liable to suffer heavy loss of biological potential under different climatological regimes.
- provide a coherent historical framework within which to develop complementary research, oriented towards the specific recommendations and remedial measures to be tested in MEDALUS II.
- provide resilience oriented policy directives for sustainable development and resource management.
- evaluate the perceptions of key actors about the environment, farming practice and policy instruments and to evaluate existing policy and its delivery in order to contribute to the design of remedial and preventative policy delivery.

Context of the project

The research to which we have referred, including our own, was born from a (justified?!) fear that our present-day environment, on which we depend for almost all vital functions, would not manage to fulfil that life-giving rôle much longer. Initially, that fear led us -as a worldwide community of scientists- to dread fundamental changes in our climate: man-made or not, an increase in global average temperatures was thought to be observed. Among CEC research programmes, this phase gave birth to the EFEDA and HAPEX-SAHEL projects. The observations made in this, and other, research place us in a dilemma: the temporal scale of observation is insufficient either to argue whether the observations are due to human pollution of the atmosphere or to natural factors, or to have a clear idea how much the average temperature might eventually change. Yet, ignoring the 'trend' could be dangerous for the future of mankind. Hence, we are led to take action in a number of different ways, at different scales, and based on different hypotheses concerning the significance of the data collected.

One line of research which became prominent in that context studied the potential impact which changes in average global temperature might have on the different environmental processes occurring around us. These studies chose a very different scale of investigation, almost the opposite of the atmospheric research. From the very large, we moved to the very small. Individual processes were isolated in as far as possible, and studied by different specialists in particular locations (e.g. MEDALUS I). There are three issues raised by such research which seem to be of relevance here. The first is the scale-dependency of the conclusions drawn from any such project, which led to the MEDALUS II project. Another is the awareness that local, non-climatological factors are of more importance in determining the viability of the local environment under changing circumstances than was previously suspected, prompting the scientific community and policy-makers to do more regional research, and research which covers different environments. And a last one, which is of no less importance for our argument, is the realisation that the role of the local inhabitants may well be of more significance than was assumed at first sight.

The present project comes in some respects close to the range of SEER (I and II) projects which DG XII has also been stimulating and facilitating. These projects are mainly concerned with the perception of environmental degradation at a number of levels, from the local to the national, and with some of the dynamics responsible for change in the perceptions involved. However, such projects do but rarely investigate in depth the way in which the research subjects actually deal with their environment. In view of the potential differences between results of research based on oral elicitation of subjects' perceptions and opinions, and research which investigates actions, differences which have been amply highlighted in social anthropology since the twenties and thirties at least, this seems a considerable limitation. It is in that immediate context, that one should see the ARCHAEOMEDES Project on which we are presently reporting to DG XII.

But there is a wider context as well, which we regularly refer to in the report, and which merits a few words of introduction: the wider debates on environmental issues, and the economic and political interests which are so closely related to them. Because of the complexity of that debate, synthesising it would be a very large project, if indeed feasible at all. But I would nevertheless like to pay homage to it by briefly referring to three major milestones. The 'Club of Rome''s report *'Limits to Growth'* (Meadows *et al.*, 1972) presented for a wide audience both a new method and a new message: it used modelling techniques to 'predict', to say something about 'the' future, and it was the first to set the alarm bells ringing: its message was one of 'inevitable doom', including the exhaustion of natural resources, caused by social dynamics, including population growth. What has become known as the *'Brundtland report'* (World Commission on Environment and Development, 1987) shifted the focus to 'sustainability', and thus went beyond the doomsday scenario to 'doing something about it'. It looked in some detail at the 'malfunctioning' of social systems which it deemed responsible for the perceived threat to the environment. It notably touched on the North-South divide: overexploitation linked to poverty in the southern hemisphere, and waste linked to riches in the northern. But the report did not relate actual and potential problems to the core of the present global socio-political and economic system, and concluded that sustainability could be achieved by improving on present-day management of the environment. The 'Club of Lisbon' report (*Limits to competition,* 1993) goes a major step further by focussing on one aspect of that system, competition, and outlining how its central rôle in the present-day global dynamic relates to a wide range of social and environmental problems. It thus firmly points its accusing finger at the core of our social system. Interestingly, then, we observe two parallel developments, one in environmental science and one among authoritative public figures, which (a) move towards a reconsideration of our present distinction between 'Nature' and 'Society', shifting the onus of environmental problems towards the human side, and (b) move the search within the social domain towards the core of the globally dominant socioeconomic system.

This report reflects, as any other, the context in which it was born. Its field is the relationship between people and their non-social environment. Its focus is on what may go wrong in the articulation between these two domains, each of which is subject to its own dynamic. Its subject matter is thus both pertinent to the present political debate and determined by it. We hope, expect and fear that it will contribute in one form or another to a much larger debate on the relationship between human societies and their environment on a world scale. We hope so, both because we are aware of the seriousness and complexity of the problems delineating themselves on the horizon, and because we firmly believe that solid research has a contribution to make towards dealing with them. We expect so because in the debate concerning the environment detailed scientific studies have made such a contribution, but we also fear that the research may be used in many different ways in which we would not care to do so.

Any research is based on choices of both a scientific and a political nature. Or maybe it would be better to say that all decisions which the planning, undertaking and executing of research requires to be made involve reasoning which is inevitably to some extent political, and thus laden with ethical values and emotional charges. Communicating about such research, and its results, inevitably caricatures it - and thus prepares the ground for understanding it in different ways, not necessarily our own.

Among the team members, opinions have varied (and they still do), as is expressed to some extent in the individual case study reports. As the present part has been written by the coordinator, it is his view which prevails in this synthesis. But the others cannot be held responsible for it.

Definition of degradation and desertification

There is considerable confusion about the definitions used to circumscribe our basic topic of research. Similarly, within the team responsible for this project, we have seen many different uses of these terms, and a number of interesting debates. As long as soil scientists and plant sociologists differ about whether the forest or the savanna is gaining in one and the same patch of forest edge in Amazonia (Latour, pers. comm.), it seems improbable that the many scientists who are now looking at the general area of degradation and desertification, from within very different disciplines, will ever agree on one particular wording of what they are doing. Such is not the nature of scientific endeavour. Thus, I do not propose to make a substantive contribution to this debate, but a brief discussion which places the terms degradation and desertification in context may contribute to the reader's ease in living with such diversity as well as clarify our own position. First, let us relate degradation to some other concepts.

What is degradation?

Erosion is often seen as the sign 'par excellence' of degradation, and occasionally the two are even conflated. That seems too simplistic. In the Vera Basin, for example, degradation is associated with a denuded soil, erosion, and badlands formation while in Epirus it is associated with expansion of the vegetation. Our definition should therefore be wider and include a variety of physical, chemical or biological changes in a landscape. On the other hand, not all such changes qualify as degradation. Those that do, indicate that the term 'degradation' *expresses change away from a situation in the (recent or more distant) past which is now appreciated as having been better.*

As a first step towards a more suitable definition, I would therefore like to make the distinction which Blaikie & Brookfield (1985, 1) introduce between (a) purely environmental processes such as leaching, erosion, acidification or salinisation, which occur with or without human interference, and (b) their relationship to the land's (socially determined) actual or possible uses. This distinction permits us to stress that one can only speak of 'degradation' in describing the occurrence of physico-chemical and other environmental processes which lower the 'quality' of the land in relation to certain uses. *'Degradation' is a relative concept which links physico-chemical processes with social, cultural and economic values.*

As with any such relative concept, both the subject and the referent need to be carefully considered to elicit the precise meaning it has in each instance in which it is used. In that respect, again, our research in Epirus presents an interesting case. There, tectonics are predominantly responsible for the fact that soil erosion is widespread, affecting large areas and regularly leading to such unhappy events as the overnight disappearence of (parts of) fields, or the sudden emergence of a large hole in the garden. Yet, that is not seen as degradation by the population, who do not even remark on such events but use the word degradation for the resurrection of the arboreal vegetation which, for centuries, has been suppressed by heavy reliance on grazing and burning off hillsides. In our work in Epirus, therefore, we were initially confronted with total incomprehension due to the fact that we had a conception of degradation, a northwestern european scientific one which links it to erosion, which was totally different from the local one.

I do not wish to imply either that degradation is only inherent in the eye of the observer, nor its extreme (and sometimes romantic) converse, that non-degradation can only occur in an environment which is not in touch with any humans. The point I wish to stress here is that *the observation 'degradation' can only occur in the relationship between humans and their (human and non-human) context.* That relationship is therefore the natural focus of our study.

An example from Papua New Guinea illustrates the complexity of the relation between cultural values and the environment. In the Western Highlands, the general tendency among many tribes is to view any kind of change as 'degradation', and to idealise a stable past. Moreover, these tribes believe that one can correct problems by, as it were, going (ceremonially) back to the point in time where the root of the problem lies, and sorting it out. In the case of the Huli, which we know very well through the recent work of Ballard (1992), we can follow the development of degradation through time (Ballard has patiently unravelled the oral history and genealogy of the tribe), and glimpse the history of a population which is slowly deforesting, and retracting from, the hillsides into the valley and into the swamps which now predominate. Thus, a population initially concerned with having water flow over their fields became one concerned with draining it out of those fields. How could that have come about?

Detailed research presents the following picture: observing some change, which is viewed as degradation because of the dominant cultural perspective, the need is felt for a ceremony to re-establish the equilibrium between people and nature. Traditionally, such a ceremony requires feasting, notably by killing numbers of pigs for the participants. The more frequent the ceremonies, the greater the need for pigs, and pig-feed.

Hence an expansion of the area devoted to horticultural activities, which is only possible by cutting down the forest. As in many parts of PNG, settlements are preferably located on hilltops and ridges. The slopes are steep and as soon as the area cut down exceeds a certain threshold size, erosion follows rapidly under the tropical rains. Slowly, the population cuts away the means of subsistence which surround it, and is forced to move downslope. Eventually, their concern to keep the environment as it was in the past has totally transformed that environment, and landed them in the marsh which is (in part) the result of all the soil that washed downslope! The population undertakes action because it perceives degradation, but that action has the unexpected consequence of accelerating the degradation.

In keeping with the above examples and many other ones, *'degradation' is here conceived of as a general (and as yet unquantified) measure of loss of (suitability for) some form of use of an area* . The implied assessment can relate to different observations, but may also relate them to different referents. As is stressed by Green for Epirus, within the rural community of Epirots it refers to the inexorable ending of a way of life. In the Argolid it refers to increasing difficulties in obtaining fresh water for agricultural purposes to the inability to continue particular ways of doing things. The perception involved is in that case related to a purpose, as well as to a time in the past.

From the perspective we propose, degradation cannot be defined in some abstract environmental terms, such as 'loss of nutrients', 'increasing distance from climax vegetation', 'loss of growing potential', etc., because that begs the question how we define the level of nutrients, the climax vegetation, the growing potential of an area in absolute terms. Indeed, the term is here used entirely in a relative sense: at best, we might be able to define the environmental corollaries to a particular kind and degree of degradation.

That in turn shifts the focus away from a universalist one, in which the processes of degradation can be *known*, and such *knowledge* applied to different areas, different conditions and different periods. Rather, it seems to us that we may generate some degree of *understanding* of the phenomena involved, and maybe succeed eventually in constructing a very general model of a number of the kinds of dynamics which may be involved in degradation. Such a model might then be used in different specific investigations in order to define more precisely under which local circumstances, and in which way, these dynamics materialise in individual instances.

What is desertification?

Literally, the word signifies 'to make deserted' - to make unfit for (human) presence. One way to look at the distinction between desertification and degradation is to see them in the perspective of the history of the development of research in the area: desertification implies the powerlessness of people in the face of natural phenomena, whereas degradation implies the impact of people on the natural environment. The former is also experienced as more serious than the latter: degradation may well be a stage 'on the road to' desertification, but the reverse is generally thought to be inconceivable.

Desertification is experienced as irreversible, because it is 'beyond us' to do anything about it, whereas degradation is due to our collective human impact, and should therefore be, at least ideally, reversible. But that distinction does no longer seem well-founded as soon as a long-term perspective is introduced. Who would wish to stick his or her neck out that the Sahara will never become as wet again as it used to be when all the fossil water we find under it was deposited? How about in a next ice-age? Irreversibility is a concept which is highly scale-related, and should therefore not be used indiscriminately. And the reader who objects against the length of the perspective proposed here, may be reminded of the fact that in SE Spain we have found evidence of at least four cycles of extensive degradation and return of the vegetation in the last 5000 years.

Moreover, if our purpose is to define degradation as an interaction between people and their environment, we need to develop a perspective that subsumes both the 'social' and the 'environmental' perspectives under a relational model that covers both. *We will therefore in this book view desertification as a special case of very heavy and large-scale degradation, and look at the wider range of processes rather than focus on desertification.* After all, one may have a difference of opinion about whether SE Spain is at present a very degraded landscape, a semi-desert or a desert, but the difference seems to us gradual. In taking this approach to desertification we are acknowledging our debt to Mainguet's (1994) train of thought, even though the initial reflections which brought us to this decision were more of a theoretical than a practical nature. We would agree with her, though, that 'the word desertification became a trap which ambushed scientists, planners, donor countries, governments of the affected countries and the mass media' (1994, 16).

Implicitly, we therefore open the theoretical possibility that human beings also played a role in the creation of true deserts. But the reader may rest assured: we will not argue here that the whole of the Sahara or the Gobi is the work of humankind. At most, we will point out that it is worth investigating whether humanity has not helped in extending the areas concerned.

The proposed subsumption has the added advantage of acknowledging the fact that in our perspective, humans play both a proactive and a reactive role in their relations with the environment.

What is desertion?

Desertion is the process of out-migration from an area which leaves it un(der)occupied. It is not always due to people being forced out, and may also be due to people being drawn away. That may in turn be due to, and/or may cause degradation. Implied is a change in relative attractivities of various areas, for example as a result of environmental social, economic, political or technological changes in one or more areas or in the perception which dominates people's priorities. We will see that in the cases of Epirus and the Rhone valley in recent times, it is argued that desertion causes, and is caused by, degradation, but that degradation implies a resurgence of the natural vegetation in both cases.

Where, when, how and why?

Now that we have some aspects of the concepts which this research is aimed at, let us very briefly look at the circumstances under which degradation occurs, and point to a few implications thereof.

Where?

Degradation potentially occurs anywhere - it is not limited to particular natural circumstances such as drought. In Papua New Guinea, for example, it occurs massively in tropical rainforest circumstances as soon as the population has cut down the slope forests - a traditional subsistence technique. Scotland and Iceland are equally heavily degraded areas in temperate and cold climes. The Vera basin in SE Spain is now heavily degraded, with sheet and gully erosion and badlands formation, yet archaeological research has shown that at several points in the past, it was a wealthy and intensively settled area, only to be degraded again and to be heavily exploited a number of centuries later. Sometimes degradation is not visible until it is too late - the Argolid is a case in point. It looks like an immensely wealthy agricultural area, yet we know that it cannot sustain its present exploitation regime for much longer.

When?

Potentially, degradation occurs anytime - it is not limited to the present, as we know from many cases in the past. SE Spain, the Syrian Desert, Yucatan, the Southeastern U.S. were all at different times able to sustain major urban settlements which have now disappeared. It is a perfectly normal occurrence with which people have dealt for millennia. Moreover, it is a temporary phenomenon in most cases - though the time-scale may be very long. Although climate as well as soil conditions and vegetation and related physico-chemical and biological processes play an important part, it could be argued that in view of the variety of circumstances under which degradation occurs - circumstances which share only the fact that human activity has locally modified the ecosystem - the responsability for many cases of degradation must firmly be placed with human activity rather than the environment.

How?

One extant trend in the literature would argue that soil degradation and erosion directly result from cumulative land-use decisions through time, and that these decisions must be considered as a part of a wider political economic analysis (Blaikie 1985. 117). This firmly places causality in the social sphere. We think that that is too one-sided, although we would like to retain the social aspect. We would therefore prefer to answer that question as follows. *Degradation occurs as a result of a conjunction of circumstances, natural and social, as soon as one or more variables accelerate or slow down out of proportion, not allowing the other (articulating) ones to keep up with them and thus causing a search for a different dynamic equilibrium of the total system.* This may sound too anodyne and/ or 'scientific', but apart from the fact that it is more even-handed on the 'nature vs. culture' issue, it captures an essential aspect not present in most other definitions, the fact that there is a relative acceleration involved which may result in a qualitative, not only a quantitative change.

Why?

There are limits to the extent to which this question (in full: 'why does it happen this way rather than another?') can be answered. For this there are two reasons. Firstly that the phenomena are very complex indeed, and that it is not easy to understand them. But we believe there is also a more fundamental epistemological reason. The perspective which we wish to argue is appropriate to this research (Faggi 1991; Perez-Trejo & McGlade, 1992) accords considerable importance to slight differences in initial circumstances in explaining much more considerable differences between outcomes. As a consequence, similar causes may have very different effects, and vice versa. It follows that we must be extremely cautious in the construction of 'causal' chains (or 'chains of entailment', *cf.* Rosen, in press). Moreover, in many circumstances - though not in all - the differences in initial circumstances are so small that we cannot observe them clearly enough to know why a particular outcome occurs. We may globally characterise the circumstances under which certain dynamics occur, and when they might transform into other dynamics - but not how these others turn out in detail.

Our approach

The next step in this first approximation of our topic is a brief outline of some of the major points in which we feel our approach differs from that commonly used in degradation or desertification studies, and notably in the research undertaken for DG XII on this topic. All of these issues will be dealt with in one way or other, throughout all the volumes of this report. In the next chapter, they will de discussed explicitly, and in some detail, as part of an attempt to formulate the 'Integrated Evolutionary Framework' which the project aimed to design. In later chapters in this volume, and in the other reports, they will be implicit, albeit in varying degrees, in the presentation and description of the data. Here, I merely want to globally position our project. But I should repeat the warning that there clearly are considerable divergences of perspective and opinion between the members of the ARCHAEOMEDES team, which we all value because they are the motor of the research, creating as they do the social and intellectual dynamic which drives the project.

The long term

Choices made in the past are the initial conditions of our present day Southern European landscape. Human societal groups, whether as farmer, stock raiser or urban resident, are continuously engaged in activities which alter and restructure the natural order. Many ways in which these alterations impinge on ecological regimes and cause profound changes are clearly manifest in the Mediterranean region over the last two millennia, and are reflected in population movements, land use changes and the rapid urbanization of coastal areas, for example. One might say that over a long time-span, regional differences in physical environment and the degree of human imposition have been tested, differentiated and transformed under a wide range of circumstances in processes in which both systemic and historical elements have played an important part.

Part of this process is a slow, but fundamental change in the dynamic between man and nature which occurs over a very long time. Whereas the spatial patterning of human activity was initially highly dependent on the environment, with time, the spatial aspects of human communication and information processing begin to dominate. Man is no longer adapting to nature; humanity is controlling the ecological dynamic - a symbiosis in which humans are responsible for the behaviour and evolution of the natural environment has now developed in a number of locations. As we will see clearly in the case of the Vera Basin and the Rhone Valley, the long-term dynamic responsible for this profound change is, among others, expressed by the spatial configuration of aggregated and dispersed human use of the environment. Some of the system states representative for this dynamic strike the eye immediately in many parts of the Mediterranean: transhumance, dispersed agriculture, intensive agriculture and urbanization, among others. But more importantly, all the elements of this dynamic are still present in the economy of southern Europe, and it seems therefore that the vulnerabilities and resiliences of the present organization of Southern Europe are best studied by investigating the long-term history of several regions which were under radically different human/environmental co-evolutionary regimes, tracing as it were the differences which have emerged from similar initial conditions. Or in complex systems methodology terms: we need to identify the major bifurcations which have occurred in the trajectory of the system.[1]

Moreover, it is the EEC's stated requirement that future policies are to be sustainable. One needs therefore to be reasonably sure that the long-term effects of various regimes are known. This is all the more important because - as we will see - many of the consequences of human interference remain hidden for a long time.

Multidisciplinarity: the social and the environmental aspects jointly investigated

Human/land relationships are complex, variable and ultimately context-specific - particularly with respect to understanding the structure of social, economic and ecological relationships across the landscape and their reproduction in time and space. We must come to terms with the way in which climatic, geographic and ecological processes and their nonlinear interactions impinge upon and create the enabling and constraining factors that account for specific human/environmental relationships and their transformation.

In view of the many different social, cultural, economic, geological, hydrological, vegetational and climatological circumstances under which degradation occurs in all parts of the world, it seems presumptuous to assume that any limited number of substantive environmental causes underlies all these examples. Indeed, it would even be easier to argue from this diversity that, if there is a limited set of causes, it should be looked for in the cultural, social and economic arena, because what unites most of the examples of degradation which we find, is that they occur in the presence of human beings.

But then, if there are such 'ultimate' causes of a cultural, economic, social or other human nature - and we reserve our judgment on that - they manifest themselves as changes in a wide range of environmental dynamics. And in order to determine which such changes are, one needs to have an intimate knowledge and understanding of these environmental dynamics. So it seems that all that one might be able to say for the moment is that the investigation should proceed from a wide range of different perspectives including both human and environmental ones.

And that requirement lands us smack in the middle of one of the most intractable problems of present-day scientific discussion and debate. From the perspective developed in this report, the size of the communities of scholars belonging to most disciplines has grown to such an extent that these communities have become relatively autonomous in their social dynamics. They have retreated in an autonomy which 'has become a way of thinking backed', in Luhmannnn's words (1985, 99) 'by collegial respect of the sort one has for something that one does not understand'. As a result they construct the problems they address, the questions they ask, the concepts they use, and the 'truths' and 'falsehoods' they adhere to by negotiation within their independent communities, and their practitioners draw their confidence from these negotiations. This trend, and the disciplinary fragmentation of the study of essentially holistic phenomena which it has brought about, are argued to be at once one of the main reasons for present-day environmental problems and a serious obstacle on the way to construct an approach which might mitigate them (*cf.* Latour 1993). The search for a way out of this dilemma has influenced both our theoretical stance, and notably our inclination to think and conceptualise in terms of complex (non-linear) systems, and the implementation of the project around a core of people who have actively worked with the means and models which that approach places at our disposal.[2]

A co-evolutionary perspective

Evidently, the relationship between humans and their natural environment may be seen, and has been seen in the past, as either 'the natural environment and the people' or 'the people and their natural environment'. In other words, it is all too easy to view that relationship either from the human perspective or from that of the environment, rather than as a co-evolution in which both are equal and complementary partners and in which the relationships are reciprocal. A widespread example of the the former attitude in the environmental arena is the assumption that 'people adapt to the environment', whereas the opposite is inherent in the ideology responsible for nature reserves.

The tendency to dichotomise in this manner is a fundamental one in the western intellectual tradition and lies at the roots of 'ecology' as a discipline. Thus, Haeckel's definition reads: 'Ecology is the science of the relationships of the organism with its environment, including all conditions of existence in the widest sense' (1859). This objectifies the environment and separates it from the (human) core of our experience, in true positivist manner.

We would argue with Latour (1992) that the whole distinction between 'society' and 'environment' is a fallacious product of the history of the western intellectual tradition, and that humanity is *'Just another unique species'* (Foley 1990). We must therefore define the environment, we must define 'what sits inside it' (society) and above all, we must develop a model of the relationship between the two, and that demands looking at a whole set of different scales and topologies of the dynamics involved.

A relevant line of argument was developed by Luhmann in his *'Ecological Communication'* (1985). He views society as a self-organising (social) system of communications, based on complementarity of expectations among individuals. These expectations are guided by meanings, which in turn relate exclusively to other meanings, and their constitution prepares the way for further communicative alternatives. Communication is therefore not seen as a transfer of information but as the common actualisation of meaning. In the process the complexity inherent in social action is reduced by harmonising the perspectives of the actors. Everything that functions as an element in the communications system of a group is therefore itself a product of that system. It follows that *a society cannot communicate with its environment, it can only communicate about its environment within itself.*

This has of course major implications for the research we are doing. For one, that the interaction between a group of people and its environment should be seen in terms of resonance: in order to be perceived, phenomena in the environment must be sufficiently close to the existing set of meanings (cognitive dimensions). Environmental problems may exist or not, but no one is to know until they are cognised and communicated. That requires the development of an appropriate set of meanings by negotiation between the members of the society involved, which is a slow process. And even then, the problems can be addressed only in such ways as the society has auto-referentially established, *i.e. with little reference to the particular problem at hand.*

We conclude that as far as its relationship with its natural environment is concerned, a social system is at once open and closed. In matter/energy terms it is completely open - there are no boundaries which hinder the transfer of either in either direction. But in information terms it is neither open nor closed. On the one hand, it is closed in the sense that any meanings are self-referentially constituted, while on the other hand it is open in the sense that society assigns meaning to the environment. McGlade (1995) has summarised the consequences of this very aptly:

- there is no 'environment'
- there is no 'ecosystem'
- there are only socio-natural systems in which many dynamics co-evolve

The implications are as many as they are complex and relevant to the present argument, and we will devote a considerable part of the next chapters to outlining them.

The role of perception

Neither the dynamics involved in environmental change nor the results are inevitable. They are at least in part due to choices made by people and therefore ultimately to people's perceptions of the environment. In our opinion, one of the most blatant lacunae in the research on environmental degradation is the absence of investigations of the human perception of the environment at different times, in different cultures and under different socioeconomic circumstances. One could even argue that the presence of degradation under different environmental, cultural and socioeconomic circumstances is related to the fact that no matter how different these circumstances, they have the biological basis of human perception, cognition, decision-making and action in common. I think such an argument could be made sufficiently cogent to merit including it among the hypotheses to be tested. But rather than make the case in full in this introductory chapter, I would like to present an example: risk perception.

Risk perception does not extend itself beyond the timespan over which an individual (or a population) retains a sufficiently accurate memory of observed phenomena. Perceived risks are therefore usually relatively short-term. Attempts to attenuate such risks, paradoxically, introduce new risks by changing the environment. Some of the new risks are characterised by relatively short temporal scales and will thus trigger further adaptations, while others will remain hidden for considerable periods. The net effect over a longer timespan is thus a transformation of perceived risks (operating at the shorter time-scales) into risks operating at longer time-scales, with delayed perceptibility. Ultimately, the latter accumulate and can undermine a system, presenting a population with what seems a crisis brought about by changes in the environment, but which is in actual fact due to human behaviour, and notably to choices made a long time in the past. It is a unidirectional cycle in which the consequences of people's own actions eventually make them lose whatever control they initially had over their environment. *'Plus l'Homme transforme ce qui l'entoure, moins il peut comprendre ce qu'il se passe'* a principle also called the 'Law of Unintended Consequences' (Hardin 1963, 1992).

If that example of the relevance to the social domain interests the reader sufficiently, I would like to try out another, which links perception to the domain of the natural sciences. In the general field of those disciplines, many conceptualisations refer back to the three basic 'commodities', matter, energy and information, which are considered mutually related in some way. From the perception point of view, I would argue that this relationship is due to the fact that human beings seem to perceive in two ways, simultaneously and sequentially. In each of these perceptive domains, they distinguish continuities and discontinuities. Perceiving only continuity does as little to us as perceiving only discontinuity. In either case, that of total uniformity and that of total chaos, there is no *patterning* to be distinguished. In simultaneous perception, the distinguishing of patterning (observation of both continuities and discontinuities) leads to the perception of *matter*, and to conceptualising spatial dimensions. In sequential perception, humans perceive patterning as stability and change. They abstract from this observation to the temporal dimension. Combined perception in the sequential and simultaneous mode leads to the stipulation of the concept *energy* (that what is needed to change or transform matter through time). And if we consider solely the relationship between discontinuities and continuities and do not take the perceptive mode into account, we are led to conceive of *information* (discontinuities in the perception of continuities and discontinuities).

Social dynamics and natural dynamics

Let us now go back to Luhmann (1985). If we accept his view that society is a self-organising (social) system of exchanges, structured by the common negotiation of meaning (through exchanges of information), but equally exchanging matter and energy, we find ourselves looking at a conceptualisation of society which is equally applicable - and has widely been applied - to the non-human living environment: the study of food chains, genetics, etc.

It also follows from Luhmann's position that because a society's environment includes everything other than itself, the complexity of the environment is always much greater. As a result, human groups are always confronted with new and different states of the environment. They can only deal with this by bringing their own complexity and that of the environment into a relation of correspondence, and notably by establishing shared cognitive constructs which reduce the complexity of the environment, thus obviating the need for point-for-point correlations between their own changes and those in the environment. While environmental complexity is thus a problem for the system it is also the motor behind the system's own dynamics, as it pushes the system to increase its own complexity.

Both these complementary mechanisms are easily observable in urban-rural dynamics such as we have presented for the Rhone Valley. On the one hand, the interaction of people with nature often simplifies the latter (the reduction of the number of spatio-temporal scales and links in a foodweb, for example, as its patchiness is altered, fields established, a number of species of plants and animals eliminated, and others introduced by cultivation or herding). On the other hand, the interaction of people with people complexifies the society (the transformation of a single house to a village to a town, for example, but also the progressive definition (and thereby distinction) of more and more different activities, functions, social roles, etc). The process is one of bringing into focus all kinds of cognitive dimensions (demarcation lines in a landscape of fuzzy and overlapping phenomena, which permit dealing with these phenomena schematically by inclusion/exclusion), and organising the social system as a function of those demarcation lines: categorisation, territorialisation, craft specialisation, urbanisation, you name it. In human-environmental co-evolution society differentiates itself self-referentially through that process from the environment.

Many socio-environmental systems are nonlinear and metastable

The potential value of a complex systems approach for a more sophisticated conceptualization of long-term structuring has been widely argued (e.g. Prigogine 1976; Nicolis & Prigogine 1977; Haken 1977; Allen 1985), and its utility is apparent in recent applications to a wide variety of socioeconomic problems such as urban evolution, fisheries management, landscape ecology, grazing systems, prehistoric settlement systems and the study of degradation (e.g. Allen & Sanglier 1981; Allen & McGlade 1987a,b; Naveh &

Lieberman 1984; Walker *et al.* 1981; McGlade 1990; Faggi 1991; Perez-Trejo 1992).

By way of contrast to conventional, equilibrium-based analyses, much of this work emphasizes the fact that ecological and human systems are often in transient states, are inherently nonlinear, and are *metastable*; *i.e.* there are two or more domains of attraction to which the system may converge. Moreover, within these stable domains, the system may fluctuate wildly, but so long as it remains within the boundaries of the domain, it is resilient; it is thus able to persist despite a high degree of disturbance, and is additionally capable of exhibiting sudden qualitative change as the system is driven over the boundary of one domain of attraction into another. Importantly, the stability domains themselves may expand, contract or disappear in response to both internal structuring processes or external perturbations. By and large, if these types of open systems are maintained far-from-equilibrium, then the intrinsic nonlinearities can act to amplify fluctuations of the variables and lead ultimately to 'symmetry breaking' instabilities, so that structure and organization can emerge spontaneously.

This capacity to transformation is, to a large extent, the results of positive feedback or self-reinforcing mechanisms which can drive the system to a new evolutionary state, or alternatively to extinction. A wide variety of studies in biology, chemistry, ecology and physics have shown that the presence of positive feedbacks can generate extremely complex dynamics, and under some circumstances the kind of structured disorder referred to as chaos (*e.g.* May & Oster 1976; Sparrow 1982; Schaffer & Kot 1985). The implications of such findings for the evolution of complex systems are profound; we thus move towards a conception of the human/environmental problematique that precludes the possibility of prediction over the long term, but might well allow us to develop a better understanding of the shorter and medium term.

Broadly, the real utility of the above framework lies in its *generic* nature; the essential features governing structure and organization may be summarised as follows:

- We are dealing with open, dissipative systems articulated by flows of matter, energy and information within and across boundaries;
- Nonlinearities in the interactions of the component elements lead to nested structures of interdependent spatial and temporal processes;
- Instabilities and structural reorganization occur, not only as a result of changes in external parameters such as climate, but also as a result of endogeneous processes *e.g.* plant colonization, soil exhaustion, hydrological mechanisms etc. Importantly, these endogeneous processes can also lead to quasi-stochastic dynamics in the absence of fluctuations, *i.e.* deterministic chaos.

This approach has the following advantages:

- It allows us to conceive a much broader human-ecological perspective, not only along conventional spatial and temporal lines, but also along cultural, conceptual and perceptual scales, integrating both qualitative and quantitative parameters;
- It can conceptually and in practice cope with both continuity and change, with process and co-incidence;
- It integrates different spatial scales and temporalities and represents the extreme sensitivity to initial conditions encountered in real life.

Taking these aspects together, this provides us with a set of tools able to comprehend the process/pattern interactions which generate the observed complexity of the social and natural landscape.

The interaction between different spatiotemporal scales

When set within an explicitly scalar context, wherein scale and spatial hierarchy are seen as structuring differential rate processes (Allen & Starr 1982; O'Neill *et al.* 1986), the above approach can contribute to rendering complex systems more analytically tractable. We are thus in a better position to initiate studies which will seek to correlate ecological, hydrological and anthropogenic processes operating at different levels of a spatial hierarchy and at different scales of temporal resolution.

The need for such a multiscalar approach can be argued in a multitude of ways, which space does not permit me to elaborate. The few remarks which follow may nevertheless make the general tenor clear.

At a fundamental level, I think we may assume that the environment is infinitely complex, *i.e.* that it may be viewed as a complex system operating at an infinite number of spatiotemporal scales at which the different processes which constitute the dynamics have their own rates. Human perception seems to categorise its observations in this respect in much the same way as it categorises colours, for example through an interactive process of 'bundling' (neighbouring frequencies of electromagnetic waves, but also events, for example) and 'labelling' them (e.g. 'seasonal', 'annual', 'decennial', 'centennial' ones), in which observations and culturally sanctioned categories are articulated. The scales which we retain are therefore (a) an oversimplification and (b) to an extent determined by past observations and tradition rather than present observations.

As a result of this process, mismanagement of scales is one of the common sources of error in observation and reasoning. If we apply this argument to degradation, we could say that human intervention in the environment so often has degradation as a result because it changes the number and nature of the spatiotemporal scales operating. The advantage of such an approach would be that it might explain the incredibly wide range of natural and social circumstances under which degradation occurs.

But let me also try and approach this issue through some examples. I would argue that the 'Tragedy of the Commons' (Hardin 1962), which has become a classic of the environmental literature, is a spatial scale problem: individual activities conflict with those of the group of which the individual(s) concerned are a part. Another example is the link between sustainability of particular plant communities and the spatial scale of the areas in which they occur. In yet another domain, Le Bras (1992) has recently shown how a multi-scalar approach of settlement patterns is more effective in modelling them than one based on a limited number of scales. Temporal scales are no less relevant, as has been shown in social anthropology by Ingold (1993) and by Schippers (1988) in his discussion of the importance of different temporal rythms in the constitution of traditional subsistence systems in the Provence. In studying them, it is an added difficulty that we can only observe processes at short time-scales first-hand. Many of the processes involved are playing on such long time-scales that they are themselves imperceptible: we can only observe some of the results. Among these are not only natural processes such as tectonic uplift but also transgenerational social ones, such as the slow establishment of the urban network or any of a number of demographic changes.

The issue of observability of processes at certain scales also suggests the need to distinguish our scales of observation and analysis on the one hand and the ontological scales of the dynamics studied on the other. Clearly, the two need to be related and that is not always as evident as it seems. So far, most of the research has used analytical scales which were in themselves defensible for the natural phenomena they were studying (from a physico-chemical or vegetational perspective): point, plot, hillslope, catchment basin and so further up to the entire Mediterranean, or even the world as a whole (for meteorological models). But scaling takes on a whole new dimension as soon as we are concerned with the social and cultural aspects of degradation. Here, analytical scales are not so self-evident, and deciding upon which scale to use is a problem which needs to be resolved in a different way for different areas and aspects of the problem.

Policy making and policy implementation are, for example, heavily confronted with the problem of scale transitions. Any decision-making is based on the gathering of information at the basis, passing it up in a decision-making hierarchy, and then passing the policy down again for implementation. In the process the information is handed from people directly concerned with an area or topic to people who are concerned with this area or topic *in a wider or narrower* context. And by context in this sense, we also imply scale. As information passes up (and down) these levels, there will be parts that stay invariant, while others are transformed. In any decision-making and policy implementation process, the behaviour of the information flow is fundamental for the success or failure of the policies.

All in all, we suggest that by using a multi-scalar perspective and investigating scale transformations and scalar spectra we may well learn much more than by (over) simplifying our observations through reduction to one or at most a few scales. In this report, we address processes which operate on a variety of time-scales, most of which go beyond the span of individual generations. Humans, for example, must not only be considered as individuals (micro-social entities), but simultaneously as groups (as macroscopic beings). It is in the interaction between scales that an intrinsic part of the dynamic of socio-natural evolution is located.

One of the advantages of the dynamical systems approach which we propose is that it allows us to model such scale interactions effectively, albeit for the moment non-spatially. The new fractalic approaches may well turn out to be as fundamental to research into the spatial dynamics, but the least they will do is allow us to see the relationship between quantity and scale of measurement, and thus the limited value of many of our quantifications.

Sustainability and resilience

Much of the current research concerned with the environment assumes that the present-day human interaction with the environment in the western world is not sustainable, and searches for ways to attain *sustainability*, *i.e.* ways to be able to continue living as we do, ideally forever. Clearly, such an approach rests on the fundamental assumption that stability (or controlled change) is natural, as well as humanly achievable. The long-term perspective which is ours, however, seems to suggest that stability is an optical illusion, created whenever long-term dynamics are viewed from a short-term perspective. When one chooses a scale of perception which is commensurate with the phenomena under investigation, we would argue that change always manifests itself. The reversal of perspective involved is quite fundamental. Instead of assuming that change is exceptional, and that investigation is therefore most profitably directed at change, we would argue that stability is the exception, and that it, not change, should be the focus of investigation.

In ecology, this change in perspective is associated with the introduction of the concept of *resilience*. As used here, resilience is not only concerned with the ability of a system to maintain its structure in the face of disturbance, but is also a property that allows the system to absorb and utilize change (Holling 1976, 1986). Here, we need to underline the fact that a system can be highly resilient and yet fluctuate widely, *i.e.* have low stability.

For human-modified landscapes such as the fragile and frequently marginal ecotopes of the Mediterranean Basin, especially those which have evolved through successive management regimes to a state of near homogeneity, there is a higher probability that the system will exhibit low fluctuations and low resilience; thus the desire to extract maximum sustainable yield may ultimately produce a more stable system, but of reduced resilience.

Understanding resilience as a dynamic force in landscape evolution is not only important for interpreting potential evolutionary pathways, but is a key to the implementation of successful land management strategies. Blaikie and Brookfield (1987) have proposed a land classification scheme which attempts to address the relationships between sensitivity and resilience so as to provide a more apposite basis for resource management initiatives:

- *Land of low sensitivity/high resilience* - only suffers degradation under conditions of very poor management. This is generally the easiest land on which to stretch the production of food and other crops.
- *Land of high sensitivity/high resilience* - suffers land degradation easily, though it responds well to good land management/rehabilitation efforts.
- *Land of low sensitivity/low resilience* - initially resists land degradation, but once the 'threshold' is passed, it is very difficult for any management effort to restore it.
- *Land of high sensitivity/low resilience* - degrades easily, does not readily respond to management/ rehabilitation efforts. This is common in many tropical and sub-tropical lands.

Clearly, such a scheme is potentially of great utility within the context of our present concerns with land degradation and desertification in the Mediterranean area, particularly since it allows us to portray human involvement as an *intrinsic* element in the process of landscape evolution, rather than as an externality, as it is conventionally depicted. Moreover, a management approach based on resilience/sensitivity criteria (as opposed to stability) places human-environmental interaction within an evolutionary framework that stresses outcomes within the context of uncertainty and vulnerability, as opposed to predictability. And while we are on the topic, resilience is in many cases achieved by a system through the dynamics of changing scale.

All this requires that one takes into account not only the sensitivity and resilience of the land, but also the *perception* of the land. The interaction between these two is what drives change in the human/ environmental co-evolution.

The role of modelling

We have chosen a perspective from which we consider that we live in a complex world where human actions commonly have unforeseen and unwanted consequences. In the scientific, as in the political, arena two strategies have emerged to cope with this complexity: theory and computer simulation. Theories are ideas about causal relations that are used to inform understanding, choices and decisions. Given that even the most brilliant theoretician has limited capacities for deductive reasoning, theories are necessarily of limited complexity. Computer simulations are also based on ideas about causal relations but these are often so complex that only highly trained specialists can put them together. Moreover, not even these specialists can claim to understand all their logical corollaries.

Most decisions have fairly uncomplicated and predictable consequences and can be made without reference to any sophisticated theory or computer model. Those decisions that precipitate irreversible changes are obviously of considerable interest; they are history in the making. Although no computer model can be expected to predict the unpredictable, it is conceivable that computer models could be used to characterise recognisable *types* of decision that have unpredictable and irreversible effects for recognisable *types* of reason.

In politics, in industry and in commerce, simulations are commonly used as *support models;* models used to infer the most likely consequences of given actions in some real-world dynamic system. Indeed the computer science and modelling literature often implies that support models are the only rational way of using computer simulations. Computerised models, one learns, are '*abstract* representations of *concrete* (*i.e.* real world) dynamic systems'. One will also read that a system is 'a collection of components, operating as a whole to reach a number of *common objectives'*.

In practice, these definitions hardly ever hold. Causal relations manifest in the 'real world' are only understood in quantitative terms. We know that poor communications and low food production may limit the growth of an urban centre, for example, and can often specify a number of equally plausible mathematical relations that exhibit similar properties. Unfortunately, we seldom have theoretical grounds for favouring one of these plausible sets as the *definitive* model to use.

But there is another kind of models. *Process* models are used to investigate ideas about a perceived, but imperfectly understood, dynamic system. By manipulating (*i.e.* analysing) the model in a manner consistent with the perceived mapping between the model itself and the theory it represents, one searches for logical implications inaccessible by traditional hypothetico-deductive methods. If the underlying structure of the model is quite simple and the range of behaviours it can exhibit is considerable, study of the way the model operates will produce results that are more widely understood than those typically generated by classical support models.

It is equally important to realise that the same set of modelling tools can be used for two, very different analytical tasks. Support modellers use computer simulations as test-beds for *policies* while process modellers build computer simulations as test-beds for *theories.* It is conceivable that one who only ever builds support models could sustain the notion of a system as a group of components with a common purpose or that of a model as an abstract representation of a concrete system. For a process modeller, however, these ideas are manifest nonsense. For him, a model is a concrete representation (in the form of equations, marks on paper, switch states in a computer) of an abstract system (a *theory).*

The distinction between the traditional use of models as abstract maps of concrete systems and the use proposed here of models as concrete maps of abstract systems is not merely a nice rhetorical point, it has profound methodological and ethical implications. On the methodological front it suggests that the principal function of a model is to evaluate theories and, ultimately, to suggest new theories for future evaluation.

On the ethical front, this distinction forces us to acknowledge that the output of any computer simulation is only as reliable as the theory it represents. That does not imply the use of support models to be inherently unethical. We live in a world where current policies must change *for the better* if humans are to avoid global disaster. Support modelling may be the only way complex political ecological or sociological theories can be harnessed and put to work. However, if we are to manage our affairs responsibly, we not only need the best support models available, we need to accept that the 'real world' (whatever that is) may not endorse them.

Description of the subprojects

Next, I will briefly introduce the six case studies which are the focus of the ARCHAEOMEDES Project. In the remainder of this volume, considerable scientific detail is presented about each of them, and about the different approaches which we have taken in each case to enlighten ourselves on the dynamics behind the observed degradation. This section serves, rather, to bring the research in the different areas together and to see what we can learn from such a confrontation. However, I would like to begin this section with a brief warning and a summary of our reasons for selecting each of the areas concerned.

First the warning. We feel there is a clear conflict between the complexity of the phenomena studied in this project and the short time allotted for the research. That conflict is compounded by the diversity of 'southern Europe'. Many of the natural processes involved may now be known in one place or another through the efforts of other researchers, but this cannot be said of the perceptual and cultural aspects of the socio-environmental co-evolution. For these reasons, we have chosen for bringing together a few compatible ongoing research projects in which the majority of data have been collected, and on which coherent teams are working from a conceptual position which is as close as possible to the one we propose here. This inevitably means that a degree of fuzziness is introduced in the research project as a whole, because these teams do have different approaches, even if they are by and large compatible.

As the data from the various areas are to contribute to the elaboration of a general approach to desertification and degradation in southern Europe, the complexity of these phenomena has been uppermost in our minds in the selection and presentation of the case studies which follow. Arguing that one of the most general ways to dissect complex phenomena would be by distinguishing the different temporal rythms which together compose the overall dynamic of such phenomena, we have chosen to compose an ensemble of case studies which reflects the widest possible range of temporal scales. Thus, we were able to include scales ranging from tens of millennia (c. 20.000 - 4.000 BP in Palaeolithic Epirus) to millennia (c. 5.000 BP to the present in case of the Vera basin and the diachronic study in the ancient Rhone valley), to centuries (100 BC-500 AD in the case of the synchronic study of the ancient Rhone valley, and 1800 AD to the present for the modern Rhone valley), to decades (1950 - 1990 in the Argolid and in present-day Epirus).

From a perspective of spatial scales, the various case studies also cover a wide range. The largest area we are considering is the Southern Rhone Valley, closely followed by Epirus. The Argolid is much smaller, and so is the Vera Basin. But maybe more interesting is what we have learned by contrasting different scales of observation in each of these zones. In Epirus, we have operated for both the Palaeolithic and the recent period at the scale of the whole region, that of Ioannina Prefecture, and that of different smaller zones within these, all the way down to the single village level. In the Rhone Valley, we have looked both at the major phases of degradation in the last 7000 years and at the social phenomena occurring since 1800 for the whole area. Detailed studies have been undertaken in a sample of regions within it. The Vera Basin and the Argolid have effectively been studied at one scale only: that of the whole catchment basin, with a focus on the valley.

Environmentally, the areas differ considerably as well. This is best understood if we briefly describe the areas on an axis from south to north. The Vera Basin, in Southeastern Spain, is badly degraded to the point that badlands dominate and very little vegetation is left. Here, drought is a severe problem, as are flash floods; the area has much of a desert (and is indeed, qualified as such from a climatological point of view). Here, the focus is on a long and detailed series of data on the environment and on human behaviour which has allowed us to describe in detail the interaction between geology, climate, vegetation, hydrology, erosion and human activities, to analyse acceleration and deceleration of degradation and to unravel the way in which periodicities of different (human and environmental) kinds combine. In the Argolid, in the Southern Peloponnese, water (mis) management is responsible for the spectre of rapid and total degradation by salinisation in the very near future, but for the moment this has only attained small valleys and the remainder is green. The shortage of water is a function of the kinds of (irrigated) crops planted, rather than linked to climate. In Epirus, situated in the mountains of NW Greece, in a zone with sufficient rainfall, there are, as we have seen, two kinds of degradation. One is very long term and omnipresent at the local level and linked to tectonic activity, and one which is no less present, but operates on a larger spatial and a shorter temporal scale, and is linked to the vegetation. We will be studying both, on a very long as well as a very short timescale. In the Rhone valley, present-day degradation is closely linked to urbanisation and its accoutrements, but we have found several major phases of earlier degradation, from about 7000 years ago onward, which cannot be explained in the same terms because at the time the nature of human impact was very different.

All in all, therefore, we hope to approach the general phenomenon of degradation also by a comparison of different regions in which the degrading processes operate at different scales. But the main players in this study are:

The Vera Basin

That basin is the meeting point of three faults, and must have been tectonically active over most of the last

100.000 years. Micromorphological research seems to indicate that deposition of aeolian sediment continued until about 10.000 years ago.There seems to have followed a phase of approximate stability or very slow erosion until about 4000-3000 BC. Micromorphological and geological evidence shows that from then on, degradation accelerated considerably, initiating the formation of badlands and the sedimentation of the valley bottom.

The first, scant, human remains date from the same period. They do not show any preferential localisation. From around 3000 BC, the population increased rather rapidly, with a preference for unevenly spead settlements on fluvisols. Subsistence was based on clearing the gallery woodland, followed by mixed farming and animal husbandry. In the hilly hinterland, occupation was discontinuous.

Between 2300 and 1600 BC, diversified cultivation continued on the valley floor with ample water, while higher up the slopes flocks of sheep and goats were important. The settlements and the tombs indicate that the area was rather wealthy, and that there was a degree of social differentiation. Towards 1800 BC there was a shift towards barley-based monocrop agriculture, followed by deforestation and desiccation of the valleys and abandonment of many settlements, beginning in the highlands. From 1400 BC, we observe an increased use of shrubs and weeds for fuel, indicating a shortage of forest. By 1200 BC., only small, dispersed settlements remained in the lowlands. The population relied again on a diversity of cultivation strategies and crops. It is at this time (much later than elsewhere) that olive and vine were introduced.

Around 700-400 BC, there was (rapid) population increase and settlement growth near the coast. Social complexity increased, as evidenced in burial and settlement differentiation. Mining and export of raw materials heightened dependency on exchange and changed the economic base. This very quickly caused fuel shortages. In the charcoal remains of this period, riverine wood species are absent and palms present. Erosion seems to have increased and led, after 400 BC, to a short period of depopulation followed by the introduction of many large, isolated, continuously and intensively occupied Roman farms in the lowlands, exploiting the area for export. The intensity of human occupation exceeded once again that of earlier periods. Irrigation was probably widespread. Towards AD 400, this socioeconomic fabric collapsed and agriculture shifted back into local diversified dry subsistence production.

By AD 750, the Arabic conquest had introduced widespread use of irrigated terraces. There was little sign of social differentiation; landholdings were all roughly the same (small) size. The vegetation indicated a drier local climate, but better surface water management. Multi-crop cultivation was predominant, with horticulture alongside cereals and large tree plantations, notably mulberry. The area as a whole was heavily, but sustainably, exploited.

Around AD 1550, there followed a rapid decline in population through expulsion of the Moors. The landholding system changed, allowing accumulation in the hands of the few. Depopulation of the mountain areas was followed by collapse of irrigation systems and terraces, erosion and the formation of badlands. Replacement of mulberries by olives along the banks of the rivers indicates (and causes) deterioration of the local hydric regime. Everything points to the movement of vast quantities of soil, extending the coast and depositing, according to one estimate, as much soil in the last 500 years as in the whole of the preceding Holocene.

A mining boom in the eighteenth and nineteenth century caused re-occupation of much of the area by many dispersed agricultural settlements, with terracing and irrigation in the highlands. The investment needed for such terracing was only viable because of the mining. As the boom ended, emigration towards towns initiated erosion yet again. At present badlands dominate, although the sparse vegetation is spreading.

The long and detailed series of data on environment and human behaviour illustrates some of the complex conditions under which acceleration and deceleration of degradation occurred. Each period of intense human activity eventually led to a commensurate 'environmental crisis'. The subsequent re-occupation of the area required a change in exploitation techniques (in Phoenician times by linking the area into a world system through mining and trade, in Roman and Arabic times by combining trade and industry with different forms of irrigation, and in modern times by use of fossil energy). These techniques are ever more demanding of investment of time and money, and therefore they create ever more dependent and vulnerable socioeconomic systems and they have an ever larger environmental impact.

On each occasion, the perception of space and of the utilization of the landscape is different, and so are the forms which human activity takes and the kinds of degradation it leaves behind. But there are two generalisations which can be made. Firstly, in each successive cycle, human control over the environment is increased. This theme recurs in Epirus. And secondly, a comparison of social and natural developments in the Argar/Late Bronze Age and Arabic/Christian transitions indicates that social structure is relevant to questions of degradation. This conclusion is reinforced by the studies which we have undertaken in the Argolid.

The role of perception in degrading the water table in the Argolid

We have argued that the dynamics of environmental change and its results are at least in part due to people's perceptions of the environment. In this context it is necessary to devote particular attention to risk perception. In the last thirty years, traditional Mediterranean polyculture in the Argolid has been replaced, in the alluvial valley, by a succession of virtual monocultures of, respectively, apricot, lemon, and orange, which were, each in its turn, largely exterminated by an epidemic and/or a change in subvention policies. Overgrazing by sheep/goat has degraded the hillslopes. The increase in irrigated citrus cultivation has in recent years led to a very rapid lowering of the underground water table. The consequent reduction of underground freshwater pressure has allowed seawater to penetrate the aquifers, while evapotranspiration has caused increasing salinisation of the soil. At the same time, the disappearance of surface water in marshy areas may have been responsible for a lowering of the local air temperature, sufficient to allow nightfrost to attack the oranges once or twice a year, causing major damage.

Our research focusses on understanding the workings of the hydrology and related aspects of the environment in detail, as well as on eliciting the perceptions which individuals in different parts of society have of the problems, the possible causes and the potential remedies. This has enabled us to define at least three different groups of farmers which I will for simplicity's sake call 'traditional', 'modern part-time' and 'modern full-time'. Although they do differ socially, the perceptual differences which influence their decisions are the focus of our efforts.

Traditional farming uses rather less migrant labour, and is not technology-dependent because the whole family farms. The children have a low level of education, and in their circles farming is socially acceptable. There is a degree of self-sufficiency, in part manifest in the fact that a diversity of crops is cultivated. These are season-dependent, and are mainly produced for local consumption or sold in the internal market. There is considerable ready capital, and where investment is made, it is in agriculture. As a result, there is a high level of hidden investment.

Modern part time farming is heavily dependent on outside (*e.g.* migrant) labour and technology. Although the farm is owned, it is not really farmed. The children have a high level of education and do not farm. In the circles in which the owners move, farming is not socially acceptable. There is therefore no self-sufficiency. Rather, agricultural production is a means to obtain cash, and the crops are adapted to that aim: monocropping predominates, and is done for the external market. There is less ready capital for farming, and investment is usually outside the sector, so that there is very little hidden investment in the system.

Of these two systems, the latter is the more consumer-oriented, because the central role played by cash ties it much stronger to the international market. Hence the heavier dependency on technology and 'artificial' means to maintain stable production. The stability of production, to which the whole approach is geared, makes such a system very inflexible. At the same time, the fact that its economy and technology are strongly linked to external dynamics makes such a system 'heavily geared' in the business sense: it has little control over its own destiny, and macro-economic changes have major impacts.

Modern part-time farming has taken over as the perception of agriculture which sets the agenda and determines most decisions in many parts of the valley. It has changed the economic context of farming, and has contributed to the creation of a third group of farmers, whom we shall call the full-time modern farmers. These originate from both the other groups, and reflect the need of traditional farmers to adapt to changing circumstances. The net effect has been to make most cultivation in the valley highly dependent on EEC subsidies and aspects of the world economy. Changes in subsidy rules have over the past few years shifted exports predominantly to Eastern Europe, which can hardly be called a stable market on which to base investment decisions.

Epirus and the case for disturbance-dependency

Much of Epirus' spatial diversity is due to the (relatively high) tectonic activity which has created a series of steep mountain ridges running more or less north-south through it. Modelling this activity has indicated those areas where the relief is continuously rising, where it is sinking, and where it remains more or less stable (King, Bailey & Whitney, 1993). Wherever tectonics has pushed ridges up, the flysch (a very soft, easily erodible sedimentary deposit) which originally covered it has eroded away from the limestone, but in those areas where upward vertical movement has been limited or absent, the flysch remains and forms the present soil.

The palaeolithic inhabitants used the barriers and passes of the relief, as well as the characteristics of the vegetation, without modifying any of them to any noteworthy extent. But it seems that people were drawn to those areas where the tectonics created regular disturbances in the usual development of the vegetation, setting the 'floral clock' back to zero (Bailey *et al.*, 1993). From the Neolithic onwards, human impact on the majority of the area was related to grazing, which also re-sets the environmental clock regularly as sheep remove young seedlings of many kinds of vegetation. In present-day Epirus, grazing is combined with periodic intentional wildfires which -again- re-set the clock.

As a result of these observations we introduced the concept 'disturbance-dependent regimes' (McGlade 1995) for socio-environmental regimes in which disturbances keep the environment oscillating within a certain 'target range' and which, therefore, mingle sustainability (unchanged survival) with resilience (survival by incorporation and change). We can thus distinguish different strategies of maintaining such regimes:

- *selective* strategies, in which people exploit areas of disturbance which they did not cause (tectonics, flooding and wildfire);
- *inducing* ones (grazing and deliberate burning);
- *controlling strategies* which make periodic disturbance superfluous by *imposing one particular regime*.

For each, we may identify variations in the frequency and duration of use of the areas concerned and their relationship to risk and predictability, as well as biodiversity (which plays an important rôle in determining both sustainability and resilience).

In some cases the disturbance is wholly or partly outside human control. It may be predictable spatially but not temporally, or *vice versa*. In the first case, use of the areas concerned is thus contained in a range between frequent sparse use and rare but intensive use (e.g. tectonics). Seasonal flooding, on the other hand, is very predictable both spatially and temporally, as well as very frequent; there is less of a risk, and permanent settlement and use of such areas are thus more likely.

Sometimes, the disturbance is to some extent controlled by humans. The risk of wildfire is only partly dependent on the state of the vegetation, and only to a certain extent predictable in time and space. Humanly-induced fires are better controlled in time, but there is still some unpredictability in space. Grazing offers yet closer control in time and space, while a rotating crop system may come closest to disturbance-dependent control. But both require continued investment from the population.

In those ecotopes of the Mediterranean Basin which have evolved through successive such management regimes to a state of near homogeneity (low biodiversity), there is a higher probability that the system will exhibit low fluctuations and low resilience; the desire to extract maximum sustainable yield may ultimately produce a more stable system, but of reduced resilience.

Urbanisation and the environment: the southern Rhône valley

In the southern Rhône valley our focus has been on the rôle of urbanisation and urban perception of the natural environment. We have focused on the last two-and-a-half thousand years, which include two major phases of urban expansion, during the Greco-Roman period (500 BC-400 AD) and in the last three hundred years.

A first question we approached is 'where do settlements locate themselves?' In developing a methodology which could also be useful for more recent periods, we viewed roman choice of location as an indication of environmental perception, and tried to analyse in eight subregions which elements of the surrounding landscape counted in making the 'decision' to locate a settlement somewhere. The landscape elements considered are, among others, slope, aspect, presence and quality of water, quality and ease of handling of the soil, and access. By following the history of each of those (altogether c. 900) settlements, we have distinguished which environmental and geographical contexts potentially allowed continuous long term settlement, and which did not.

In the area around Orange, we worked at a finer scale. There, the so-called 'Cadastre B' provides Roman price assessments of plots which may be localised in the present-day landscape. We combined this information with roman agronomers' soil classifications and with archaeological data to monitor the lifespan of the settlements in the area, in a detailed study of the relationship between perception, settlement location and settlement history. It points to the importance of time of foundation, settlement size, and size and shape of territory, among others, in selecting for or against continued occupation among environmentally similar settlements. But probably the main lesson to learn from this study is that social dynamics played a predominant rôle in ending roman settlement in the area: there is a direct relationship between the end of maintenance of drainage channels in the valley, and badlands formation on the slopes.

To understand the dynamics of urbanisation better, we have on the one hand assembled a detailed statistical analysis of demographic and social trends since c. 1800 and, with somewhat less precision, since around 1600. These have been viewed against a backdrop of the environmental, technical and economic history of the area in an attempt to elicit how these partly external aspects relate to the inherent dynamics itself.

On the other hand, we have used a parallel-processing simulation technique to study the urban dynamics in different local environments. Here, individual towns were allowed to emerge by applying a universal set of rules, describing what is known of urban dynamics, in different circumstances which reflect the set of local situations. The first results illuminate, for example, the question of 'false starts' in urbanisation, and allow us to clarify under which circumstances a settlement can grow into a viable town or not. They also permit us to test the stability of the whole urban system under a range of circumstances.

Finally, to investigate the role of urban dynamics in structuring the environment, we initiated comparative historical research in two subregions with a very different socioeconomic structure, *i.e.* the Camargue with a system of large landholdings which incorporate very different economic activities, and the Comtat with a system of rather small landholdings each devoted to one kind of agricultural activity. The aim of this research, which is still ongoing, is to understand the role of resilience and sustainability better under circumstances where the external market encroaches on rural life, and notably with respect to the size and diversity of landholdings.

Conclusions

To end this chapter, I will briefly review some of the main points of the project, under three headings, methodological advances, substantive insights and areas for future research.

Methodological issues

Based on the assumption that complex phenomena are complex because they combine a multitude of qualitatively different dynamics which interact because the spatio-temporal scales of their dynamics overlap and interweave, the research has focussed on *long-term temporalities* (*e.g.* AFR 2, 299 ff.) and their interaction. We have thus been able to better discern the temporal scales at which a multitude of natural, social and socio-natural dynamics are involved, to identify some of the ways in which social and natural phenomena collude to either trigger or postpone degradation, and to trace some of the time-lags between natural and social phenomena. In particular, tectonics, settlement pattern in general and urbanism in particular, and human perception of the environment have been identified as major 'players' alongside the better-known natural ones. We have also become increasingly aware of the importance of local historical trajectories in shaping present-day events.

Secondly, we argued that both natural and social dynamics, as well as the dynamics of interaction between people and other living species are *co-evolutionary* and *self-organising* (*e.g.* van der Leeuw & McGlade 1995), so that new phenomena may emerge from them without the impact of external factors. We have therefore made a beginning with the systematic integration of socioeconomic aspects into the study of degradation. To do so, we chose a *Complex Systems approach* (Aida *et al.* 1985; Allen 1992), arguing that a hierarchy of nested spatio-temporal structures emerges in a system as part of an historical process, the result of successive structural instabilities which are inherently difficult to predict, and which change the system qualitatively through time. In this view, though climate, soils, land-use, economic and social structures, exchanges, etc. all have different levels of description, they are in fact linked to each other, and have *structured themselves and each other* through an evolutionary process: the different spatio-temporal scales of organisation are mutually interdependent, as are their characteristic features. This suggests that dealing with land degradation by studying the mechanisms of soil erosion and searching for ways of reducing it, or dealing with floods by building dams to regulate the flow, is insufficient. Whilst such specific answers may sometimes be quite successful, generally they correspond to an attempt to correct the symptoms of a problem and not its underlying causes. Such 'natural calamities' have to be seen as the result of *the manner in which a system is functioning,* and it is overly simple to point to any one cause, or even to a specific combination of factors without analysing their role in the system dynamic as a whole, across a range of spatio-temporal scales. Rather than the construction of chains of 'causal linkages', understanding of the phenomena requires analysis of the evolving interdependencies of such complex systems, of their history, and of the spatiotemporal scales at which the various kinds of dynamics play a part. This has vital implications for us. Policy or action at one spatio-temporal scale may affect any number of the other scales. The environment at one level is part of the system at another, and what may be presented as 'unexpected consequences' are in reality often the result of not understanding this point.

Thirdly, we have initiated a 'vertical' integration in our research - considering simultaneously aspects of the *whole trajectory from scientific research to policy formulation and implementation* (Lemon, Seaton & Park 1994; AFR 5(1)) and their effects. One of the results has been a growing awareness that knowing the perceptual categories and decision-making pathways among the main groups of participants is essential to any understanding of the dynamics and/or problems involved. Such knowledge contributes to our understanding of the dynamics of degradation by directly drawing upon actors in the communities concerned rather than building an information base from scratch (which is often very costly). But over and beyond that, it is only by eliciting perceptions and attitudes among those directly concerned by the problems that we are able to suggest the most appropriate policy implementation methods. Subsequently, the 'Environmental Perception and Policy Making' Project (EV5V-CT94-0486) which is being undertaken by a closely related group of contracting institutions has began to focus in some depth on the relation between perception and policy implementation, clarifying a number of aspects of the information transfer between various levels of local and regional administrative hierarchies, and elaborating models concerning the interaction between different perceptions of the same dynamics which drives such information transfer.

Finally, we explored the concept of sustainability in determining strategies for the future. It seems to us that sustainability reflects a point of view where change is the exception, and has to be explained. Rather, we would argue that *change is normal, and the suppression of change is the exception which must be investigated.* To us, the future will always entail change, and the choices to be made are not between sustainability and crisis, but between different long-term strategies which are resilient because they incorporate change (*cf.* Gallopin 198; Holling 1973; Lavigne 1988; AFR 4, 11-26, and in different terms Albaladéjo 1992).

Substantive insights

From among the many substantive insights which this project has provided, I have selected a small number which seem, to me, particularly relevant. In making the selection, I have deliberately remained at a level relevant to the project as a whole, in order not to pre-empt on the chapters dealing with particular areas or periods. My list is the following:

- Social dynamics which are not immediately visible may drive the response of a system to policy measures. Such measures are then 'redirected' by the end users, and do not achieve what they set out to do. It follows that prior knowledge of such social dynamics will considerably increase the effectiveness of policy measures.

- It is thus impossible to predict degradation based on knowledge of the natural system alone; such prediction requires that we transform the traditional degradability map into a map which takes social dynamics into account.

- The settlement pattern is an important indicator of a society's interaction with the environment, as the location reflects an initial choice concerning the landscape, while the current dynamics reflect among other things the adequacy of the relationship between the settlement and its environment.

- The last two millennia, and notably the last two centuries have seen a changeover from a matter/energy centred settlement dynamic, in which location was mainly *constrained by* the environment, to an information-driven settlement dynamic which *impacts on* the environment. The extent of this transformation differs from region to region, and needs to be taken into account in considering the relationship between a population and its environment.

- The importance of urbanisation in causing degradation far exceeds spatial non-linearities of population distribution and resource needs - it affects the perceptual core of decision making, limits its temporal perspective to the shorter end of the spectrum and generates a sense of 'helplessness', and a loss of resilience on the part of the rural population.

- The investigation of land-use competition and land-use conflict proves to be a very effective route to the mapping and understanding of the various organisational and spatiotemporal scales which structure a society, as well as to an understanding of the perceptions and positions of the participants in such competition.

- A major deficiency of many present-day solutions to environmental problems is that they are technology-driven and effectively take away constraints to an expanding system, so that the system simply grows further until it comes up against the next constraining factor. This kind of 'solution' only aggravates the problems.

Lessons for the future

The multitemporal approach we chose has accrued our understanding of the nature of degradation (and notably the role of human activity in generating it), and permitted us to design potentially generic models which glance (a very limited distance) into the future, such as we have done for the Argolid. To see, for example, that what may be renewable in a natural system may not be sustainable in a socio-natural co-evolution. But it seems to us that the approach would provide much better insights if we were to further develop it to transcend the following limitations:

- The *interactions* between *the dynamics operating at the various relevant levels* in a society are insufficiently known. Yet such interactions are a fundamental aspect of all self-organising processes as a system's resilience resides in them; they determine a system's coherence, and they generate the structure which we observe. Our lack of understanding explains, for example, the difficulties encountered in 'upscaling' from experimental research to the scales at which the phenomena occur in everyday life.

- Most of our research has been limited to the *nature* and temporalities of the phenomena concerned, and we have *not been able to say where particular future phenomena might occur* in any detail. The evidence seems to point to the fact that the interaction between natural and social dynamics implicates a set of insufficiently known non-linearities. Moreover, on the basis of our case studies in the Argolid and in the Rhône valley, we contend that the spatial organisation of the landscape itself often triggers non-linearities which were not at first evident, and that rural dynamics must be viewed within the context of the spatial patterning of the natural resources, the population, and its interactions, for example. Blaikie and Brookfield (1987), among others, confirm this conclusion.

- Thus far, although we have gathered data concerning the impact of EU, national and regional policies and agencies, and concerning the wider trends which constitute the context, *most of our work has been on the sub-regional scale*, investigating the interaction between localities or communities in a (mostly naturally defined) small part of a region (Argolid, Vera, NW Epirus). Only in the Rhône valley have we exceeded that scope (but not taken the local level into account), and nowhere have we gone down to the individual level of decision-making. *Research by others, though, shows that dynamics operating at all these levels are of paramount importance in the eventual outcome.*

Footnotes

1 In this context, it may be worth remarking that introducing the long-term perspective required a fundamental change in approach of the archaeologists and historians involved in the project, who had to develop a different position with respect to the relationship between past and present. In these disciplines it has been customary to study the past for its own sake, even though such study was justified by referring to the use which could be made of it to improve the present. Here, we wish to break out of this attitude and create a much more direct and substantive link between the study of past and present.

2 According to some, the present report does not move far enough in this direction - but at least we have given it a serious try. It seems to me that further work with more or less the same team is required before this try can be judged - after two years, we have only just begun to understand some of the major disciplinary and cultural differences between ourselves.

2

Chapter 2

Multidisciplinarity, policy-relevant research and the non-linear paradigm

S.E. van der Leeuw

Introduction

In approaching the problem of degradation in the project, we have used the concepts and results of a number of disciplines, and have thus been confronted with the difficulties of multidisciplinary research. These are in our opinion to a considerable extent inherent in having the wrong expectations of such research. What is expected is 'knowledge' and the possibility to integrate results from these disciplines as if they were equivalent. But such integration is virtually always achieved at the level of the lowest common denominator, and therefore tends to be much more simplistic (and often functionalist) than necessary. In striving for 'clarity', such an approach loses sight of the fact that most complex phenomena are multi-faceted and so rich in information that any one coherent picture of them is at best a very partial representation.

Research on the climatological aspects of global warming, for example, is capable of presenting a very coherent picture of those phenomena *because* it confines itself to using tools and concepts which have been developed over a considerable period by a limited community of scholars - these tools and concepts, and the models they create of real-world phenomena, have as it were been 'negotiated to (relative) homogeneity' between the scholars involved. The same is true of the analytical methods, concepts and models of soil science. It is that process of negotiation which gives such paradigms their explanatory power, facilitates their use as tools for communication, and selects the kinds of phenomena to which they can be applied. But it achieves this by simultaneously defining the limits of the paradigm's applicability - by defining the kinds of phenomena, problems and issues to which the toolkit can be applied - *and thus by defining the areas where it cannot successfully be applied.* Little wonder, then, that any disciplinary approach to degradation cannot by itself explain that phenomenon.

All we can in our opinion hope for is what could be called a 'bee's eye view', a multi-faceted picture which can provide some insights if one is prepared to accept the fracture lines between the facets and to make a number of 'leaps of faith' across them. Although that goes against our (culturally determined) tendency to insist on clarity and simplicity of explanation, such a 'bee's eye view' is not necessarily a disadvantage in dealing with complex information - most insects which have such facetted eyes manage very well with them, thank you! To distinguish the results of such an approach from the traditional scientific one, one might perhaps suggest that what we strive for is sufficient *understanding* (as opposed to knowledge) to be able to deal with complex phenomena. The distinction is introduced to highlight the fact that whilst we do not aim for the same degree of coherence in our explanations because we believe it can only be achieved for very simple phenomena (if those exist!), we hope to compensate for that by gains in the applicability of our understanding to the 'real world'.

In the following pages, we will examine some of the background of the differences between the various disciplines involved in degradation studies. First, we will present a brief overview of the history of the central dichotomy between 'nature' and 'culture' in our western intellectual tradition. Then we will argue that a 'tangled hierarchy' of perception is responsible for the present state of affairs. Finally, we will look at some of the consequences of this state of affairs for the various disciplines involved in degradation research.

History, Nature, Culture, Environment, Society, Science and ... degradation

Whether one measures it in terms of the area brought under control, the degree of that control or the extent of degradation, our modern western techno-society has had much more of an impact on the natural resources at our disposal (including forests, meadows, waters and fields) than others before it (or elsewhere). This cannot simply be attributed to population increase, industrialisation or any such phenomenon alone. It seems linked to our society's attitude to nature and the environment. How did that attitude come about?

We propose to present some ideas about this by retracing some steps in the history of the concepts "nature" and "culture" and the relationship between them. Such concepts, and many related ones, do more often than not bear some relation to the ways in which one categorises phenomena, links them in one's mind and thus creates a model of them in the mind's eye. This is not the place to present an exhaustive historical survey of the development of the conceptual apparatus we bring to bear on the issues of nature, the environment and degradation. There are others, better qualified, who have done so. But their conclusions do have relevance for our work. What follows is therefore a brief outline based on the literature which, we hope, will show some of the many ambiguities involved in the complex relationships between nature and culture, between society and its environment, between scientific knowledge and the sociology of scientific communities. These relationships and their ambiguities explain many of the difficulties we encounter with the concept of 'degradation'.

Natura is the latin equivalent of the classical greek word *physis* which we encounter in 'physics', 'physiology' 'physician' and many other words in the european languages. Lewis (1967) argues that already in classical greek the word conveys an ambiguity, as it can mean both 'that which is real' (as opposed to fictional) and thus 'the way things should be' (in accordance with nature), and 'non-human', relating to the world of non-human beings. The ambiguity clearly expresses the difficulties in locating human beings on the greek mental map of earthly phenomena. Human beings must under certain conditions be considered part of nature, while in other circumstances it is preferable to exclude them from nature. The duality is also an essential step in the 'objectification' of nature as it allows one to think of 'nature' as subject to its own dynamics, its own laws, its own behaviour, distinct from those which govern the dealings of people. Such objectification is a *conditio sine qua non* for any attempt to reduce perceived 'natural risks', indeed for the description of any presumed interaction between people and that what surrounds them.

Evernden (1992), who is the author of two very interesting multi-disciplinary studies concerning the concepts of 'nature' and 'environment', argues that this duality runs through the whole further history of western civilisation, to the present day, enabling control over nature and requiring a strict maintenance of the categorical boundaries by 'education'. He describes some of the main episodes in the process of separating the human and the natural, a development which in our day and age translates in the distinction between 'nature' and 'culture'. Let us follow some of its main stages.

Our starting point lies somewhere in the Middle Ages, in which a single, 'vitalistic' world view pertained to all aspects of the world around us, whether mineral, vegetal, animal or human. All these realms were seen as inhabited by living beings of different kinds, and they had close links between them and with the realm of the divine and supernatural. In effect, all that is happening in these realms is seen as an expression of a divine configuration, and in this respect there is no difference between human beings and any other aspect of nature.

The Renaissance, following on the heels of the three major plague epidemics of the 14th century (which in some locations reduced population numbers by 50% or more), is the next major step. Historians and art historians have long linked the Black Death and the Renaissance in their interpretations (*e.g.* Gombrich 1961, 1971; Hay 1966), focussing for example on the contrast between the *'danse macabre'* and the subsequent explosion in the arts, but also on the introduction of the concept of the individual (as manifest in the first portrait paintings, for example, and the emergence of the signature as a means of identification, *cf.* Cassirer 1972) and that of measured time (the first clocks). Evernden cites the ground-breaking work of Jonas (1982) in according fundamental importance to this period in which a shift occurs from a perspective in which life is the norm and death the exception to one in which death is the rule, life the anomaly.

What does this conceptual transformation imply for our ancestors' attitude to nature? For one, it potentially opened the door for a notion of an inanimate universe, nature as lifeless 'behaving matter', a notion which has grown ever since in a movement which is closely related to the emergence of mechanistic physics (the so-called Newtonian paradigm). It is Evernden's contention that this growth was made possible by what he calls 'the great wall of dualism' (1992, 90), which protected our conception of humanity from the same kind of lifelessness. Indeed, by maintaining that (non-human) 'nature' was subject to fundamentally different 'laws' than were human beings, it became possible to concern oneself with the study of the former without attacking the human sense of identity, and thus to reposition human beings with respect to their non-human surroundings. Thus, in the centuries following the Renaissance, Copernicus, introduced the idea that humans are not living on the central body of the universe, but on one among a series of more or less identical planets turning around the sun. Human life thus became an epiphenomenon, a mere anomaly on one planet out of (eventually, centuries later) millions assumed to exist in the universe.

Of more direct importance for us in the present study is the push for objectivity in the study of nature, linked to the idea that because human beings are outside the natural realm, their observations and actions on nature would essentially distort its dynamics and our perception of them. As expressed by Shapin and Shaffer: 'the solidity and permanence of matters of fact reside in the absence of human agency in their coming to be' (1985, 17-18).

Evidently, this has consequences for epistemology and the conception of knowledge, which shifts from one in which knowing is achieved through identification with the object of study to one in which knowledge is in the mind, independent of the object.[1] Evernden illustrates the first stage of the change with examples from Italian and Dutch painting (1992, 78-9). The stereotyping of Italian landscape painting seems to indicate that, here, *nature is assumed to be a system* whereas in Dutch landscape painting the attention for detail and 'realism' seems to indicate that *nature is made up of details* which project oneself on the retina. May we go so far as to extend the contrast which Alpers suggests (1983, xxv), i.e. that Dutch society was oriented towards the visual and Italian society towards the verbal, and point to the discovery of the microscope by van Leeuwenhoek in the Netherlands around this period? However that may be, it is clear that from this period there emerges a contrast between developments in northwestern and in southern Europe. Its most eminent manifestation is the growth of Empiricism (followed by the industrial revolution) in Britain and Holland, in opposition to the Cartesian 'rationalist' position in France and Italy.

A last aspect which is of importance to our further discussions is the growing separation between the natural sciences and the humanities which is an inevitable corollary of the separation between humanity and nature. Humanity is a sphere in which values, thought, spirituality and novelty dominate the scene - contrasting with the mechanics which are thought to dominate in the natural sphere. This fundamental conceptual distinction between the two spheres probably has had as much to do with the differences in method, technique and theory which presently hamper multidisciplinary research as do differences in the phenomena observed. It would exceed the aim of this chapter to go into detail, but one example may serve to bring home the scope of this assertion: that of the rôle of temporality and the reversibility of time in the two disciplines.

Newtonian physics (the dominant paradigm until the beginning of this century) built from empirical observation a world view in which phenomena could be isolated from one another, and in which processes occurring at the most fundamental scales were considered reversible (*e.g.* state changes such as between vapour, water and ice), cyclical (*e.g.* celestial mechanics), or repeatable (most chemical reactions, if they were not reversible). It is a world view which is essentially aimed at 'dead' phenomena - those whose nature does not fundamentally and irreversibly change during their existence (Allen 1976). In this perspective, time was reversible at the level at which most phenomena were studied.

In the humanities, on the other hand, invoking history seems to have been the dominant form of explanatory reasoning, at least since the Renaissance. In historical interpretation irreversible time was a dominant strand. As a formal discipline (i.e. as a domain isolated from everyday life), History emerged when invoking irreversible time as explanation was challenged by the emergence of the natural sciences in the 18th-19th century. Nowhere is this development clearer than when one monitors the emergence of 'innovation' as a concept during the same period: while in the 17th century innovation is akin to sin, nowadays it is hailed as our saviour, the only way society will survive (Girard 1990). Change and irreversibility have become dominant once again.

We must now go back a little to pick up the thread of Evernden's argument again, at the point where the driving forces of this history move North, taken over by the Empiricism of Britain and Holland from the Rationalism which remains dominant in France and Italy for several centuries after the Renaissance. The opposition between between Rationalism and Empiricism resides in the different ways in which the relationship between experience and reason are dealt with. Cassirer's rationalist example is Leonardo da Vinci for whom 'a dualism between the abstract and the concrete, between 'reason' and 'experience' can no longer exist' (Cassirer 1972, 154). It is resolved by making experience conform to reason. In Britain and Holland, on the other hand, there seems to be an aversion to attempts to generalise, to build a reasoned world view. Such a system is hidden to the senses, reasoned and therefore human. It interferes with the direct observation of nature. Hence, Bacon's view predominates that to resolve nature into abstractions is less relevant than to dissect it into parts. In arguing that reason *has to conform to experience*, and that experience deals with *the manifest details of nature*, the Empiricists set about building another world view by deliberately crumbling the existing one into oblivion.[2] It is essential to underline that this disaggregation prepared the way for a slow shift, over the next couple of centuries, in which 'century by century, item after item is transferred from the object's side of the account to the subject's. And now [...] the subject himself is discounted as merely subjective; we only think that we think.' (Lewis 1967, 214-15).

But what is it that is thus transferred? Nature. Via the 'detour' of dualism, we return to a monistic world view, but a different one which has exchanged the vitalist philosophy of classical Greece and the european Middle Ages for a materialistic monism in which atoms, molecules and hormones prevail. The growing importance of the natural sphere (and the theories which attempt to explain its phenomena) has created a fundamental paradox in our world view :

> 'We have in effect been consumed by our own creation [e.g. Nature], absorbed into our contrasting category. We created an abstraction so powerful that it could even contain -or deny- ourselves. At first, nature was ours, our domesticated category of regulated otherness. Now we are nature's, one kind of object among all the others, awaiting final explanation' (1992, 92-93).

It is in this context that we must consider the rise of that hybrid set of disciplines, the life sciences. Unfortunately (and strangely) they do not figure separately in Evernden's account. But he gives us an indication which seems worth following up:

> 'Even though Nature is, in the first instance, a creature of history, that is, of human conception, it audaciously attempts to make History a subcategory of Nature. [...] Once again, the dualism vanishes, and history becomes a curious subset of material nature, simply a bizarre instance of behavioural complexity that has arisen through the eternal pressures of natural selection.' (*ibid.*)

Why is it that introducing temporal irreversibility in the natural sphere has led to a law-like conception of change, such as Darwin's evolutionism, and not to one which pays more attention to coincidence and chance? Why necessity and not chance? Because the life sciences are in the 15th to 19th centuries part of Nature's domain (defined, we must recall, as 'everything non-human'). As such, their 'history' is constructed from the perspective dominant in the natural realm.

Jonas argues that as soon as the natural sciences are, [in seventeenth century northwestern Europe - S.v.d.L.] sufficiently mature 'to emerge from the shelter of deism' (1982, 39), the explanation of the observed functioning of physical systems in terms of general principles gives way to the reconstruction of the possible generation of such systems' antecedent states, and ultimately from some primordial state of matter. And

> 'the point in modern physics is that the answer to both these questions (i.e. functioning and genesis of the system) must employ the same principles. [...] The only qualitative difference admitted between origins in general and their late consequences (if the former are to be more self-explaining than the latter and

> thus suitable as a relative starting-point for explanation) is that the origins must, in the absence of an intelligent design at the beginning of things, represent a simpler state of matter such as can be plausibly be assumed on random conditions' (ibid). [3]

Within the mechanistic approach to living beings which was dominant at the time, the sheer perfection of the construction and functioning of most living beings made it difficult to envisage their simpler and cruder precursors. The odds against a mere chance production of such 'perfect' beings 'would seem no less overwhelming than those against the famous monkeys' randomly hammering out world literature'. (Jonas 1982, 42) And moreover, these near-perfect beings continually died and were recreated! It would thus have been easier to explain them as the result of some (divine) design, but such a theory was incompatible with Empiricist thought. In a sense, therefore, the two centuries of delay between Kant and Laplace's explanation of the origins of the solar system and Darwin's idea of the origins of living species are indicative of the extent to which the study of living beings was caught between the two prongs of a dualistic world view. 'The very concept of *dévelopement (sic!)* was opposed to that of mechanics and still implied some version or other of classical ontology' (Jonas, *ibid*). In a sense, therefore, the two centuries of delay between Kant and Laplace's explanation of the origins of the solar system and Darwin's idea of the origins of living species are indicative of the extent to which the study of living beings was caught between the two prongs of a dualistic world view.

The contrast between the Lamarckian and the Darwinian models of the origins of life allows us to glimpse what was necessary to resolve the problem. Lamarck's explanation of the living world remained thoroughly 'natural' in the sense that he saw reproduction as the identical re-creation of individual generations of complex beings according to a grand design. But at the same time, he introduced a historical element in his point of view by arguing that, though the design remained the same, it had sufficient flexibility to allow changes whenever 'the environment' imposed different conditions. There lingered doubt about whether such changes could be passed on to later generations. Historical explanation over the timespan of a generation was admissible, but not (yet) beyond. First representatives were still called for, and remained unexplained.

The post-Darwinian model, on the other hand, avoids the difficulties around the improbability of chance origins by arguing that the first representatives could have been much simpler than the present ones. Distinguishing ontogenetic from phylogenetic evolution allows it to explain the past and the present of living species in different ways. The essential rôle of central, mechanistic, theory unifying the explanation of past and present is henceforth played by the mechanism accounting for evolution (*i.e.* variation and natural selection), *introduced at the meta-level of the long-term existence of species*, rather than at that of the individual and/or the single generation. And last but not least in our perspective, the theory of evolution introduced the idea that heredity is linked to change, rather than to immutability (Jonas 1982, 44). This broke the iron grip of reversibility and/or replicability on explanation, and heralded the reintroduction of historical (rather than evolutionary) explanation in the realm of nature. In this, it was inextricably tied to both geology and prehistoric archaeology - other children of the 19th century which helped us push back the age of the world and everything in and on it (*e.g.* Schnapp 1993).

In this context, it is interesting to devote a few words to the concept of 'environment' which is invoked by Lamarck, and which Darwin reconfigured as 'the conditions of natural selection'. Haeckel developed what he called the 'new science of ecology', which he described in 1859 as 'the science of the relationships of the organism with its environment, including all conditions of existence in the widest sense'. Whereas Darwin included mankind in his 'web of life', Haeckel does not - he defines 'environment' in much the same way as 'nature' was defined a millennium or two earlier - as 'non-organism'. Such negative formulations, of course, do not define anything but they are nevertheless revealing. In this case, there is a change in perspective on time (past-present-future) on the one hand, and on 'inside-outside' on the other. The distant past and the environment become objectifiable and separable around the same time, giving rise to history and ecology as rigorous, 'scientific' disciplines.

The next episode begins in about 1910, when the concept 'human ecology' is introduced to denote the study of the relationship between humankind and its environment - and accelerates with the rise of General Systems Theory (e.g. von Bertalanffy 1968) and the concept 'ecosystem' in particular. After reimposing a distinction in the late 19th century between humanity and its environment, the two are brought together again in two concepts which, each in their own way, make 'humanness' a little bit more 'natural'. Following a phase of reductionism which was made possible (but not initiated) by Darwin, we see the pendulum swing back towards more complex relationships between different parts of nature, including human beings. As we have seen in chapter 1, humanity becomes *'Just another unique species'* (Foley 1987), part of the complex web of inter-species relationships which is the fabric of life.

We conclude this all too brief and simple overview with the observation that the 'life sciences' as an independent set of disciplines sprang up between the humanities and the natural sciences at a time, in the last century, at which these two disciplines could no longer meet or understand each other, after the cohabitation of dualism had finally been replaced by the battle which accompanies a divorce. These new disciplines delimited a deliberately ambiguous middle ground, a fuzzy no man's land much smaller than the original domain which included all of nature and humanity. They served both as a second line of defense against the onslaught of Nature, and as the breeding ground for a fifth column which eroded humanness even further, linking humanity organically to the rest of life through evolution, and thereby making it into an object. We cannot reject such an objectification of humanity without exposing the fiction at the core of dualism.

The past hundred years appear to witness the culmination of the impact of materialistic monism as an explanation for everything under the sun and, through the industrial and techological revolutions, as a way of life. Its crowning achievements are the research on DNA and on the human brain. Between the pincer movements of on the one hand deriving *'Mind from Matter'* (Delbrück 1986) and on the other having the essence of human individuality evolve from non-living substances which govern the uniformity and diversity of all living beings, humanness seems inexorably trapped. Is it?

The present dilemma

Our first reaction has been to deny the dilemma. C.S. Lewis (1955, 83, cited in Evernden 1992, 97) formulates it thus:

> 'The price of conquest is to treat a thing as mere Nature. Every conquest over Nature increases her domain. The stars do not become Nature till we can weigh and measure them: the soul does not become Nature till we can psychoanalyse her. The wresting of powers *from* Nature is also the surrendering of things *to* Nature. As long as this process stops short of the final stage we may well hold that the gain outweighs the loss. But as soon as we take the final step of reducing our own species to the level of mere Nature, the whole process is stultified, for this time the being who stood to gain and the being who has been sacrificed are one and the same.'

To go beyond such negation, a structural analysis of what has happened seems very helpful. In many ways, the gains made by research in the natural and life sciences tipped a complex balance which resembles nothing as much as a 'tangled hierarchy' - a situation of oscillation between two terms which, through the complex set of ties which link them, keep each other in a dynamic, approximately stable, equilibrium - not unlike two rivals, each alternately gaining the upper hand for a short time without ever completely defeating the other (Dupuy 1990, 112-113). Thus, in the realm of Nature, the material takes precedence over the ideal, but in the realm of the Ideal, which is itself secondary, the ideal is above the natural. That which is superior at the superior level becomes inferior at the inferior level - inverting the hierarchical opposition within itself, according to the scheme presented by Dupuy (figure 1):

In such a situation, the possibility of the reversal is contained within the encompassing hierarchy. In our case, the two positions may be outlined as follows (Evernden 1992):

- In one view, all applications to 'better manage natural environments to protect them from the consequences of industrial society' start with the expectation of a set of objects obeying natural law. The task is to understand how this system operates so as to be able to ameliorate any harmful effects. All institutional structures assume it. Some herald it as the basic tool of an enlightened 'stewardship' of nature. The expectation is that humankind must use more of the same - that is, direct control through applied science - to help nature (and thus humanity) to survive;

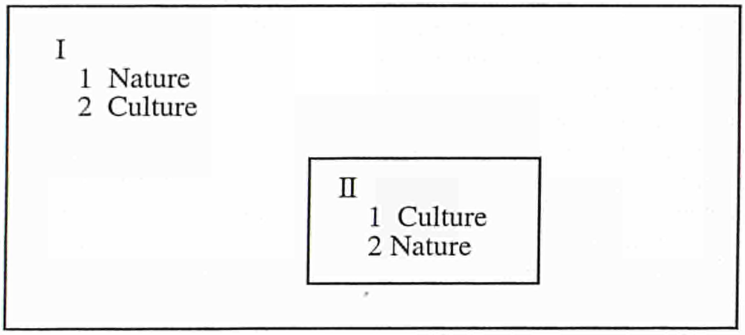

Figure 6.1.1: *a 'tangled hierarchy' between 'Nature' and 'Culture'. There are three hierarchies involved, numbers I and II, and the one which subsumes these two in that order of priority.*

- The other position is to disabuse ourselves of the notion that we are merely skin-encapsulated individuals, and to realise that we actually have a 'field of care' in which we dwell. That makes us literal participants in the existence of all beings, and we will realise that to harm nature is to harm ourselves. Nature as extended self. *We are them..*

Is nature more 'like us' or are we 'like them'? In the former case, we should treat nature as we would other persons; in the latter, we could treat other persons as we would 'natural resources'. In other words: 'What is this *for* me?' is opposed to 'What is this *to* me?'.

The essential thing to remember about this tangled hierarchy is that it does not concern 'Nature' and 'Culture' (or the natural and the human), but different humanly constructed configurations of the relationship between the two, in which either the 'natural' is dominant or the 'human'. The perceiving human remains central.

Jonas presents the underlying dilemma in which we now find ourselves with typical forcefulness (1982, 16-17):

> 'From the hard-won observation that there can be matter without spirit, dualism inferred the unobserved reverse that spirit can also be without matter. [...] Every conception of being that can come thereafter is in essence, not merely in time, postdualistic [...] there are, on principle, not one but two possibilities of monism, represented by modern materialism and modern idealism respectively. [...] A new, integral, i.e. philosophical, monism cannot undo the polarity: it must absorb it into a higher unity of existence from which the opposites issue as faces of its being or phases of its becoming. It must take up the problem which originally gave rise to dualism.'

Dupuy would, we think, argue that self-deconstruction is at the heart of the natural order, as he does for the Liberal world view, with which the present material perspective on nature has become so entangled (1990, 114-116).

How could one disentangle the hierarchy? For one, one could try to impose a sort of arbiter, as does Leopold with his 'land ethic' (cited in Evernden 1992, 100) - the extension of moral boundaries to include not only other peoples but also other species and even the land itself. The problem with this is that humans should not (and could not) devise the ethic for the other beings, as we cannot experience them other than as 'the Other' - i.e. without understanding or feeling or any other form of real contact. Thus, this option would lead to an acceptance of a 'natural chaos' in which for each living being, each aspect of nature, we would impose the same total and absolute freedom as Hinduism allows for cows in India.

Evernden (1992, 94) proposes that the only way is to admit the fictional nature of the opposition. That is, if we want to prevent the realms of Humanity or History from becoming sub-categories of Nature, we will have to admit to ourselves that Nature is in fact a subcategory of Humanity or history - that we are, after all, the authors of the system we call Nature. And moreover, that we are the authors of the dualism that facilitates the existence of humans and nature as separate and qualitatively distinct entities. We will have to admit our own role in the constitution of reality, which in turn means admitting something quite fundamental about the nature of our knowing.

This closely follows the schematic 'solution' proposed by Dupuy, for whom a disentanglement would consist of a double reversal of the hierarchies entangled within themselves (figure 2). But it seems to me that this would 'merely' twist the tangle the other way around - responding to another one of Jonas' points: if humanity is just a part of nature, then what sense does it make to suppose that nature may not have properties similar to our own?

Moreover, it raises two other questions:

- How would one realise such a reversal, while acknowledging that we cannot go back to a state of innocence or naiveté in which vitalism was reinstated as the dominant doctrine?
- What would be the implications of a, structurally similar, reverse tangled hierarchy?

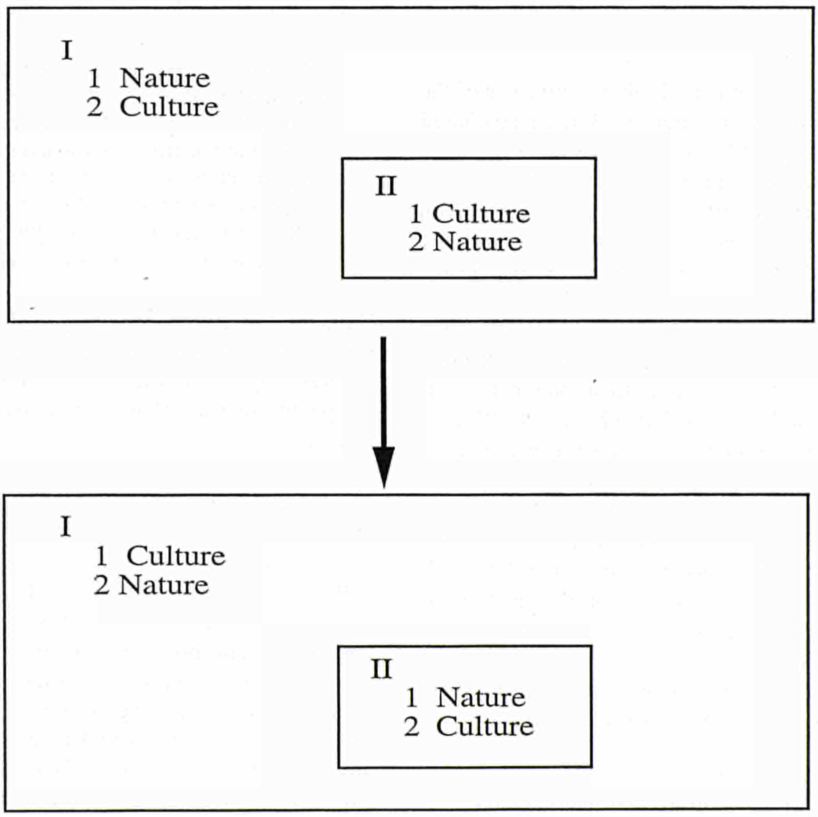

Figure 6.1.2 : *Reversal of the tangled hierarchy between nature and culture*

In the above quote, Jonas proposes yet another 'solution' - subsumption of the duality under another approach or paradigm. This superficially looks like the best solution. But if we acknowledge on the one hand that the dualism is of our own creation, and that it is eminently 'cultural', we cannot hide that our work (in the present project) on both past and non-western socio-cultural systems seems at first sight to indicate a considerable similarity between different 'autochthonous' cases of long-term development of socio-natural relations and our own culture's history.

We must thus ask first whether scratching under the surface of such case-studies brings to light any fundamental differences of the kind that would give us hope that other 'solutions' exist. If it does, we may try to admit some non-commonsensical, intuitive insights into our conversation. That might help us to avoid looking at the ends of the balance, and focus on the fulcrum. Rather than explain by invoking either a materialist or an idealist world view, this might require accepting certain phenomena (and only these), without question, as experiences of the 'Other', and tolerating 'divine chaos' - wildness (as opposed to wilderness - which one always finds in a reservation). In doing so, one would of course follow the lead of such philosophers as Bachelard and Merleau-Ponty. But maybe one could do worse ...

Because if it didn't look like that might work, we might have to accept that some form of tangled hierarchy ('power game') between nature and humanity is inevitable for human beings; to accept that the world is neither significant nor absurd (it *is*, quite simply), and to acknowledge that to contemplate *letting something be* is very nearly beyond human ability. In that case, all we can do is to attempt the Dupuy solution to at least stave off disaster for a while longer.

For the moment, we have our work cut out for us! But in our efforts to investigate such issues, we should not forget that we are primarily human, social and political beings, and that our researches are a means of arriving at opinions, opinions which play a part in the social negotiation going on today. We may use our areas of expertise to arrive at more powerful insights, more cogent arguments, and to avoid any of a wide range of unexpected consequences, for example. But in the end the process of social negotiation which is essential for our survival as a group and as a species is threatened if we do not take position.

A bee's eye view of multidisciplinarity and degradation studies

Having thus presented the reader with some elements of the context in which the differences in attitude to 'Nature' and 'Culture' developed, we need first to stress that there are many other ways in which the above story can, and has been, told. For clarity's sake, we have for example ignored all the social aspects, such as Foucault has been dealing with. It seems that we are here not so much concerned with the 'why' of the above intellectual development, as with the fact that in the present, different disciplines dealing with nature have very different perspectives. All we have therefore tried to do is present one description of the process which has led to the present situation.

If we now turn our attention to the way in which various disciplines and practitioners participating in the ARCHAEOMEDES Project have articulated some of the central dimensions just outlined, this might provide us with a *'grille de lecture'* for some of the apparent contradictions and inconsistencies of the full report.

Le milieu et l'environnement

Maybe it is best introduced by pointing to an essential difference, in French, between *'le milieu'*, i.e. that which human groups are in the midst of, and *'l'environnement'*, that which surrounds human groups. In the former case, although the focus is on what surrounds human beings, the perspective is a human one, whereas in the latter case, the perspective is decidedly non-human. A very simple example may clarify some of the implications. What would be called 'degradation' from the environmental perspective could, equally justifiably, be called 'socialisation of the *milieu*' were one to apply the other perspective. There is thus a (poorly defined) area which can be (and is) studied both from a human and from a natural perspective, in which all (or most) of the essential interactions between a society and its natural environment are played out.

Degradation studies find themselves smack in the middle of that interdisciplinary battleground, as is illustrated by an anecdote from Latour's work in Brazil (Latour, *pers. comm.*). There, in a multidisciplinary team investigating biotic systems at the edge of the Amazonian rain forest (or the human frontier, if one so desires), a hefty debate broke out between the agronomists and the botanists on whether the pampa was 'winning' or the forest 'losing', a debate which was essentially driven by their differences in defining the subject of study and the 'markers' which could be derived from it. What was 'degradation', i.e. loss, to the botanists was 'gain' to the agronomists. The debate is essentially the same as that between the archaeologists working in the Vera basin, who see degradation as the result of human intervention, and the soil scientists working in the same area, who argue that degradation is an omnipresent natural process, and that viewing it as something which can be avoided is 'romantic'.

Protohistoric archaeology (in the french sense[1]) is the *temporal* meeting ground of these two approaches, as it focusses on the period between the prehistoric and the historical epochs - taking data from both the sets of disciplines involved in their respective study, but more importantly, trying to ask questions on the origin of modern-day society with its agriculture, markets, towns, money, trade, administration, *etc.*, rather than on the origins of humankind (as does prehistory). This may explain some of the divergences between archaeologists and palaeoenvironmentalists working on degradation in different periods: in the Palaeolithic, degradation would be assumed to be 'natural', and in the Roman and later periods 'anthropogenic'. For the Neolithic, Bronze and Early Iron Ages, the situation is not so clear and the stress is essentially on the interaction between environmental and human dynamics.

Past and present

Another observation concerns the different relationships of environmental studies to present and past. There are a number of fracture lines in this area. A very evident one runs between the historical sciences and the environmental ones. The former generally concentrate on the past for the past's sake, while the latter confine most of their studies to the present. This has affected the data-sets involved, but even more so the methodologies. Within the environmental disciplines, data involving the passing of time have been collected about geology and geomorphology, palaeoclimate, and to some extent about palaeohydrology, *i.e.* areas in which human impact has been considered of limited importance. But data concerning the development of ancient soils, palaeodemography, ancient methods of land use and settlement patterns, for example, have predominantly been collected in an archaeological context. The study of ancient plants and animals roughly fits between the two groups of disciplines.

In that context, it is remarkable that archaeologists have only rarely transgressed the boundary between past and present. Generally, they study the past for the past's sake and shy away from the implications which the past may have for the present. Whether or not they see the past as a 'foreign country' (Lowenthal 1985), they maintain a dualism which allows them to leave implicit the fact that much of their research is concerned with finding the 'origins' of phenomena they have experienced in the present (van der Leeuw 1990).

One of the interesting corollaries of these distinctions is the degree to which it is acceptable, in the disciplines concerned, to make a statement which has political implications. Whereas social scientists are used to doing so openly, natural scientists have a much more ambiguous attitude. While denying the subjectivity of their research and the social background of the problems investigated, and thus denying any direct involvement in politics, the natural sciences have nevertheless managed to set the political agenda on a number of environmental issues. One clear example is the IPCC report (1990) on the greenhouse effect which has triggered a major research effort on palaeoclimate and related issues.

Archaeologists have traditionally (and not necessarily consciously) banked on similar ambiguities. Although the work is said to be scientific, in the sense of 'objective', and the discipline generally refuses to use its results in the construction of 'the past', the general public is not so shy: archaeological discoveries are immediately 'appropriated' in the construction of justifications for one or more versions of the present which 'fit' the interests of part(s) of the wider community. This raises the question whether archaeology would not be better served by acknowledging its relationship with the present, taking hold of the way its results are being used in a modern context, and in the process positioning itself as a fully grown discipline which, like all others, plays a role, and finds its justification in, its contribution to the world in which we live today. The signing of the Malta treaty and the increasing involvement of archaeologists in the management of the 'Cultural Heritage' are clear milestones in that direction, but we cannot escape the feeling that much of the archaeological community (in most of the western world) is being dragged in that direction, rather than taking the lead in these developments.

The integration of perspectives on the past and on the present of the environment is in many ways even further away. Whilst palaeoenvironmental recon–struction derives most of its outlook, methodology and interpretations (and virtually all of its techniques) from the natural and life sciences, it has remained their stepchild - research concerning past environments has had little or no impact on our knowledge of present environments, except in climatology. That is, of course, not surprising in view of what we have said about the natural and life sciences, but the demand for data on past environments is increasing (Martinez Alier 1990), and applying long term perspectives on the dynamics of socio-environmntal interaction leads to interesting results.

The temporal dimension

We have seen that bridging the gap betwen the social and the natural realms involves two different ways of linking past and present. An *historical approach*, which views the present as the result of a 'forward' sequence of events in which humans played a part, vies with an *evolutionary approach*, which introduces the temporal dimension by working backwards from the present, and explains in terms of *generalisations* which have initially been derived from observations in the present.

Each from their own perspective, both approaches attempt to deal with a past in which we observe sequences of events which seem to unfold regularly, and which we call 'processes', as well as sequences which appear insufficiently coherent to describe them as such. But the historical approach does not presume observable coherence, whereas the evolutionary approach does. Each has its own advantages and inconveniences - the historical approach is not particularly efficient in dealing with a mass of relevant information, whereas the evolutionary approach may be accused of oversimplifying, particularly in its more functionalist forms. The historical approach may operate at the level of the individual, while the evolutionary approach focusses on the group. These differences work through in many different ways, some of which are quite insidious for our inter-disciplinary debates, such as different conceptions of causality, of the appropriate level of analysis, of the validity of generalisations, the nature of 'explanation', etc. Many such differences can be found by comparing the chapters in this volume.

But we could not end this section without drawin attention to the fact that neither of these approache normally takes into account the possibility of eithe discontinuities or of continued social renegotiation o our understanding of the past, a re-negotiation whicl regularly changes our perception of the past to conforn more closely to perceptions of particular interest group in the present. Yet, there are more and more indication that these last two aspects of past and present are as rea as those which we have traditionally considered. On example of such re-negotiation is the shift in meaning attached to the concepts "natural" and "human" t which we have devoted the first sections of this chapter

The spatial dimension

A similar (and related) contrast exists between tw perspectives on the spatial dimension of socio-natura interaction. From a naturalist point of view, th landscape is the evident scale to study phenomena Erosion occurs in certain places, such as hillslopes and the material which descends the slopes may end u at a considerable distance, in some alluvial valley - on thus has to study the material in that valley to understan the process occurring on the hills. In a perspective lik this, humans are seen as impacting on the landscape And because long-term time is in this case a secondar dimension, the initial focus is on spatial patterns. T reconstruct the hydrology, our first reflex is to map th areas where water comes down from the sky, and relat these to the spatial structure of the landscape in orde to predict its flow down to the sea. Once that cycle ha been construed, our next effort is to see how thi pattern varies through time.

But from the historical perspective, the temporal dimension is dominant, and observation tends to begi on the spatial scale of the locus of interaction betwee human beings and their milieu: the site. One studies th stratigraphy, infers from it (and from the samples take in the sections) the diachronic development of soils vegetation, snails and other fauna in the particula location concerned. The next assumption is that such a reconstruction is valid for the immediate environmen of the site. Projecting the information over a wide surface is notoriously difficult, and brings together i a relatively intuitive way the spatial and the temporal perspectives - merging data about present-day landscape dynamics with the information about diachronic developments. It requires in some cases techniques which have only recently been developed, such as for pollen analysis, whilst in other cases it remains a very tenuous thing to do (*e.g.* Winder AFR vol. 1; also below, Ch. 4).

One might summarise the problem by pointing out that in the naturalist's spatial perspective, settlements are points in a landscape which are occupied by human beings, whereas the historian or archaeologist would see the spatial dimension of the landscape as consisting of 'dots', a collection of areas of human occupation or activity. This is most evident in the history of that most notorious of archaeologists' tools, the distribution map.

That this dilemma is of more than passing interest becomes clear when one realises that in basic simulations of intra- and inter-species collaboration and competition in resource appropriation, the spatial dimension plays a much more crucial part than is often realised (Winder *op. cit.*; May *et al.* 1995).

In this area, we must note the contribution of those who deliberately chose for a systemic perspective in which people and their natural environment are linked. Here, the second part of the Ancient Rhône Valley report is innovative in two ways. Firstly, because it considers the site as representing a choice, made by its first inhabitants, which reflects these inhabitants' perception of the landscape. And secondly, because they use a Geographic Information System to derive certain environmental characteristics of the sites from their natural environment, instead of vice versa.

But from either perspective, the reconstruction of the spatial dynamics of the landscape is fraught with difficulties, to which we will return.

Experience and reason

We must also consider the striking differences between the anglophone and the francophone approaches to the nature-culture debate against this historical background. Those differences point to the fact that the two scientific cultures involved have very differenty sets of priorities. Throughout the project there are those who lean towards the empirical, (re)negotiating the subject-object relationship (including, to some variable extent, their own position) every time they undertake a new piece of research. Others position themselves somewhere (in the philosophical sense) and approach the world around them from that fixed position. In such an approach, the subject-object relationship is only renegotiated in so far as the object is concerned.

Based on my own experience working both in an anglophone and in a francophone context in archaeology over the last ten years, and on my observations during this project, I would venture that the two sides of this debate are to some extent identifiable with the positions in the 16th and 17th century debate on the respective roles of reason and experience in coming to grips with our perception of the reality of the world around us.

Anglophone archaeology, grown up in an empiricist tradition, generally accords primacy to the experience. Although that may seem paradoxical, its inveterate tendency over the last twenty-five years to generate one 'new' theoretical framework after another stems from the renegotiability inherent in according more importance to experience than to reason. New experiences have continually, in the empirical tradition, led to reformulation of ideas. Reasoning has thus had to adapt itself, and 'theories' are seen as so many 'keys' to the explanation of ununderstood, misunderstood or uncognised phenomena. 'If you don't understand it - try another theory on it'. As a result, we have a crumbled mixture of perspectives, each consisting of a theory and the data which have been related to them.

Francophone archaeology is often seen by its own practitioners as having more respect for, or in others' eyes as being more interested in data. It seems to me that the rationalist position of bygone days is also responsible for this insufficiently subtle image. Attaching more importance to a reasoned structure as the basis of explanation makes it less likely that that basis will be changed. The only option open then, is to continue testing data against the explanatory paradigm, to see where parts of that paradigm need to be reconstructed, changed or reinforced. The result is a relatively coherent world view which is to different degrees corroborated by data, depending on the particular area one is concerned with.

For me, one of the interesting things to observe over the last twenty years is how these two perspectives influence each other - what they take from the other, how they assimilate it, and what they do with it. Such developments have to be seen against a backdrop of relative undertheorization of archaeology itself - in the sense of the development of theories which have been derived from, and are uniquely applicable to archaeological research. Anglophone archaeology has introduced a series of new theoretical ideas and positions which have first been developed by french intellectuals outside archaeology (Godelier, Meillassoux, Terray, but also Foucault, Bourdieu and more recently Lyotard and Leroi-Gourhan), while french archaeologists have drawn upon their *'collègues d'outre-manche (et d'outre-atlantique)'* for the development of new methodologies (experimental archaeology, ethnoarchaeology, spatial analysis, and many techniques of environmental archaeology, for example).

Of course, these things may well be very different for the other disciplines involved in this project. Archaeology has been used as an example in this paragraph because it has in some ways provided a meeting ground for the others - a meeting ground which was neutral, yet where many practitioners had had something to do with colleagues in other sciences, both natural and social. But we would contend that even if the particular developments in other disciplines are different, they differ for the same kinds of reasons - each may be the result of its own particular mixture of time, process and event, but it is a mixture of these three elements nevertheless. And because these disciplines have 'grown up together' in the same general culture, and have interacted among themselves from their earliest origins, the chances are that similar cultural differences have shaped attitudes in each of them.

Multi-disciplinarity and policy-relevant research

As if these disciplinary differences are not enough, the situation is further complicated by the fact that the research undertaken in this project is directly related to policy-making and implementation. We cannot proceed to the next stage - an outline of how we have attempted to deal with the problem of multidisciplinarity in the project - without looking at this issue.

Allen, Seaton *et al.* (AFR 5(1), Ch. 1) argue that the traditional, rational, modernist view of scientific research related to decision-making issues reduces complexity and seeks to identify simple causal relations, in much the same way as we have done in the beginning of this chapter for scientific research *tout court*. They believe that it is chosen because it provides an appropriate way to develop an understanding of classes of phenomena about which scientific methods were already developed so that we know that they are efficient generators of new knowledge. Adopting this framework, according to them, assumes that a 'decision-issue' has been correctly identified, that symptoms of a 'problem' have been correctly linked to a single decision issue, that there is a single homogeneous audience for change (the problem owners) and that the problem setting can be bounded. Moreover, it assumes that in the future the causal factors and the problem setting will be the same, and that, therefore, the future is forecastable. These conditions are difficult to meet, and whether they are met or not is difficult to ascertain. In the complex, messy real world (Checkland 1981) such a view often results in 'unintended' consequences which in turn become a new set of 'unanticipated' decision-issues.

Allen, Seaton *et al.* also point out that policy-making and policy-implementation in fact include a mixture of two very different kinds of decision making, which one might call 'end-state' and 'open-ended' decision making. In the former, decisions about physical infrastructures have to be handled with regard to the problems of engineering design and implementation that have to be solved in order to guarantee an outcome which conforms to specifications, while in the latter strategic decisions are made with respect to ever-changing organisations and communities. For such practical, technological, 'end-state' decision-making the existing scientific approach is indeed appropriate, but for decisions concerning the future behaviour of the communities for which the technological decisions are made, it is not. As the gap between these two kinds of decision-making is unbridgeable, there is therefore an inherent tension between technological solutions to problems with long lives and the rate of change of the context for which they are designed.

In other words, in policy-relevant research and decision-making, ideas formulated in open, fuzzy categories have to be combined with other ideas which have been defined sharply; the observation of uncontrollable dynamics has to be fruitfully combined with total control over certain processes which are affected by the ones over which we have no control. This is a new element because it introduces a distinction between 'pure science' and 'technology' alongside the one we had already made between the disciplines concerned with the 'natural' and the 'social' worlds, and focusses that distinction on whether the research deals with single predetermined outcomes to processes and dynamics ('end-state research'), or with multiple potential outcomes ('open ended'). Of course, we encounter here in a different guise the pervasive distinction between 'pure' and 'applied' research. It is instructive to follow the way in which Allen, Seaton et al.outline the respective roles of the main actors in 'end-state' oriented research and argue why such research is inappropriate for 'open-ended' research efforts

The traditional role of the technical analyst with respect to decision-making, the recipients of policy and the decisions themselves generally follows the 'end-state' approach. Its most striking feature is the simplified notion of 'decision-maker' that is commonly used. In practice the vast majority of strategic decision issues involve a complex decision-making process which includes a diversity of information, views and participants, rather than a single individual ('the boss'). The idea of decision making as a complex, human centred process is common in politics, management and social policy, all of which may use formal intellectual devices with different traditions to natural science. Increasingly there is an emphasis on the role of social disciplines in formulating the appropriate decision context to which science and technology knowledge has to be applied (Newby 1992).

Secondly, the traditional approach confuses accountability with agenda setting. In other words it sees the role of the analyst as providing information to the 'decision-maker' on an issue that has been determined by that 'decision-maker'. In contemporary research this is surprisingly common. Scientists and engineers are particularly vulnerable to it when they apply themselves to policy issues. This approach makes the questionable assumption that the agenda for change of the recipients of decisions and policy is fully comprehended by the decision-maker (Lemon, Hart & Seaton 1992). The relationship between the decision-making process and the recipients of policy and decision making is assumed to be about the selection of options and not about option generation. In practice the amount of knowledge the policy formulating process has about the priorities for change and the likely response of a recipient population to a specific policy or policy instrument is very limited.

Thirdly, the nature of the relationship between the researcher or analyst and the recipient population is a problematic one in this approach. For Epirus, Green makes a distinction between 'lived' and 'learned' knowledge, stressing that, at least from the perspective of one who has acquired his or her knowledge 'live', learned knowledge seems counterintuitive and sometimes inaccurate (below, Ch. 9). Such lived knowledge is, of course, knowledge acquired directly from the messy real-life situations and observations which Allen, Seaton *et al.* refer to, whereas the 'learned' knowledge has undergone the process of disciplinary negotiation we have referred to in chapter 1, which has resulted in defining a perspective, a set of accepted scales of observation and analysis, and a 'toolkit' which both defines the kinds of problems to be tackled and the general kinds of solutions to be found.

An agronomist and a farmer in the Argolid would run up against similar differences between them if they were to attempt to deal together with a problem - if he were true to form, the agronomist would analyse the problem, collect data about the past behaviour of the system and treat these data scientifically in the hope of coming up with an adequate solution. But the farmer would not have the conceptual and material toolkit to do the analysis, and he would approach the problem by trial and error, drawing on his experience of the range within which the solution is probably to be found. The agronomist will aim for a 'cast-iron' theory and explanation, formulated in terms of well-defined, closed categories, whereas the farmer will predict what might happen in approximate terms - i.e. in open categories.

The crucial point seems to be that people such as the individuals with 'lived' knowledge (or 'understanding' as we would prefer to call it here, contrasting it with 'knowledge' (rather than Green's 'learned' or 'scientific' knowledge') are essentially concerned with creation and with actions, while scientists are more analytical, describing such actions in words and searching for their significance. As a result, these two groups develop different ways to describe the same phenomena, which are very similar to the empiricist and rationalist perspectives discussed earlier. In the experience-based perspective, the underlying assumption is that our experience may change, that we cannot expect that what we observe at any moment in time will last, even though most of the time, our observations will stay within the range of the expected. Unexpected things may happen which cause us to change our minds about accepted interpretations. Phenomena are therefore deemed to be poly-interpretable, and ideas change as required by the observations. The knowledge-based point of view, on the other hand, lacks that experience of unexpected change and relies primarily on ideas to 'deal' with the world. Because those ideas have been negotiated by a whole community of people, they are less easy to change - and therefore the way phenomena are viewed is limited by constraints which are not so much inherent in the phenomena as by what is acceptable to the community involved. The famous German adage reflects this well: *"Die Interpretation schwankt, aber die Tatsachen bleiben"* ("The interpretation may twist or turn, but the facts remain" - note that the German does not use *'sich ändern'* or another verb meaning 'to change').

No wonder, then, that the recipient population is usually seen as a set of objects to be observed and analysed. Where they are questioned it is usually about the researcher's agenda without regard to the relevance of that agenda to the respondents. The problem is that the analyst takes no responsibility for enquiring into those diverse agenda and decision spaces. The consequence is that the relevance of the nominated issue to people on the receiving end of policy and strategic change is never known (Lemon & Naeem 1990).

Last but not least, current policy formulation in the technological and environmental fields often affects not only the target recipients but also other, unanticipated, groups because of physical and social linkages that can only be identified through interaction with the population. When the focus is on the set of decision issues that involve social, technological and natural world interactions, many decisions may involve an element of technological change which in turn affects populations who can be quite difficult to identify. What is required is the formal recognition of the diversity of agendas for change and the range of priorities for different individuals and groups.

In summary, the traditional approach of the analyst and the related view of strategic decision-making have severe limitations when applied to decision issues that involve interactions between the social, technological and natural worlds. In pointing this out, Allen, Seaton *et al.* highlight from a different angle some of the reasons which have driven the sociologists of science and technology to describe both scientific research and technological implementation as a social process, rather than in the formal ('end-state') terms chosen by, for example, philosophers of science. The weaknesses have to some extent also been recognised in the social disciplines through the development of techniques and mechanisms for the elicitation of perceptions of relevant 'problems' and the prioritisation of decision issues.

Multi-disciplinary research and the adoption of a 'creative' perspective

In order to facilitate multi-disciplinary research which encompasses the realms of nature and society, we would argue that a very fundamental change is needed, a new perspective which does away with the 'negotiating down' of observations into relatively narrow, often mechanistic and functional but at any rate disciplinary, theories to explain them. Rather than work with closed categories, we must learn to think in, and work with, open-ended, fuzzy categories (Zadeh et *al.*, 1975); rather than use a determinist causal ('end state') logic, we must develop a possibilist ('open-ended') logic based on observed synchronicity or contingency (Monod 1970; Olsson 1979; McGlade & McGlade 1989); rather than basing our scientific procedure on abstracting from the data in successive steps which look for similarities between them, we must develop a 'contrastive approach' which aims at seeing more and more dimensions of variability rather than fewer and fewer (*cf.* van der Leeuw 1987), and which may lead to proximal explanations involving individuals and individual phenomena rather than aggregates.

In positing this, our starting point is the contrast we have outlined in the first part of this chapter, between the Newtonian sciences of the natural which assume that the causes of change are external to the system, and the humanities and the life sciences as well as, latterly, the social sciences, who view change as self-generated by the system. As long as that contrast existed, the gap between these two sets of disciplines was, as we have seen, unbridgeable. We also argued that we felt that the subsumption of the existing approaches to both realms was probably the only way open to us. What would a paradigm that were able to do so, look like?

It seems to us that the main shift in perspective required is the acceptance, in the natural sciences just as in the other disciplines, that any system is permanently in interaction with its surroundings, that it is permanently changing, and that such change implies a contingency of external and internal dynamics. In other words, the approach to be proposed should be able to describe both natural and social systems as 'living' systems, which may grow and otherwise change of their own accord.

It follows from the idea that all systems are living ones, in the sense that they can transform themselves of their own accord and thereby change the whole of the dynamics concerned, that one can no longer think in terms of fixed futures, that similar causes may have different effects and different causes may trigger converging developments. Hence the implication that we have to move from a determinist to a possibilist logic or logic of concomitance.

And that, in turn, demands of the person who studies such systems that their trajectories be followed through time. If it is no longer possible to 'predict' as we used to, because there are limitations to the assumptions concerning like causes and like effects, we can no longer 'postdict' either. That implies that the way we have usually tried to 'explain', for example by evoking evolutionary trends, has to be replaced by describing the trajectory of a system step by step, arguing at every point the relation between past, present and future of the system's trajectory: describing the history of a system becomes an essential part of understanding it. The example of the Vera basin (below, Ch. 5) makes this point very effectively - the articulation between the various kinds of dynamics with different periodicities would never have surfaced had we not chosen to use such a long-term perspective.

In such a situation, if the categories used to describe such systems are to make sense over some length of time, they clearly cannot be perfectly neatly circumscribed but must leave some leeway for fuzziness. They can describe what may belong to them, but cannot be expected to exclude now that which later may turn out not to belong, as that is not knowable a priori.

Furthermore, if things change continually, it makes no sense to keep suppressing differences in each of the steps of our scientific procedure, as we often do by categorising, classifying, averaging, approximating or using another from the arsenal of techniques of our standard scientific repertoire. Such steps (over) simplify the complexity of living systems, and therefore present us ultimately with a caricature of what goes on. And as we have seen in many environmental studies, this literally 'takes the life' out of many processes. Rather, if we are to enrich our knowledge and understanding of such complex phenomena, we must do away with 'Occam's razor', the assumption that if a phenomenon can be explained in two different ways, the simplest of these is automatically the one to choose. And that again implies that rather than look predominantly for similarities between phenomena, we must give at least equal attention to differences, be they sometimes small. And often, as a matter of expediency, it is useful to deliberately search out differences and contrasts in order to map more dimensions of the changes occurring and the dynamics behind them.

Conclusion

Multi-disciplinarity is both a necessity and a problem; it provides a unique richness in the debate, and leads to frustration because we cannot 'solve the problem'. To some extent, our perspective will probably always be a composite one. But what this chapter has attempted to show is that, at present, multidisciplinary research suffers from the hangover caused by six or seven centuries of a pronounced dualism in our ideas concerning the nature of nature and of culture. A hangover which has driven the social and the natural sciences farther apart from each other than is, in our opinion, necessary.

Next, we have looked at the relationship between research on the one hand and policy-making and -implementation on the other, and we have concluded that the goal-directed aspects of policy make the scientific approach unsuitable for the formulation of policy, while the relation between the policies and the world in which those people live at which they are directed, is lost. A better vertical (i.e. cross-scalar) link must be created in our analyses and syntheses, and between them and the everyday world which they so heavily influence.

And finally, we have briefly argued for an 'open-ended', creative perspective based on many of the developments introduced in various disciplines under headings such as 'complex systems', 'autopoiesis', 'self-organisation', etc. We believe that such an approach might subsume the existing social science and natural science paradigms, and thus allow for a better integration of disciplines than has often been observed on environmental issues.

Footnote

[1] I.e. from the second half of the Neolithic to the Late Iron Age