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The Ordos Plateau of China

UNU Studies on Critical Environmental Regions
Edited by Jeanne X. Kasperson, Roger E. Kasperson, and B. L. Turner II

Note from the editors

This book is the fifth in a series from the United Nations University (UNU) research project, Critical Zones in Global Environmental Change, itself part of the UNU programme on the Human Policy Dimensions of Global Change. Both endeavours explore the complex linkages between human activities and the environment.

The project views the human causes of and responses to major changes in biochemical systems – global environmental change broadly defined – as consequences of cumulative and synergistic actions (or inactions) of individuals, groups, and states, occurring in their local and regional settings. The study examines and compares nine regional cases in which large-scale, human-induced environmental changes portend to threaten the sustainability of an existing system. The aim is to define common lessons about regional trajectories and dynamics of change as well as the types of human actions that breed environmental criticality and endangerment, thereby contributing to global environmental change. The overall results of the comparative analysis are found in *Regions at Risk*, the initial volume in this series.

Titles currently available:

- Regions at Risk: Comparisons of Threatened Environments
- In Place of the Forest: Environmental and Socio-economic Transformation in Borneo and the Eastern Malay Peninsula
- Amazonia: Resiliency and Dynamism of the Land and its People
- The Basin of Mexico: Critical Environmental Issues and Sustainability
- The Ordos Plateau of China: An Endangered Environment

The Ordos Plateau of China: An endangered environment

Hong Jiang

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Glossary

Arlatengzhagesu	Mongolian name
Balajinima	Mongolian name
banner	administrative unit, equivalent of county
bao shou	conservative
Dalad	banner name
dan	measurement unit for grain (used before 1949); 1 dan = 1 hectolitre
di qi	quality of land
Dongsheng	city name
Ejin Horo	banner name
Eer Duo Si Bao	local newspaper (*Ordos Daily*)
gacha	Mongolian term for village
Gelatai	Mongolian name
Hanggin	banner name
Hobq	desert name
jin	measurement unit; 1 jin = 0.5 kg
jun	administrative unit equivalent to a prefecture or province
Jungar	banner name
kulum	enclosed pasture; plot of enclosed pasture
league	administrative unit, equivalent of prefecture

li	measurement unit; 1 li = 0.5 km
mu	measurement unit; 1 mu = 0.0667 ha (hectare)
Mu Us	name of a sandy land
Narengaowa	Mongolian name
Nimazhamusu	Mongolian name
Otog	banner name
Otog Front	banner name
Ren Min Ri Bao	national newspaper (*People's Daily*)
sumu	Mongolian term for township
Uxin	banner name
Uxin-Ju	sumu name
xiao kang	well-off; beyond poverty
xing gong	royal visiting palace
Wangdannima	Mongolian name
yuan	unit of Chinese currency
Zhu Xiangdong	Chinese name
zhou	administrative unit similar to a prefecture or province

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Preface

The Ordos Plateau has an extraordinarily lengthy record of human transformation of the environment. Since the Mao revolution and the installation of a socialist economy, the pace of change has accelerated dramatically, leaving extensive devegetation, soil erosion, and sandification in its wake. Meanwhile, the power of the central state has increased greatly, and with it intervention into the local economy and nature-society relations. The context of substantial climate variability in a sensitive arid and semi-arid region and the presence of Han and Mongolian cultures renders distinguishing human-induced transformation from a backdrop of natural change and discerning long-term trajectories of change unusually challenging.

Hong Jiang profiles at length the distinctive deceleration in the rate of change since 1949. The early 1950s were a period of recovery from war in the regional economy, a time during which farmers and shepherds received land rights. The period between the late 1950s and the early 1970s marked a time of extraordinary, even cataclysmic, fluctuations in human imprint on the environment, involving the Great Leap Forward and its drive for a communal structure of agriculture during the late 1950s, and the Cultural Revolution of the 1960s and its extensive expansion of cultivation into marginal areas. In the late 1970s, the Household Responsibility system mandated a return of

land management to the households and an easing of the land degradation that had characterized the previous two decades. During the 1980s and extending into the 1990s, the greater role of the state in coordinating regional economic development and environmental protection has mitigated and ameliorated a trajectory headed toward criticality and begun to flatten the slope of the trends of threat. In describing this profile, Jiang makes a persuasive argument for the prominent role of central-state intervention in regional environmental change. Indeed, this volume provides the greatest reach into the role of the state in environmental transformation of the various books in the UNU Studies in Critical Environmental Regions series. Elsewhere (Kasperson, Kasperson, and Turner, 1996), we describe the Ordos as persuasive evidence of the need to broaden the IPAT (impact = population × affluence × technology) construct (Ehrlich and Holdren, 1971) to an IPAT-plus formulation in which various other cultural and political phenomena enrich our interpretation of human-induced environmental change and responses. At the same time, this volume also demonstrates how complex ''chains of causality'' can be when exploring the tapestry of regional nature-society relations. Current research on the human dimensions of global environmental change and attempts at ''wire diagrams'' of change (Jacobson and Price, 1991) operate at a very general level of ''driving forces'' and ''proximate factors.'' This study suggests the limitations of such broad attempts at explanation and the hopes that some megatheory will provide a convincing interpretation and point to pathways for the next generation of modelling human-induced environmental change.

Jiang also makes clear that culture matters in nature-society relations, while at the same time indicating how difficult it is to extricate the distinctive effects of culture in the environmental transformation of the Ordos. The Mongolians, who evolved from the semi-arid grasslands of northern Asia, have led a traditional life of pastoralism – migration in search of grass and water, high mobility, an absence of stable settlements, and a key place for domesticated animals in the economy. The Hans, by contrast, have practised a form of grain cultivation for more than 7,000 years, in which they have relied principally on the natural fertility of land, a relatively sparse population, and a form of shifting cultivation.

Over the past 50 years, both groups have undergone significant cultural change. Owing to large population increases since 1949, the Mongolians have experienced substantial degradation of their pas-

ture lands. The Chinese government's promotion of more permanent settlement of Mongolians has in turn encouraged the use of irrigation and fodder-crop cultivation, thereby reducing their vulnerability to climatic fluctuations. Meanwhile, ventures into more intensive grazing prospered through the sale of wool. These changes are reflected in improved diet and health, but they have led to dramatic environmental degradation in the form of extraordinary soil erosion, devegetation, and sandification, all of which Jiang examines at length. The Hans, for their part, have progressively moved into occupations not based on land and also registered major gains in social well-being. For both, land-based economic activity has become increasingly identified with a low standard of living and inferior social status. Generally, experience in the Ordos suggests that governmental policy and economic change have continuously altered the traditional role of culture in structuring nature-society relations.

In according state intervention a prominent place in human-induced changes in the Ordos, Jiang distinguishes among types of government policy – those she describes as ''core'' state policies that alter the broad array of government relations with regions, socio-economic policies that typically affect one or several driving forces or proximate factors, and those policies particularly aimed at environmental protection. Core policies in China – such as the Great Leap Forward or the Cultural Revolution – have involved wrenching changes in nature-society relations in the Ordos and elsewhere. Environmental-protection policies have emerged only recently and have had modest effects in ameliorating damaging activities in the Ordos. Most important, however, have been those policies that have wedded regional economic development and environmental management. The use of such policies, Jiang argues, has reached deeper into altering the local economy in ways that have slowed the trend toward greater environmental degradation.

These changes over the past 10 to 15 years afford some optimism for the situation of the Ordos. Jiang argues that rates of environmental degradation have been slowing for a decade. Whereas the Ordos clearly remains a marginal region beset by many of the problems associated with such a position, as other volumes in this series make clear, she sees gains in indicators such as bank deposits and GNP per capita that suggest increased buffering to the long-standing historical pattern of environmental variability. The impacts of an emerging market economy hold the prospect for both potential gains and risks for the Ordos. Indeed, this region lags behind most other

regions in China in terms of the impacts of technological and economic change and the infusion of capital investments. Coal may be a notable exception and wields the potential for altering the traditional economic status of the region, as well as introducing a new set of environmental threats.

In her final chapter Jiang provides some quantitative measures that suggest how ''trajectories of change'' can be characterized empirically. Most volumes in this series rely largely on qualitative assessments of the overall regional movement towards or away from criticality. This analysis indicates that even for a remote region of the world quantitative data can be brought to bear effectively in trajectory analysis. The route to assessing changing risk trajectories may be a more effective and direct way of engaging the issues implicit in ideas of sustainability than current efforts aimed at defining and identifying elusive indicators of sustainability.

Jeanne X. Kasperson
Roger E. Kasperson
Billie L. Turner, II
Series Editors

1

Introduction

Global environmental change takes two forms: systemic and cumulative (Turner et al., 1990b). Systemic changes are those that occur in the globally operating systems of the atmosphere and oceans, whereas globally cumulative changes are localized changes that are widely replicated and that in sum constitute change in the whole human environment (Turner et al., 1990a, 1990b). Examples of the former include global climate change, and examples of the latter are soil erosion, deforestation, and land degradation. Neither kind of change is a novel phenomenon, as systemic change occurs in nature, and cumulative change has taken place throughout human history (Marsh, 1965 [1864]; Turner and Butzer, 1992). What is novel is the ever-increasing intensity and extent of both changes as they are driven by human activities (Turner et al., 1990a; Stern, Young, and Druckman, 1992). Since 1700, human impact has taken an apparent leap, and global environmental change since then has increasingly been of human origin (Kates, Turner, and Clark, 1990).

Global environmental change not only originates largely in human activities, but also exerts increasing effects on the security and well-being of societies. Thus the human dimensions of the change have attracted the attention of the scientific community recently. The concern spreads from causes to consequences of environmental change

in a society, i.e., human impacts on the environment, and impacts of environmental change on the society. Stern, Young, and Druckman (1992) and Kasperson et al. (1995) group the human dimensions into three major areas: human impact of environmental change, human driving forces, and societal responses to the change. In addressing human impact of environmental change, the central concern is no longer that of what in the environment has changed and how much it has changed, but that of how significantly the change has affected society – its well-being, income, production, health, and livelihood. Studies of human driving forces not only identify human contributions to environmental change but also seek to determine how individual forces have interacted with the environment through proximate human activities, as well as how combinations of forces interact with the environmental system. Research on societal responses recognizes human potentials and efforts, or a lack of them, in responding to the environmental changes that have happened; the focus is on how society attempts to slow down and reverse the change in progress. Responses may also invoke further environmental degradation, if the approaches are not appropriate (Kasperson et al., 1995; Kasperson, Kasperson, and Turner, 1996). Again, the human-environment relationship is not portrayed as a static loop but as multiple-route dynamics.

Most assessments of global change have addressed systemic change and have been planetary in scope. Yet a regional approach to the study of global change is essential for understanding both physical changes and their human dimensions. Increasingly it is recognized that global change cannot be adequately addressed without understanding the significant variations in the global average (Stern, Young, and Druckman, 1992). The spatial variations in the forces, types, and human consequences of environmental change are so large that the usefulness of global-scale assessments is questionable. Moreover, it is recognized that biophysical impacts, human causes, and human responses must be seen in terms of their synergistic relationships, and a regional approach is the only feasible way to understand the role of regional historical, cultural, political, and socio-economic contexts in environmental change (Turner et al., 1990a; Kasperson, Kasperson, and Turner, 1995; Stern, Young, and Druckman, 1992).

Systematic research in regional approaches into environmental change and its human dimensions has been lacking (except, perhaps, Kasperson, Kasperson, and Turner, 1995), although human impacts, human driving forces, and societal responses to environmental change have been considered in many regional environmental studies

(e.g. Blaikie and Brookfield, 1987; Haas, 1990; Smil, 1987). This project focuses on human dimensions of global change based on a regional case study, attempting to contribute to the understanding of regional patterns of environmental change. Only those aspects of a society that are closely related with the environment and environmental changes are studied, and the emphasis is on their relationships with environmental changes. This, with increasing proximity to environmental changes, may be extended to embrace every aspect of a society and included in a regional study that can date back for tens or even hundreds of years. Even so, the difference from an all-inclusive regional study is clear because the focus of this approach is environmental changes, and the relationships between socio-economic factors and environmental changes are explicit. Nevertheless, the regional approach to environmental change is related to, and benefits from, previous regional studies because the regional context is important to both.

This research is part of a collaborative international effort aimed at understanding regional patterns of global change. In 1990, recognizing the need to study global environmental change from a regional perspective, Kasperson and colleagues initiated the Project on Critical Environmental Zones (ProCEZ). Case areas were selected around the world based on the following criteria: the region is identified in the literature as one experiencing environmental crisis; the set of regions selected represents a range of environmental and political-economic conditions; and lastly, ongoing research on the region can provide a base from which this project could draw (Kasperson et al., 1995). Among the nine case studies, the Ordos Plateau was selected, representing frontier grassland transformation under the Chinese socialist political system (Jiang et al., 1995). The aim of the project was to identify key human dimensions – human driving forces and societal responses – of environmental changes, to explore how broader patterns of global change were manifested within regions that have their own unique socio-economic contexts and historical and political conditions, and lastly, to derive from the study patterns, trends, and methodologies that might inform other regional studies. The first stage of the project has generated a book, *Regions at Risk: Comparisons of Threatened Environments* (Kasperson, Kasperson, and Turner, 1995). In the second stage, the cases have generated a series of monographs, in which this study is included.

My involvement with the Ordos Plateau case study started in 1991, when I worked as a research fellow at the Institute of Geography,

Chinese Academy of Sciences. Drawing upon China's relatively rich research in physical geography in areas including the Ordos Plateau, this study focuses on the human dimensions. Fieldwork was done in 1991 and 1992, and certain socio-economic data were collected after that.

In selecting the case study of the Ordos Plateau, my concern has been regional environmental degradation (i.e. cumulative changes) instead of globally systemic changes such as global warming. Although there has been rising scientific and public concern over global systemic change during the last two decades, particularly in developed countries, cumulative environmental changes are still more important for developing countries, as they are more intimate to the society involved and place greater conceivable present and near-future pressure on regional human use systems and, therefore, on regional security (Mathews, 1989). In some parts of developing countries, environmental degradation has become so significant that it threatens life-support systems (Blaikie and Brookfield, 1987; Jodha, 1995; Rocheleau, Benjamin, and Diang'a, 1995). When vulnerability to environmental change is involved, regional environmental changes that limit regional well-being become more important as they restrict the capacity for societal responses to any kind of possible negative environmental changes. It is, therefore, this concern over regional patterns and the significance of cumulative changes that centres this research in the Ordos Plateau.

China's environment has long been transformed by human activities (Smil, 1984; Zhao, 1992). With the establishment of a socialist regime in 1949, and the tremendous changes thereafter, the state of the environment has undergone significant changes (EDRPRC, 1992; Qu, 1990; Ross, 1988; Smil, 1987, 1992a). Environmental changes have not occurred evenly over space and time, nor have their human causes and consequences been uniform. This variation has reflected the changing environment-society relations embedded in the dynamic socio-economic situations. Environmental change itself has attracted great attention in China, yet owing to the tendency in China's post-1949 geographical study to neglect the explanatory exploration of nature-society relationships, the human dimensions of environmental change have not attracted in-depth study (but see Smil 1987, 1992a, 1992b).

The Ordos Plateau lies on the northern frontier of China. Semi-arid and arid, and populated mainly by farmers and pastoralists, it is both physically sensitive and socially vulnerable to environmental

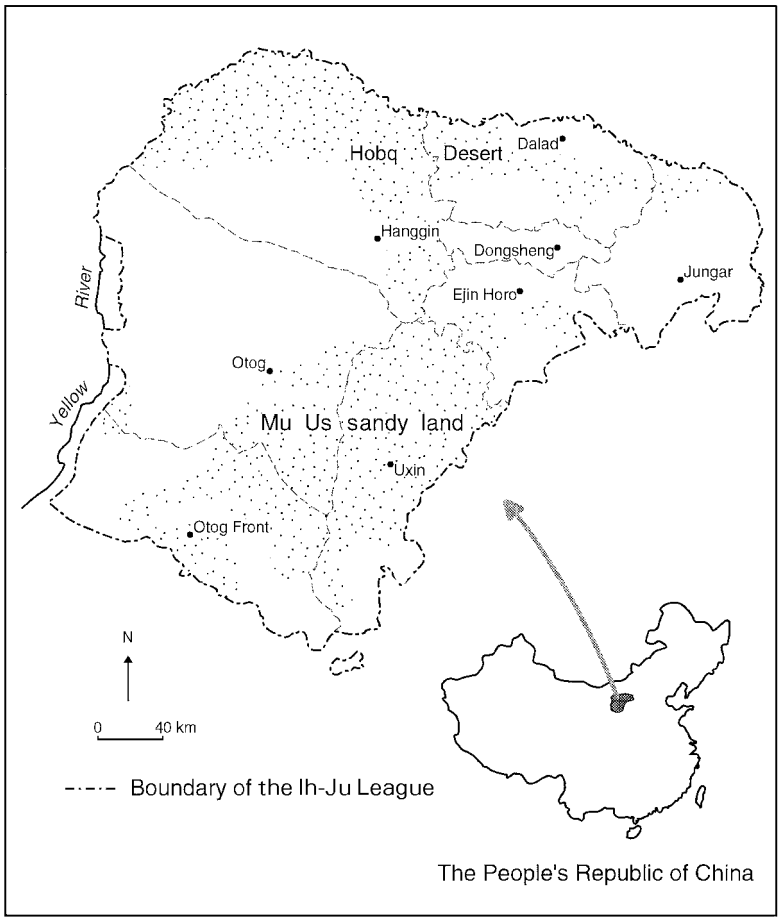
change. Since the establishment of the socialist regime in 1949, the environment in the Ordos has undergone tremendous changes. The land has been sandified and some areas improved, the vegetation degraded and some areas recovered, and the soil depleted and some areas replenished. The overall trend is toward increased environmental degradation, however. Discontinuity and improvement in this trend are also clear. The issues addressed in this research are what societal factors and processes have contributed to the change, how the changing socio-economic situation has affected the environment, how the society has consciously or unconsciously responded to the environmental problems, how the environment-society relationship is constructed and changed, and finally, where the society is headed in terms of criticality and sustainability.

The Ordos Plateau

The study area, the Ordos Plateau, is situated in the Mongolia Autonomous Region in north China (fig. 1.1). Bounded by the Yellow River and the Great Wall, the Ordos Plateau covers 87,427 km^2, and its natural environment is arid and semi-arid, windy, and sandy, with grass (steppe) as the natural land cover. Historically, it was mainly a pastoral area inhabited by nomadic Mongolian people; but in recent centuries, especially since the eighteenth century, Han people have moved in, and the area has developed a mixed economy of grazing and farming.

Administratively, the Ordos Plateau comprises mainly the Ih-Ju League of the Mongolian Autonomous Region, which constitutes the focus of this study. Throughout this study, the term Ordos Plateau refers only to the administrative Ih-Ju League. I shall use ''the Ordos Plateau'' (or ''the Ordos'') and ''Ih-Ju League'' interchangeably, with the latter emphasizing governmental management and administrative jurisdiction. Other administrative units include banner (or city), township (or *sumu*, the Mongolian equivalent), and village (or *gacha*, the Mongolian equivalent) in a subordinating order under the League. (Township and village were called ''commune'' and ''brigade,'' respectively, during the Cultural Revolution.) In the Ih-Ju League are Dalad, Hanggin, Jungar, Ejin Horo, Otog, Otog Front, and Uxin banners, and Dongsheng city (fig. 1.1); each banner or city contains many townships (*sumu*) and each township many villages (*gacha*).

The period following the emergence of the Chinese socialist state



Dots represent sand cover.

Figure 1.1 **The Ordos Plateau of China**

witnessed enormous changes in the socio-economic situation of the Ordos Plateau. Take agricultural production and management, for example. The early 1950s marked a period of economic recovery, during which farmers and shepherds were given rights to land and its management, and agricultural growth flourished. The late 1950s to the early 1970s was a fluctuating but generally disastrous period. Communes established during the Great Leap Forward in the late 1950s claimed both ownership and user rights of the land. The excessive governmental control abolished individual rights to land management but took its toll on agriculture. Soon the mistake was

recognized and remedied in the early 1960s, only to give way to the even more devastating period of the Cultural Revolution, when farming was politically prioritized but without due consideration to suitability of land. As a result, farming was expanded to areas that were not suitable, and pastoral development was largely neglected. With the end of the Cultural Revolution in the late 1970s came the Household Responsibility system, which allocates land-user rights to households and loosened governmental controls. The return of land management to the household level greatly stimulated private enthusiasm, and as a result agricultural production began to grow rapidly.

The environment has also changed over the same period. Official studies (Ih-Ju League, 1988, 1990) revealed serious environmental degradation, including sandification, soil erosion, and vegetation degeneration – all closely connected to the quality of the environment for human use. These reports have also pointed out that environmental degradation was apparent in the 1950s, rampant during the 1960s and 1970s, and has slowed or halted since the early 1980s.

The strong correlation between trends in socio-economic and environmental changes in the Ordos Plateau suggests, but does not establish, a close relationship between changes in the society and patterns of environmental degradation. It presents an interesting task of interrelating environmental changes and their human dimensions, and, particularly, finding important factors in the society that have contributed to environmental changes, and establishing the causal linkages that exist in the relationships. Past research (Huang and Song, 1986; Li et al., 1990; Sheehy, 1993; Yang, Di, and Huang, 1991; Zhu and Liu, 1986) has pointed out that human activities such as overgrazing, improper reclamation, and heavy bio-collection of fuelwood and medicinal herbs have contributed to environmental degradation. The direct impacts of environmental degradation are also apparent in hazardous events of sand mobilization and soil erosion that damage properties and even lives.

Overall, the physical dimensions of the environment have been studied in detail. But the human dimensions – human impacts, proximate factors, driving forces, and individual and societal responses – have received little systematic study, while such important factors as poverty, policy, and institutions have yet to be addressed in depth.

Data for this volume come from several sources. Past research (conducted by other researchers), governmental archives, socio-economic statistics, and local newspapers have provided necessary

material for constructing the socio-economic and environmental background of the Ordos Plateau. Data and material from fieldwork and interviews, conducted by the author during the spring of 1991 and summer of 1992, constitute the main source for the study of human dimensions of environmental change, the core of this study. Most data stop at 1992, when the last fieldwork for this study was conducted.

Organization of the volume

This study has revealed that since 1949, the physical environment of the Ordos has undergone extensive change under tremendous human driving forces. The next chapter identifies and assesses these changes, and defines their trends and characteristics, including transformations in the vegetation and soil and changes in sandification. Also included in chapter 2 are the major impacts of environmental changes on local livelihoods, economy, and human well-being.

This book centres on the human dimensions of environmental change. The important tasks are to investigate human driving forces and their effects on human and ecological receptors, and societal perceptions and responses to environmental changes. Chapters 3 and 4 address human driving forces that have contributed to the environmental changes. Chapter 3 deals with culture and its relationship with the perception of land and land-use practices, providing a broad social background and cultural context in which human driving forces operate and can be interpreted. Chapter 4 investigates the major human driving forces of environmental changes. It seeks to identify proximate human activities that directly caused environmental change, and human driving forces that operate at a deeper level in a society, generate proximate activities, and are more indirect and difficult to identify. Previous studies have pointed out the negative effects of overreclamation, overgrazing, and undue collection of fuelwood and medicinal herbs. This study documents the extent and intensities of these activities, but also examines the processes by which these activities directly induce environmental changes. Underlying human driving forces recognized by the global-change community of scholars and apparent in other regional studies also occur in the Ordos Plateau – an analysis of population increases, attitudes and beliefs, economy, technology, government policy, and resource institutions identifies their particular roles and relations in the region.

Emphasis is given to how they cause and contribute to environmental degradation.

Population growth can exacerbate direct demands on the environment. Both natural increases and migration are analysed in order to investigate how population increases have contributed to environmental degradation. For attitudes and beliefs, previous work has recognized the difficulties in selecting and measuring attributes to generate needed databases. This study explores how Han-Mongolian cultural differences affect environmental transformation. Economic factors include both the restricted economic situation (i.e., poverty) that limits human choices of resource use, and economic mechanisms (such as pricing). Government policy and resource institutions, which appear to be important driving forces in the Ordos Plateau, are also examined in some depth.

Finally, chapter 4 examines the interactions among the complex human driving forces to help understand their relative relationship, different roles, and immediacy to the changes taking place. This is done by employing the methodology of graph theory.

Chapters 5 and 6 investigate how social groups have perceived environmental changes and responded to them. The human perception of the environment and environmental degradation is the base of environmental awareness, and is dealt with in chapter 5. The traditional view of the environment and the ways it has changed over time are explored, and land-use practices are emphasized. Chapter 6 identifies major types of societal responses and their relationships with environmental changes. Societal responses are investigated at various levels: national government, local government, villages, and individuals. Government policies are accorded the predominant attention that they require in the Chinese context, and both their direct and indirect impacts on the environment are analysed through selective documentation and analysis of policies and their implementation. Three kinds of government policy are analysed: political policies (core state policies deciding political directions), socio-economic policies (those dealing with population, economy, technology, education, and so on, which form the context of environmental change), and environmental policies (those dealing directly with environmental protection and improvement). The emphasis is not on policy history *per se* but on the related political and socio-economic changes that policy has brought about, and their positive relationships with the environment. The first two policy types affect the environment

only indirectly, but their roles in resource management and environmental change should not be underestimated. Technical measures of environmental improvement are also investigated in relation to each type of environmental degradation.

Chapter 7 assesses the regional trajectory of environmental change by means of a structured regional assessment, using the concepts of the criticality-sustainability spectrum (Kasperson et al., 1995; Kasperson, Kasperson, and Turner, 1996). Environment-society relationships are emphasized in the assessment. Past trends are examined in three significant time periods, while future possible trajectories are projected based on the new changes in market economy and industrial development. In assessing regional trajectories of environmental changes, challenges in defining and integrating criteria are important concerns. Based on the evaluation, key issues in adjusting the relationship of the society with the environment are examined and pathways towards future sustainability in resource use are discussed.

The last chapter also addresses the following five broader questions posed by the global-change community, which have generated debates and further research. This study seeks to shed some light and perspective on these which may be useful to other researchers.

Environmental change: Natural reasons or human causes?

The sources of environmental change are both natural and human induced, with the latter playing a more and more important role in the process. The study of human driving forces is important, not only to *explain* but, more importantly, to *alert* us to the danger and what we need to do to avert damage. This, however, does not mean that natural features are not important and can be left out in the study. Just the opposite, because they participate in the act of human causes and cannot be separated from them. In studying the mechanism of change, natural factors become even more important in recognizing human contributions. In particular, I wish to explore the contribution of the natural dry-windy environment and its interplay with human activities.

Does culture matter in environmental change?

Culture, if broadly defined, has everything to do with human activities, value systems, and traditions; therefore it is the ultimate explanation of human behaviour and its contributions to environmental

change. In this study, however, culture is narrowly defined as land-use tradition and related values in a society. Using this definition, I attempt to determine whether Han and Mongolian peoples have different views of the environment based on different land-use practices, and how such differences have affected the environment.

The role of population

Population has been considered a key factor in inducing environmental degradation (Arizpe and Velazquez, 1992; Ehrlich and Ehrlich, 1990). Is population the ultimate force of environmental change, or does change work through other factors in a society? Regional contexts such as this case study provide the best conditions for revealing the links of population with other socio-economic and political factors. In addition, is it population numbers or living standards that are more important in affecting the environment, and in what way? In the Ordos Plateau, population has clearly increased a great deal in the past, but its role in environmental change is not as self-explanatory as Malthusians might suggest. The specific mechanisms and chains of causality through which population growth has contributed to environmental change need to be explored.

Economy – how is it related to the environment?

Economic factors are considered crucial in human resource use (Hosier, 1988). Economic capability, affluence, or poverty is considered a key factor in global change (Agarwal and Narain, 1991; Ehrlich and Ehrlich, 1990; Kates and Haarmann, 1992). Whereas it is affluence in the developed world, it is the opposite, poverty, that limits options of resource use and contributes to environmental degradation in the developing world, including the Ordos Plateau. Although it is common to conclude that poverty is the cause of environmental degradation, how is poverty linked with the intricate socio-economic system and how in the end has it negatively affected the environment?

What is the role of policy?

Interpretations attribute most of the causes of land degradation to structural factors such as global capitalism (Blaikie, 1989; Schmink and Wood, 1987) and marginalization of the less powerful (Susman,

O'Keefe, and Wisner, 1983). In a regional context, governmental policy is considered the most influential factor in affecting environmental changes, with or without clear ideological goals of further empowering the already powerful (e.g. Galaty et al., 1981). In other words, policy intervention can play an important role without specific capitalist aims, as is perceived to be the case in China. In the Ordos Plateau, under the Chinese socialist political system, what is the role of government in the environmental change? How has government policy interacted with socio-economic factors and ultimately affected the trend of environmental change?

Answers to the foregoing questions will highlight the key relationships between societal factors, both driving forces and societal responses, and environmental change in the Ordos Plateau. These are also the key areas in which this research seeks to contribute to the study of human dimensions of global (cumulative) change, by either challenging some of the prevailing views on the relationships between societal factors and environmental change, or offering greater empirical support for others.

2

Environmental changes and their societal impacts

The focus of this chapter is on environmental changes and their societal impacts since 1949. First, a review of environmental changes during the geological and historical periods places recent changes in a long-term perspective. Environmental changes since 1949 represent the continuation of earlier changes, but at increasing intensities and rates, over wider areas, and with greater human impacts than before. Though mainly the result of human activities, environmental changes in the Ordos also have natural sources. A discussion of the natural fragility of the land makes for a better understanding of the changes in the Ordos.

The principal environmental changes in the Ordos Plateau are sandification, vegetation degradation, and soil erosion and degeneration. Each will be described in detail, but it must be kept in mind that they are interrelated both phenomenally and causally. The degree and extent to which environmental changes work against a society depend upon social vulnerability: upon the way the society is related to the environment and the society's capacity to resist or counterbalance negative impacts. In the Ordos, environmental changes exert profound effects, among which those on agroeconomy (farming and grazing) and livelihood are the most important.

Environmental changes during the geological and historical periods

Geological and historical time represent different temporal scales and periods. Geological time begins with the origin of the earth, and the resolution of the record is very coarse, usually measured in thousands of years. Here, I deal only with the most recent geological era – the Quaternary. The historical period here refers to the period of human occupation, beginning from 35,000 to 60,000 years ago in the Ordos, especially about 2,150 years ago when a written record of the area appeared (Shi, 1991). Environmental changes in the geological period were caused solely by natural factors, whereas human activities have increasingly affected the environment within the historical period.

Quaternary environmental evolution

The Ordos Plateau is part of the North China Platform. It underwent tremendous changes during geological time, from sea to basin to plateau; from humid to arid; from hot (subtropical) to cool (temperate); and from forested to grass-covered. Before the Quaternary period, except for two major sea invasions, the general trend, if any, was from subtropical humid forest to temperate semi-arid steppe. At the inception of the Quaternary, the region was a quasi plain with forest-steppe vegetation under a semi-arid temperate climate (Li et al., 1990; Shi, 1991).

Dong, Li, and Gao (1983) and Shi (1991) have reconstructed the Quaternary geographical environment of the Ordos using information retrieved from paleodeposits and pollen. There were two major climate patterns: cold-dry and warm-humid, alternating in phase with global glacial movements. In the Pleistocene epoch (2–3 million to 10,000 years B.P.), against the background of terrestrial glaciation and the Himalaya Tectonic Movement, the Ordos rose and the climate became drier and colder, with the occasional return of warm-humid conditions. When the climate was warm and humid, forest and steppe vegetation dominated and sand was stabilized; when it was cold and dry, the steppe changed into drier types, the forest disappeared, and the sand was reactivated. Dominated by the cold-dry climate, the area developed loess and eolian sand deposits in the Middle Pleistocene era. The Late Pleistocene period was extremely cold and arid. Continuous land upheaval shaped the area into a high plateau, much of it covered by moving sand (Shi, 1991).

Beginning 10,000 years B.P. in the Holocene epoch, the climate became warmer and more humid. The Early Holocene (10,000–8,000 years B.P.) witnessed a transition from cold-dry to warm-humid conditions, and moving sand was semi-stabilized. The warm, humid conditions of the Middle Holocene (8,000–3,000 years B.P.) peaked around 6,000–4,000 years B.P., the time of the global ''climatic optimum.'' Steppe and forest-steppe developed, moving sand stabilized, and soil formed. In the Late Holocene (since 3,000 years B.P.), a cold and dry climate returned. The climatic conditions between 3,000 and 1,500 years B.P. were very dry, and moving sand spread south of what later became the Great Wall. Another favourable climatic period extended from 1,500 to 1,100 years B.P., when moving sand shrank and the steppe expanded. Over the last 1,000 years, the climate has slowly become colder and drier.

Environmental changes in the historical period

Studying environmental changes in the historical period is important for understanding how the relationships between environmental changes and human activities have changed. This kind of study generally relies on two sources of information: relic artefacts and written records. In China, information about environmental changes over a long historical period is abundant, although its proper interpretation poses important research questions. The following review of environmental changes draws upon the work of other researchers (Lin, Chen, and Chen, 1983; Shi, 1980; Wang, 1982; Zhu, 1986) who have obtained information on environmental changes from ancient relics of human occupation and from literature describing land, rivers, and environmentally significant human activities.

Much information exists about early sandification. The Mu Us sandy land was recorded as expanding (Wang, 1982; Wang, 1986a, 1986b). Although some researchers believe that the Mu Us sandy land existed earlier (Dong, Li, and Gao, 1983; Zhao, 1981), moving sand was first recorded in the Tang dynasty (618–907 A.D.) (Lin, Chen, and Chen, 1983). In the fifth century, the Xiongnu leader Helianbobo set up the Xia state in the Ordos and built the capital city of Tongwan along the Wu Ding River south of the Ordos in 413 A.D. According to *Tai Ping Yu Lan* (*Peace and Imperial Survey*), Helianbobo once climbed the high terrain north of Tongwan and admired the beautiful land and streams. By the eighth century, the city of Tongwan had been recorded sandified. Today, the city site is surrounded by a belt of

moving sand about 10 km wide. Wang (1982) found that town relics of the Han dynasty (206 B.C.–220 A.D.) are now the furthest into the central moving sand at the north-west of the Mu Us sandy land. Those of the Tang dynasty are away from the centre but still in the moving sand, and relics of the Qing dynasty (1366–1644 A.D.) are only at the edge, indicating a gradual process of sandification. From this, Wang concluded that the Mu Us sandy land has continuously expanded throughout the historical period, destroying the human living environment in the area of these relic towns.

Records also show that the Hobq Desert expanded both eastward in its length and to the south and north in width. Wang (1982) noted a description of a war in the *Wei Shu* (*Wei Book*), in which masses of people from different tribes escaped from today's edge of the Hobq Desert, where residents are now very few. Archaeological discoveries shows that some towns of the Western Han dynasty (206–24 B.C.) are now buried in the Hobq Desert (Shi, 1980). It is reasonable to conclude that these areas were suitable for human occupation at the time and sandified afterwards.

Drawing on the *Shui Jing Zhu* (*Explanation of Rivers*) written by Li Daoyuan in the Northern Wei period (386–534 A.D.) and the *Xin Tang Shu* (*New Tang Book*) from the Tang dynasty, Wang (1982) sketched sandification maps of the Ordos showing an expansion of moving sand between 500 and 900 A.D. Other information on the environmental changes of the area includes the story that the Ordos was once the hunting area for the emperor and had a *xing gong* (royal visiting palace) in the Northern Wei period. Since the imperial hunting areas were usually luxurious and beautiful steppe, this suggests that the general environmental conditions then were much superior to today's.

Vegetation also declined in the historical period. From the *Xin Tang Shu*, archaeological discoveries of ancient tombs, and the remaining pine forest in Argui Temple south-west of Jungar banner, Shi (1980) concludes that from the Warring States period to the early Qing dynasty, forest existed in the north, east, and south of the Ordos. Subsequent wars and land opening in the Qing dynasty were responsible for deforestation.

Physical fragility

How much the land is affected by human interference is closely related to the land's quality. Blaikie and Brookfield (1987) use the

terms *sensitivity* and *resilience* to characterize land quality. Sensitivity ''refers to the degree to which a given land system undergoes changes due to natural forces, following human interference,'' whereas resilience ''concerns the ability of land to reproduce its capacity after interference, and the measure of need for human artifice toward that end'' (p. 10). Land with high sensitivity and low resilience is easily degraded and does not readily recover.

The Ordos Plateau is such a land. Its physical features can be characterized as semi-arid to arid climate, steppe to desert-steppe vegetation, loess to sandy soil texture, and windy to stormy air movement. Here, I emphasize the critical physical factors and relate them to the environmental changes that have occurred. These critical factors intertwine closely with human activities to produce environmental changes. Three major factors contribute to the high sensitivity and low resilience of the Ordos Plateau ecosystem: fluctuating precipitation, high wind velocity, and loose land-surface material.

Situated in inland China, the Ordos lies on the margin of the southeast summer monsoon climate zone. Given the instability of the monsoon climate, precipitation in the Ordos varies greatly both seasonally and annually. About 60 to 80 per cent of the precipitation falls from June to September. From year to year, the total precipitation is a random variable with an average variation of about 30 per cent around the mean. As a result, drought is frequent. According to the Ih-Ju League (1990), spring, summer, and winter seasons can all experience drought, and spring drought is the most frequent: of the sampled springs, 29–55 per cent experienced severe drought and 22–35 per cent intermediate drought. The primary biomass of both grassland and crops fluctuated with precipitation. For example, from the eastern steppe to the western steppe desert, pasture biomass deviates more significantly from the mean (Li et al., 1990). Crop yield in drought years can fall by 45 per cent on average. The overall system fluctuation caused by precipitation variation has a greater impact when combined with human management activities. Rain-abundant years stimulate increased livestock numbers well beyond what a dry year can carry. Overgrazing occurs in average and especially dry years, when grassland and cropland yield is reduced drastically and the ecosystem is more sensitive to disturbances. For example, 2 million livestock died and crop yield dropped tremendously (from 71 kg/*mu* in 1964 to 39 kg/*mu* in 1965) during the 1965 drought (Ih-Ju League, 1990). Reduction in crop production in dry years, to some degree, also stimulated overreclamation of land in response.

High wind velocity, especially in winter and spring, reflects the influence of the winter monsoon when a winter north-west air mass comes from Siberia. The average wind velocity ranges from 2.0 to 4.3 m/s through the year, and the maximum can reach 18–28 m/s. Strong wind (17 m/s or more) occurs on 20–40 days per year on average and on over 100 days in extreme cases. Sandstorms, which blow away the loose surface soil, develop in 15–28 days per year. The windiest days coincide with the dry season, when the cropland is bare and dry, pasture vegetation is sparse, and surface soil is loose, which multiplies the adverse environmental consequences. When affected by over-reclamation and overgrazing, the land is even more exposed to winter wind erosion, and the results can be disastrous.

Land-surface materials are mainly loose loess and sandy deposits formed in the geological period. Loess is known for its low erodibility, owning to its coarseness and vertical jointing. Gullies are dense (9–11 km/km^2) and sloping land is dominant in most of the eastern loess area. Water is the major agent of land transformation in the loess area. Sheet and gully erosion occur under intensive precipitation in the summer months. The high percentage of gully gravity erosion (about 30 to 40 per cent of the total) in the loess area makes erosion control even more difficult (Zhao et al., 1989). Sandy deposits, on the other hand, lacking capillary structure to hold water and moisture, are easily broken loose and eroded by wind. Not only is sandy land very difficult to revegetate once exposed to the wind, but moving sand will cover the adjacent vegetated area on the leeward side and spread the sandification. The combination of environmental factors is such that the eastern loess area has high precipitation intensity during the summer, and the sandy area is extremely windy in the spring, in both cases exacerbating the sensitivity of the land.

Besides drought and sandstorms, other natural forces also contribute to the sensitivity of the Ordos ecosystem. They include dry-hot wind and hails in the growing seasons, and cold and frost hazards at the beginning and end of growing seasons. Though small in scale, they may severely damage grassland and crops. For example, on average, more than 200,000 *mu* of cropland (about 6 per cent of the total cropland) suffers from hail every year.

It is obvious that the physical features in the Ordos make the land highly sensitive to destruction and hamper recovery from degradation. Empirical experience shows, however, that environmental degradation has not precluded successful environmental protection and improvement. The reason for this lies in other more favourable

environmental factors, such as abundant groundwater in the sandy land, and in related social, political, and technical forces that promote environmental improvement. This theme will be discussed in later chapters.

Environmental changes since 1949

In the Ordos Plateau, major environmental deterioration includes sandification, degradation of vegetation, and soil erosion and degeneration. They are closely related, but each has its own characteristics.

The year 1978 marks a turning point in the general trajectory of environmental changes. From 1949 to 1978, environmental degradation was the dominant trend, followed after 1978 by slowed degradation and some improvement. In this section, I first discuss environmental changes between 1949 and 1978. Owing to shortage of systematic data, changes after 1978 receive a less detailed discussion.

Environmental changes between 1949 and 1978

Sandification

Sandification is a process by which utilizable land is converted into, or covered by, sand. The process may involve both sand erosion (mainly by wind) and accumulation. Indicators of sandification are soil coarsening, sand cover enlargement, and a decline in productivity. The classification of the Lanzhou Desert Institute, Chinese Academy of Sciences (Huang and Song, 1981; 1986), recognizes three grades according to the percentage of moving and fixed sandy land, vegetation cover, and soil nutrients. Severely sandified land displays moving and exposed sand over at least 90 per cent of its area, with less than 10 per cent of annual plant coverage and little soil organic matter and clay. Moderately sandified land is covered mostly by semi-fixed and moving sand, of which moving sand accounts for 30–50 per cent; the sand accumulation or erosion depth is about 20 cm, vegetation cover is 20–30 per cent, and the loss of soil organic content and clay is over 50 per cent. Light sandification is indicated by a combination of fixed, semi-fixed, and moving sand, with moving sand occupying 10–20 per cent of the area; sand erosion or accumulation is less than 10 cm, and the loss of organic content and clay is less than 30 per cent. These are the criteria by which sandification is discussed here.

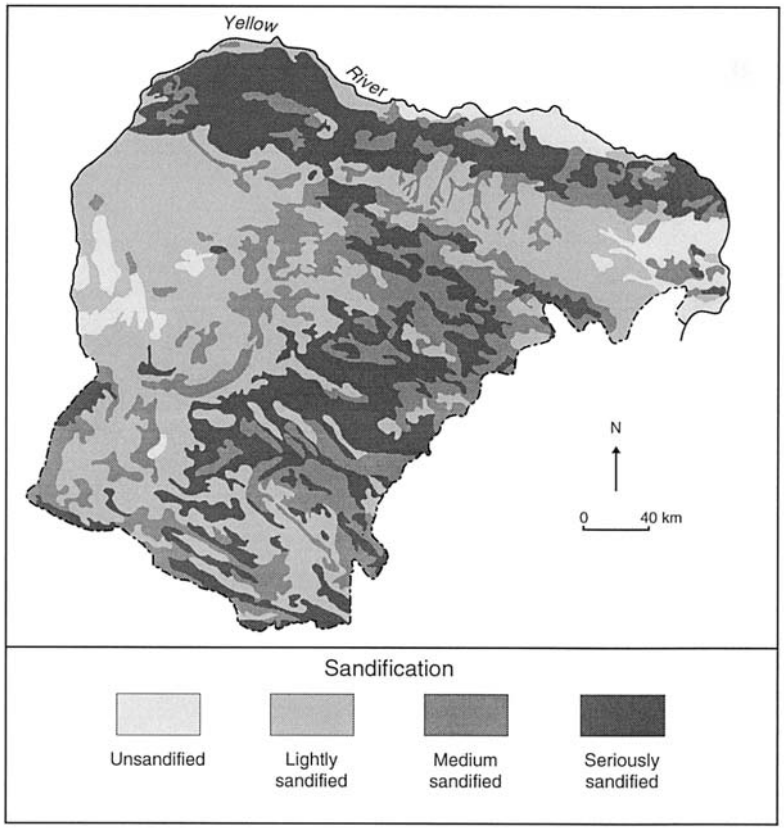


Figure 2.1 **Sandification in the Ordos Plateau**
Source: Adapted from Ih-Ju League (1988).

SPATIAL DIFFERENTIATION OF SANDIFICATION. Most of the Ordos Plateau suffers from sandification (fig. 2.1). The total sandified area in the Ordos is 62,545 km^2, 71.5 per cent of the total land area. Serious, moderate, and light sandification accounts for 20,725, 10,490 and 20,928 km^2, respectively (Ih-Ju League, 1990). Seriously sandified areas occur mainly in the Hobq Desert (especially its western section in Hanggin banner) and the northern part of the Mu Us sandy land (north of Uxin, north-eastern Otog Front, and south-eastern Otog banners). In Uxin-Ju, Gelute, and Ulan-taolegai *sumus* of Uxin banner, for example, as much as 50 per cent of the land is seriously sandified. In the joint area of Hanggin, Otog, and Ejin Horo banners where reclamation expanded before the 1970s, seriously sandified land also represents a large percentage of the total. Moderate sandi-

fication exists mainly adjacent to or mingled with the seriously sandified areas in south-east Hanggin, east Otog, the whole Ejin Horo, east Otog Front, and south Uxin banners. Other parts of the Ordos Plateau, having little sandy material, weaker wind, or less human pressure, are mostly lightly sandified or unsandified. In south Dalad, Dongsheng, and Jungar, water is a far more powerful agent of transformation than wind, and therefore sandification is light.

The microgeography of sandification is determined by past and present land-use practices. Around livestock shelters and drinking-water sites, overuse of pasture almost always induces sandification. A roughly concentric pattern is formed: sandification is severe close to these places, and it is medium, light, and absent at growing distances. Reclamation in the middle and west Ih-Ju League caused sandification on and around the fields. Severe and frequent disturbances surrounding human settlements caused more serious sandification. This tendency, however, has weakened in recent years owing to strong efforts towards environmental improvement of the seriously disturbed areas.

TREND OF SANDIFICATION. Because uncertainties in physical measurement and human judgement make the classification of sandification somewhat subjective, data from different sources about sandified areas are not consistent. They all show, however, that sandification increased from 1949 to the end of the 1970s. According to aerial photo interpretation by the Lanzhou Desert Institute (Yang, Di, and Huang, 1991), the area covered by moving sand in the Ih-Ju League increased from 16,446.5 km^2 in 1957 to 27,660 km^2 in 1977, the annual increment being 561 km^2. The originally separate Hobq Desert and Mu Us sandy land had joined at Uxin, Hanggin, and the Ejin Horo bordering area in the late 1970s. In 1957 the Hobq Desert was 10–40 km wide, with an area of 16,200 km^2, whereas by 1977 it had increased to 30–65 km in width and 16,757 km^2 in area (Ih-Ju League, 1990). Over the same 20 years, the Mu Us sandy land expanded south-eastward by 3–10 km, 20 km at the utmost. Sand dunes grew and the inter-dune lowland shrank. According to statistics from Zhang (1980), the total sandified area in the Ordos was 10,000–12,900 km^2 in 1949 and had increased to 33,667–35,000 km^2 by 1974, growing by 850–906 km^2 a year.

The rate of sandification (represented by the percentage of net increased sandified area per year over the total land area) has varied over time. From the late 1950s to the 1970s, it was generally rapid.

Following a drought year (such as 1960, 1962, 1965, or 1972), sandification expanded more rapidly than usual on both pasture and farmland. Accelerated sandification also followed overgrazing and unsuitable reclamation. In south-eastern Hanggin, western Ejin Horo, and north-eastern Otog, sandification intensified after the periods of overreclamation in 1957, 1959–1961, and 1970–1972. Some western areas with less than 250 mm of annual precipitation, such as Gongqirige *sumu* and Shanghaimiao *sumu*, were quickly sandified after reclamation in 1970–1972.

The rate of sandification also varied across space. The overall rate of sandification for the Ordos was about 1 per cent from 1957 to 1977, and that of serious sandification was 0.65 per cent. The rate was higher on the southern edge of the Hobq Desert and northern part of the Mu Us sandy land. In Sishililiang township south-east of Hanggin banner, for example, moving sand increased at the rate of 1.2–2 per cent, and Ejin Horo banner had a high sandification rate of 1.67 per cent. Certain places south of Otog Front banner also experienced rapid sandification owing to excessive reclamation and collection of medicinal herbs. For instance, moving sand in Zhuhe township grew by 1.3 per cent per year from 1957 to 1977. A moderate increase in the rate of sandification occurred in the areas around the central continuous moving sand (which existed before 1949) in the Hobq Desert and the Mu Us sandy land, as well as in areas in middle Otog, middle Otog Front, western Dongsheng, and eastern Ejin Horo banners. In the rest of the Ordos Plateau (the eastern hills, western high plateau, and the centres of desert and sandy land), the sandification rate was low.

Vegetation degradation

Vegetation changes before 1978 were characterized by degradation of pasture. The indicators were decline in coverage, height, biomass, and biodiversity, and a decrease in high-quality plants and an increase in poor-quality species. According to Li and colleagues (1990), degraded pasture represented 41,389.8 km^2, 66.8 per cent of the total usable pasture area in 1986, and of this 32,321.5 km^2 was seriously degraded. Ih-Ju League Agricultural Regionalization (1990) shows that pasture had mostly low productivity; 60 per cent was of the sixth grade (with 1,500–3,000 kg/ha of green biomass) and 32.4 per cent of the seventh grade (with less than 1,500 kg/ha of green biomass). Most (79 per cent by area) was of medium to low quality, containing 30–60 per cent of less palatable species and 10–20 per cent of infe-

rior species by weight. It contrasts sharply with the original non-degraded pasture.

Most pasture was degraded after 1949, especially from the 1960s to the end of the 1970s. From 1966 to 1979, pasture biomass in the Ordos declined by 26 per cent, and pasture area shrank by 17 per cent. Zhang (1980) estimated that in the early 1970s, moving sand buried 2,000 km^2 of pasture every year. In 1949, the total area of *Salix* shrub on sandy land was 3,330 km^2; by 1989, it had fallen to 520 km^2, and the inferior species *Sophora peauroides*, *Aneurolepidium dasystachys*, and *Penisetum flaccidum* had taken its place.

Examples of pasture degradation are found all over the Ordos. In the Taoli valley meadow in the Mu Us sandy land, for instance, according to a sampling comparison of 1975 and 1979, *Achnatherum splendens* was degraded, indicated by a decrease in density from 17 to 3.4 numbers/m^2 and in biomass from 145 to 48 g/m^2. Meanwhile, the annual salt-tolerant *Suaeda comiculata* and *Glaux maritima* increased (Zhang, 1980). On sand dunes and the sand-covered western high plateau, when *Artemisia ordosica* was degraded, *Psammochloa villosa*, *Artemisia frigida*, and *Artemisia scoparia* became the dominant species. Seriously degraded land covered by sparse (less than 10 per cent) *Agriophyllum squarrosum*, an annual plant, was even ungrazable. In the eastern section of the Hobq Desert, degradation along the river valleys was serious. In the Hantai valley of Dalad banner, the *Caragana leucophloea* oasis teemed with wildlife in the 1950s, including Mongolian gazelle, fox, rabbit, and various migrating birds. Human impact left it bare, with only scattered patches of *Caragana leucophloea* plants in the early 1980s, and most of the wildlife disappeared.

Spatial differences in pasture degradation are apparent. Typical steppe vegetation became seriously degraded. The original steppe was dominated by *Stipa bungeana* and had a dry biomass of more than 1,300 kg/ha. Most areas are now dominated by *Thymus mongolicus* and *Artemisia frigida*, and biomass has been reduced to 700–800 kg/ha.

Also apparent is the degradation of sandy steppe and meadows in the Mu Us sandy land and the eastern part of the Hobq Desert. In the Mu Us sandy land, pasture biomass was estimated to have decreased by 30–40 per cent from 1949 to the end of the 1970s (Cao, 1988; Zhu and Liu, 1986). Compared with sandy steppe, valley meadow has been more degraded by overuse. Shepherds remember that the *Achnatherum splendens* meadow was high and dense enough to hide cattle and

Table 2.1 **Degradation of desert steppe pasture**

Status	Major species	Coverage (%)	Number of species per 25 m^2	Green biomass (g/m^2)
Undegraded	*Stipa breviflora, Caragana stenophylla, Artemisia frigida*	46	21	108
Moderately degraded	*Artemisia scoparia, Cleistogenes songorica, Caragana stenophylla*	50	28	91
Seriously degraded	*Artemisia scoparia, Peganum, Carex duriuscula*	30	6	72.5

Source: Adapted from Zhang and Wang (1986).

horses before the 1960s, but by the end of the 1970s it had become so short and sparse that even a running rabbit was visible. Less palatable and even poisonous species, such as *Potentilla anserina* and *Oxytropis glabra var. tennis*, were increasingly prominent in the vegetation formation.

Most of the desert steppe in the west is degraded moderately or lightly. As degradation increased, high-quality species disappeared, while biennial, inferior, and even poisonous species took their place (table 2.1).

Soil erosion

Water and wind are the two principal agents of soil erosion. Water erosion occurs mainly in the eastern river catchment. Most other parts of the Ordos are affected by wind erosion. The transitional area in between is affected by both water and wind.

The degree and extent of wind erosion are obviously relevant to sandification. Severe wind erosion occurs on the cropfields of the unprotected western plateau, where erosion depth can reach 5–7 cm per year. Sand dunes march 3–10 m along the wind direction every year. Vast areas of sandy land, desert, and western high and dry plateau suffer from serious wind erosion.

Water erosion dominates the eastern area. According to Li and colleagues (1990), the water-eroded area covers 15,131 km^2, 17.7 per cent of the Ordos, with light, moderate, and serious erosion areas accounting for 5,502, 5,133, and 4,496 km^2 respectively. Here, light, moderate, and serious erosion is defined by the amount of erosion

per year (<2,500, 2,500–8,000, and >8,000 t/km^2, respectively). Western and south-western Jungar banner is severely eroded, with erosion amount ranging between 15,000 and 20,000 t/km^2 per year. Above the Tertiary silt, sand, and shale rock only a 20–30 cm loess layer remains on average. In many places, loess has been totally eroded, with bedrock exposed and the land unusable. Erosion is serious east of Jungar and west of Dongsheng (about 8,000–15,000 t/km^2 per year) and the soil layer is about 50 cm deep. The areas south of Dalad and east of Dongsheng show moderate water erosion, amounting to 5,000–8,000 t/km^2 per year; but wind erosion becomes apparent. The south-eastern Hobq Desert is a typical wind-water eroded area, where water erosion is light and wind erosion plays a more important role. Along the Yellow River is a lightly eroded plain, with erosion amounting to less than 2,500 t/km^2 per year.

The total area of erosion has increased since 1949. Data from the Water Conservation Centre of the Ih-Ju League show that it grew from 31,505 km^2 in 1949 to 47,299 km^2 in 1983, and the rate of erosion accelerated between 1958 and 1978. In the Jungar, Dalad, Ejin Horo, and Otog banners, soil erosion was rapid. In Jungar banner, for example, the eroded area increased from 774 km^2 in 1949 to 7,114 km^2 (94.4 per cent of the total area) in 1983. Gully area increased from 20 per cent in 1955 to 32.5 per cent in 1979 and 34.8 per cent in 1985. Dalad had an eroded area increasing from 45 per cent in 1949 to 76.4 per cent in 1983. Otog and Otog Front banners experienced an increase of eroded land from 4,500 km^2 in 1949 to 13,245 km^2 in 1983.

Soil degradation

Soil degradation in this context refers to a decline in soil quality as a result of soil erosion and sandification. According to one study (Huang and Song, 1986), the organic content of dry cropland decreased by 20–30 per cent (from 0.5–0.9 per cent to 0.4–0.6 per cent), and total nitrogen by 25–46 per cent (from 0.04–0.13 per cent to 0.03–0.07 per cent), from the 1960s to the early 1980s. In the cropfields of wind erosion areas, the stripping of topsoil at an average rate of 5–7 cm per year accounts for an average loss of 518 kg of organic material, 26 kg of nitrogen, 36.6 kg of phosphorus, and 2,600 kg of clay (<0.1 mm) per *mu*.

Erosion has caused serious loss of both surface soil and soil nutrients. Take wind erosion, for example. The strong wind of 18–19

Table 2.2 **Soil nutrition under erosion and sandification (0–20 cm topsoil)**

Type	Degree	Organic (%)	Total nitrogen (%)	Available phosphorus (ppm)	Available potassium (ppm)
Uneroded	none	0.87	0.05	5.62	177.24
Water eroded	light	0.5468	0.0394	1	68
	medium	0.4629	0.0308	3	66
Wind eroded	light	1.1915	0.0689	5	36
	medium	0.9677	0.0508	4	30
Sandified	light	0.7195	0.0474	1	36
	medium	0.5736	0.0404	1.5	35
	serious	0.4911	0.0248	2	58
	severe	0.3154	0.0240	1	24

Source: Adapted from Ih-Ju League (1989).

April 1980 eroded 50 cm of surface soil in sandy cropfields around Bainijing and Hangjinghao in Dalad banner. The water erosion area loses an average of 1–4 cm per year from cropfields. Even under vegetation protection, the formation of topsoil requires hundreds of years; soil depletion in the Ordos is proceeding far more rapidly. In fact, strictly defined, cultivation is now based on the mineral soil matrix instead of soil nutrients. The most critical situation is reached when even the loose soil matrix has been eroded, leaving only hard rock exposed, as is the case in many parts of western Jungar.

The decline of fertility in pasture soils is closely associated with soil erosion, sandification, and vegetation degradation (table 2.2), which reduce soil nutrients and coarsen soil texture.

Soil salinization and alkalization on the Yellow River Elbow Plain should also be mentioned. Modern cultivation of the plain began in the 1910s. In the 1950s and 1960s, irrigation systems were built and farming expanded quickly. The use of flood irrigation without drainage, however, raised the groundwater level and resulted in salinization and alkalization of the cropland. In the 1970s, countermeasures including strengthening of the irrigation and drainage systems, use of wells in irrigation (called groundwater irrigation) and drainage, and control of salt by fishponds, salt washing, and land levelling mitigated the problem. A soil survey in the early 1980s showed that the salinized and alkalinized area had declined from 39.3 per cent in 1962 to 37.2 per cent. The 1980s witnessed further improvement (Ih-Ju League, 1989).

Environmental changes after 1978

Since 1978, environmental protection efforts have slowed, stopped, or reversed degradation. The levelling-off of environmental degradation has not occurred uniformly over space; some locales experience continuing degradation whereas others undergo improvement. On the whole, environmental degradation in the Ordos has largely halted, and improvements in certain locales are very significant. Detailed examples of the spatially varied efforts and results of environmental improvement appear in chapter 6; this section will show only some general trends of change in each aspect of the environment. Data are rather sketchy owing to a lack of continuous research and monitoring, but they are enough to suggest an overall trend. Other studies of different places in China also reveal the same trend of environmental change over the same period (see Ross, 1987; Smil, 1992a).

A decline in sandification is clear. According to Li et al. (1990), from the 1970s to 1984 the sandified area remained about the same. Other research (e.g. Yang, Di, and Huang, 1991) suggests that sandification continued in the early 1970s but halted and reversed after 1978. Yang, Di, and Huang (1991) concluded that, from 1981 to 1986, both moving sand (seriously sandified area) and total sandified area decreased in the Ih-Ju League, from 27,660 to 22,374 km^2, and from 75,926 to 72,812 km^2, respectively. Net change is the sum of two coexisting processes: continuous sandification on the one hand, and environmental control and improvement on the other. For example, in the previously sandified Uxin banner, improvement of sandified areas has balanced the continued sandification of 1,700 km^2 per year (interview with Uxin Forestry Department, 1992). Where improved and recovered areas exceed the newly sandified areas, sandification is reversed. In Ejin Horo, the sandy land improvement experimentation area witnessed positive changes. Sandstorms were reduced by 66 per cent between 1976 and 1984, and the sandified area decreased from approximately 2,000 km^2 in 1973 to 470 km^2 in 1984.

Rigorous efforts in pasture protection and improvement after 1978 have slowed pasture degradation. Sampling by the Animal Husbandry Department of the Ih-Ju League (unpublished report) shows that biomass decline was halted between 1985 and 1989. Pasture quality and biomass on enclosed and planted steppe and desert steppe have increased significantly. The same source also indicates that with the project endeavour of revegetation for hazard resistance in Otog, Otog Front, and Uxin banners, pasture biomass has

Table 2.3 **Soil erosion changes in the Huang-puchuan watershed (t/km^2 per year)**

Item\time	1960–1964	1965–1969	1970–1974	1975–1979	1980–1984	1985–1989
Measured total	13,492	18,044	18,080	20,950	12,791	13,895
Natural erosion	9,546	8,665	10,429	10,194	7,103	7,512
(%)	70	48	58	49	56	54
Human induced	4,225	9,902	7,652	11,037	5,836	7,724
(%)	30	52	42	51	44	46

Source: Adapted from Zhao et al. (1989).

increased from 20–30 to 50–75 kg/*mu* (dry weight) and vegetation coverage from 30 to 40 per cent.

Effective measures have been taken since 1978 to combat soil erosion. As a result, in the early 1980s newly eroded area totalled 1,366 km^2 per year, while over the same period 920 km^2 of already eroded land was restored, so the net increase of erosion was only 446 km^2/year (Ih-Ju League, 1990). The late 1980s witnessed more significant erosion control and improvement efforts. According to Zhao and colleagues (1989), soil erosion in the Huang-puchuan watershed was alleviated after 1980 (table 2.3). Total erosion was highest during the 1970s and declined afterwards. They also used a soil erosion function to calculate natural erosion (using natural vegetation coverage, topographic roughness, slope, base rock, soil type, and precipitation characteristics at different locations), and subtracted it from the total measured erosion to identify human-induced erosion, whose trend confirms that of the overall soil erosion.

Because soil-column building is so slow compared with other environmental changes, the restoration of soil fertility also proceeds slowly. Soil erosion control shows results only years later. Although other environmental problems have been mitigated since 1978, soil depletion remains serious.

Environmental changes in perspective

The changing environmental factors discussed above are closely related to one another and to some other factors not yet discussed. For example, air dust and sandstorms accompany wind erosion and sandification. Changes in land surface albedo caused by sandification and soil exposure may exacerbate drought. These changes combine and interact to degrade the whole ecosystem. Positive feedbacks among

these factors have formed a vicious cycle, making restoration and improvement of the ecosystem more difficult. Net ecosystem deterioration can be gauged by declines in productivity and carrying capacity.

Vegetation plays a particularly important role in such deterioration. It is not only the major victim of human disturbances, but also a chief medium for environmental improvement. Sandification begins when vegetation is disturbed. Experiments show that sand dunes covered by *Artemisia ordosica* and *Salix psammophila* are about 30 times rougher than exposed sand and can reduce wind speed at the land surface (0–20 cm high) by 26 per cent. When the vegetation cover reaches 15–25 per cent, the amount of transported sand is reduced to 22–31 per cent; when vegetation cover is 40–50 per cent, the amount will be reduced to only 1 per cent (Yang, Di, and Huang, 1991). Vegetation cover has equally significant effects on soil erosion. Controlling environmental deterioration relies principally on protection and reconstruction of vegetation.

The good news is that the environmental deterioration in the Ordos has not precluded the possibility of recovery. In other words, the deterioration is reversible, either by natural regeneration after a halt to exploitation or by deliberate human reconstruction of the vegetation. Annual precipitation of 160–400 mm provides necessary conditions for vegetation regeneration or reconstruction. If the land has not been severely degraded, natural restoration takes about five to seven years in the Mu Us sandy land and eight to 10 years in the western high plateau (Zhu and Liu, 1986). It is obviously true that destruction is easy and recovery difficult, and rapid recovery requires concerted human effort in planting and reconstruction. Generally, however, environmental restoration is technologically feasible, given favourable socio-economic and political conditions.

As for the underlying reasons for environmental changes in the Ordos, competing opinions exist. Using a geological time-scale, one view emphasizes a natural trend of desiccation. Disputes on the causes of environmental changes over historical time are apparent. In his paper on the formation of the Mu Us sandy land, Zhao (1981) argues that natural conditions have played a dominant role and that human activities have only had slight impacts. Similarly, Dong, Li, and Gao (1983) believe that human activities are less important than natural causes. Zhu (1986) and Shi (1980), on the other hand, accord human factors a much heavier weight. Yang, Di, and Huang (1991) contend that human activities are the principal cause of environmental degradation. They have even calculated that the human share of

responsibility for sandification change since the 1960s is 87 per cent. In general, it is widely accepted that, against a background of climatic aridity through historical time, human activities have either accelerated or slowed (or both) natural environmental changes more and more significantly. The time-scale of this study is too short to identify any clear trend of natural changes in the Ordos ecosystem, while the intensity of human activities increases with increased environmental degradation. It is both statistically apparent and qualitatively justifiable (see chapter 4) to conclude that human activities play the predominant role in contemporary environmental changes. This is not to deny the role of natural forces, as no cut-and-dried boundary separates the interwoven factors of natural background and human causes.

It is important to point out that natural and human forces always act in combination to produce environmental changes. The global environmental change literature focuses on environmental changes that are ''human in origin'' (Stern, Young, and Druckman, 1992; Turner et al., 1990a); this is true in terms of initiating forces. In terms of processes, however, it is necessary to link natural factors with human activities. Environmental degradation in the Ordos can be better understood by considering both factors. Under the harsh natural conditions analysed earlier in the section on physical fragility, human activities easily set degradation processes in motion; at the same time, human-damaged natural conditions further accelerate degradation and frustrate efforts for environmental improvement.

Societal vulnerability

In hazard studies, the concept of vulnerability includes two major components: exposure and coping ability (Dow, 1992; Green, 1990). Societal vulnerability to environmental changes refers to the susceptibility of a society to environmental degradation and the ability to absorb and divert negative impacts in order to maintain societal stability and development. It can be understood as the sensitivity and resilience of a society to its environment, analogous to an ecosystem's sensitivity and resilience to outside forces.

The multiple factors contributing to vulnerability in the Ordos include government policy, resource-use institutions, human perception, technology, and economics, most of which are discussed in chapter 4. Indicators of vulnerability in the Ordos Plateau include two categories: high dependence on the environment due to land use

Table 2.4 **Land-use structure of Ih-Ju League (1985)**

Land-use type	% in area	Land-use type	% in area
Cropland	4.16	Garden	0.02
Woodland	8.15	Pasture	63.62
Settlement	0.3	Industry	0.16
Transportation	0.11	Water	1.63
Special land use	0.01	Unusable	21.84

Source: Adapted from Ih-Ju League (1990).

and economic activities, and low coping capability owing to low mobility of people, lack of economic options, narrow buffer zones in ecosystem management, and poverty.

Land use

The Ordos Plateau is an agricultural area, and its socio-economic system relies mainly on its ecological resources. In this study, the definition ''agriculture'' includes both farming and grazing. Forestry is also included in the statistics. Land-use structure (table 2.4) shows a dominance of agricultural use in 1985. For example, about 76 per cent of the total area, 97 per cent of the total utilized area, was agriculture (including cropland, woodland, and pasture) and managed by farmers and shepherds (82.7 per cent of the total population). The linkage with urban areas is relatively loose.

Spatial differentiation of agriculture is demonstrated by fig. 2.2. Farming occupies the Yellow River alluvial plain in the north, the eastern loess hills area, and southern river valleys in Uxin banner. Most of the western and south-western parts are pastoral areas. Between the two is a farming-grazing transitional area.

In the farming area, rain-fed dryland farming is predominant, with staple crops and oil plants as the main crops. Data for 1986 indicate that of the total cropland area, broomcorn millet accounted for 30.22 per cent, oil plants (sunflower and castor) 15.38 per cent, wheat 8.85 per cent, corn 7.63 per cent, and millet 5.38 per cent. Millet is the main staple food of the Ordos Plateau, but wheat is increasing in importance. In pastoral areas, the main livestock are sheep and goats, accounting for 92.98 per cent of the total number in 1986. Pigs are important livestock in farming areas and account for 6.32 per cent of the total livestock.

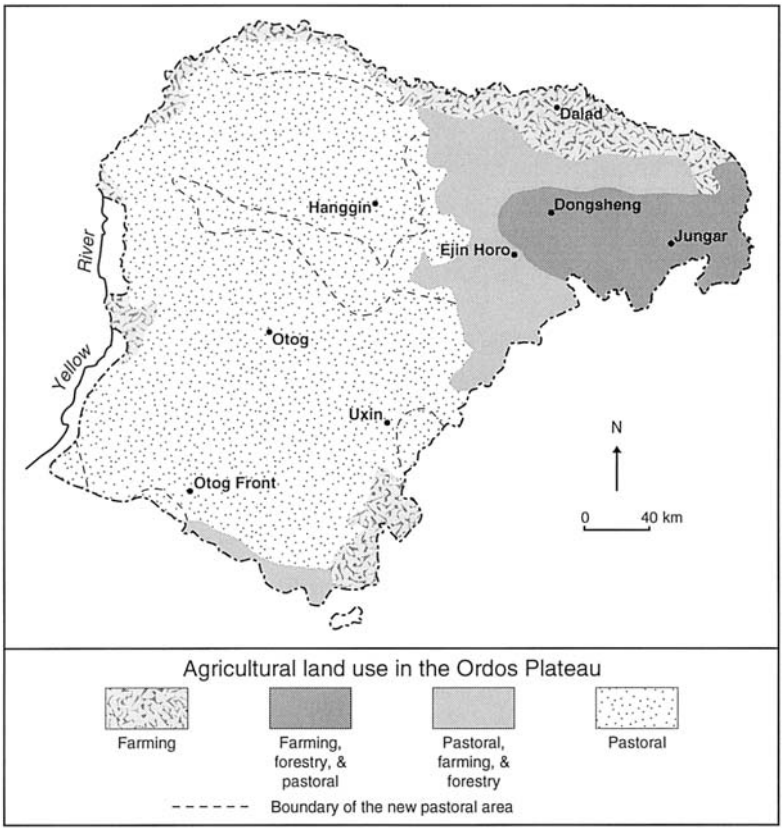


Figure 2.2 **Agricultural land use in the Ordos Plateau**
Sources: Adapted from Ih-Ju League (1988, 1990).

Agricultural productivity is low. In 1989, grain yield was only 129 kg/*mu*, and the oil crop 68 kg/*mu*. Pasture is composed of mainly degraded natural grassland with low (dry) biomass (69 kg/*mu* in 1989); livestock death rate is high (3–15 per cent in the 1980s). On average, 0.87 ha pasture raised one sheep unit (unit of measurement for different types of livestock; for example, one sheep represents one sheep unit, one goat represents one sheep unit, and one cow represents five sheep units), which already represents overgrazing. Offtake ratio of livestock is low: 29 per cent in 1989. Agriculture depends mainly on naturally accumulated soil fertility and vegetation resources, and changes significantly with the fluctuations of the climate. In terms of gross production in the area, across all sectors, agriculture accounted for only 43.4 per cent in 1989, of which farming repre-

sented 37.8 per cent, animal husbandry 45.7 per cent, and forestry and other sidelines 16.5 per cent. This contrasts sharply with the high percentage of agricultural land use.

Given this land-use system, the predominantly agricultural society on the Ordos Plateau relies heavily on its environment. Environmental deterioration directly degrades the systems supporting human life.

Coping capability

In the past, high dependence on the environment did not necessarily mean high vulnerability, so long as people had other undegraded land to which they could move. Nowadays, however, increased population and the extensive human interference with ecosystems make such movement impossible. There was little movement of people to other areas or to other resource-use systems (non-renewable, for example). In general, the low level of migration cannot be regarded as negative, although it contributes to vulnerability in the Ordos. On the scale of China as a whole, it is actually a stabilizing element. The difficulty of alleviating dependence on renewable resources is due to economic restrictions, together with technical and political limitations.

The dearth of effective coping strategies in the economic system is another reason for high vulnerability. The ecosystem in the Ordos Plateau fluctuates, but its management, the human-use system, tends to disregard this natural tendency and seek linear growth. The different ideological ends of the two systems make environmental management a difficult but important task. Effective environmental management seeks a balance between the fluctuation in the natural system and stability in the social system. For instance, in animal husbandry the livestock numbers can be balanced according to available forages and grasses every year and season, whereas human livelihood can be regulated through compensation between the fluctuated years or other resources. An appropriate buffer zone can ward off direct confrontation between the two systems and provide both with better protection.

The human managers and their institutions, however, are constrained by their desires, understanding, power (ability), and social and political structures. Human ideology is always imposed on to the ecosystem, and the Ordos is no exception. The lack of a buffer between the natural and human systems has been apparent. By buffer zone, I refer to a margin of error available in the system and the

existence of effective protective measures. It can be measured in the Ordos partly by the ability of the human system to resist hazards and the untoward impacts of natural fluctuations. The lack of economic resources and entitlement narrows further the already narrow buffer between the environmental and economic systems. As a result, the economy fluctuates greatly with natural fluctuation of climate and impact of natural hazards, as does well-being. In years of extreme natural events, because of the lack of protective measures and capability, the productivity of both cropping and livestock is reduced significantly. For example, in 1965, owing to severe drought, crop yield per *mu* fell to 39.4 *jin* and the livestock death rate in the following year reached 22.46 per cent. Economic surpluses in abundant years are not sufficient to maintain well-being during the hazardous years. Undue slopeland rain-fed farming and natural pasture grazing have contributed to this vulnerability, especially before 1978 when the limited area of highly productive cropland and man-made pasture afforded little buffering. There is much in the structure of economy, society, and culture to explain the rationale of the management (e.g. Johnson, 1993), but nature has a large potential to ''bite back'' when poor decisions are made.

Many authors have noted an association between poverty and vulnerability, although the causal relations are contentious (e.g. Kates and Haarmann, 1992; Leonard, 1989). Poverty in the Ordos reinforces both a high dependence on the environment and poor environmental management. Poverty often precludes the possibility of further development that might reduce pressure on the environment. Poverty provides few choices and alternatives and therefore limits resource-use options and systems. One example is biomass burning. The Ordos has abundant coal resources, and local mining produces a certain amount of coal. But because of the poor transportation facilities and a shortage of purchasing power, most farmers and shepherds lack access to the coal. Poverty-environment linkages are discussed further in chapter 4.

Societal effects of environmental changes

It is difficult to attribute social trends and patterns solely to environmental changes, positive or negative, because each is affected by many closely interacting environmental, social, and political factors. Statistical relationships may be explained (e.g. Rudel, 1989), but they can only show associations instead of causes. It is often difficult to

determine whether certain societal symptoms are causes or consequences of environmental changes, and, in fact, they can be either or both in many situations. This section seeks to identify the links between environment and society, and to draw conclusions about environmental impact from the empirical records and an understanding of the mechanisms and relationships within the systems. The basic argument is that because the Ordos is heavily dependent upon its ecosystem, environmental degradation profoundly affects every aspect of human life, from livelihood to economic activities, and from wealth to spirit.

Impacts on the agricultural economy

The environmental changes inflict serious harm on farming. According to Li et al. (1990), declines in cropland fertility significantly affect agricultural productivity (the correlation coefficient is 0.89). From 1949 to the early 1970s, yield averaged 40–70 kg/*mu*, but some slopeland and sandified fields only yielded 5–10 kg/*mu*. According to Zhao and colleagues (1989), continuing soil erosion reduces crop yield on slopeland by 9.9 per cent per year after reclamation. On average, slopeland yield is only 57 per cent that of the protected or gentle slopeland. In west Jungar, soil has become so thin as to expose bedrock, and cultivation is not possible in many areas. As a result, some farmers (such as in Deshenxi township) seek to migrate to other places in search of better land or other economic opportunities. Wind erosion and sandification impede crop production by eroding topsoil, manure, seeds, and even seedlings. As a result, an average of 2.25 million *mu* of cropland has to be resown three to five times per year (Ih-Ju League, 1988). Destruction of seedlings causes significant decline in yields; it is estimated that about one-third of cropland suffers from such damage every year (Huang and Song, 1986).

Since the mid-1970s crop yield has increased, but overall productivity has remained low. Gains from the slow infusion of technology and human interventions have largely been counterbalanced by the negative effect of environmental deterioration, and farming development has been greatly hindered.

The degradation and shrinkage of pastureland directly affect livestock grazing. A decline of 26 per cent in biomass and 17 per cent in pasture area between 1966 and 1979 restricted the number of livestock and the pasture area per animal. The livestock numbers, clearly increasing until 1963, have fluctuated with climate and socio-

economic factors ever since. Per-capita livestock holdings have decreased. Meanwhile, pasture area per animal has fallen sharply, from 3.6 ha in 1949 to 1.1 ha in 1985, with one-third less biomass. Not only is forage insufficient in cold seasons (winter and spring), but even the warm period (summer and autumn) witnesses overgrazing. As a result, average livestock weight has decreased and livestock production has also dropped. For instance, the average one-year-old sheep in the early 1980s weighed only 72 per cent that of a similar animal in the 1950s (Zhu and Liu, 1986). In Zhuhe township of Otog Front banner, the average weight of sheep declined by 40 per cent from the 1960s to the 1970s. Before private-user rights of pasture were established in 1980, shepherds with degraded pasture had to shift to grazing tens or even hundreds of kilometres away, causing not only a waste of livestock energy but also pasture degradation.

The effects of environmental deterioration on the regional economy are apparent in the near-stagnation of GNP per capita, gross social agricultural production (GSAP), and agricultural national income (ANI) for the agricultural population (table 2.5). These economic indicators fluctuated without a clear upward trend of increase until the 1980s. The economic gains of the 1980s, largely attributable to socio-economic transformation, also reflect recent environmental improvement.

Impact of extreme events on daily life

Besides its indirect impact on human well-being through the economy, environmental deterioration affects human life directly. Sandification and erosion have damaged human health and private and public properties and have impaired daily life. Several examples are relevant.

- The Huqutu Reservoir is a medium-sized (over 15 million m^3) reservoir in Jungar banner. The project started in 1975, when the maximum depth of water was 25 m. Siltation caused by serious soil erosion in the catchment resulted in a depth of less than 4 m in 1977 and about 1 m in July 1980. Before a conveyance irrigation system was completed, the reservoir had been silted up, at the cost of about 400,000 yuan in national investment (Shen, 1981).
- The Xiliu stream is a short tributary rising in south Dalad and running northward to empty into the Yellow River. Cars can ordinarily pass across the stream bed. The sparsely vegetated catchment area is seriously eroded. In 1961, over 200 mm of rain fell

Table 2.5 **The agricultural economy under environmental degradation**

Year	Cropland		Livestock number		Economic measures (using 1980 prices)		
	Acreage (million ha)	Yield (kg/ha)	Total number (millions)	Per agricultural capita	GNP per capita	GSAP per agricultural capita	ANI per capita
1950	64.7	107	184.4	4.6	248	310	196
1955	55.0	412	323.9	6.5	303	326	204
1960	66.8	345	440.4	7.2	372	339	222
1965	49.7	300	494.5	7.3	233	273	178
1970	46.0	592	496.4	6.4	289	325	213
1975	32.4	802	465.5	5.4	327	297	194
1980	24.4	960	470.8	5.1	332	284	175
1985	21.7	1,530	469.8	4.8	450	326	226
1989	21.6	1,706	473.2	4.8	587	395	278

Source: Ih-Ju League Statistics Bureau.

from 21–23 August, causing serious flooding and silting and washing away seedlings on more than 26,000 ha of cropfields, burying 8,670 ha of cropfields with thick sand, submerging 11 villages, destroying more than 8,000 houses, and damaging the highway from Dongsheng to Baotou. The amount of sand the stream washed away was so gigantic as to form a sandy barrier in its mouth at the Yellow River, which cut off the flow of the Yellow River for three hours and raised its level by four to five metres, with significant effects on both the upper and the lower reaches. Similar floods occur about two or three times every 10 years (Shen, 1981).

- On 28 April, 1983, a sandstorm in the Ih-Ju League left four people dead, 37 people injured, 44,837 livestock dead, 101 houses and 378 livestock shelters demolished, 195 wells buried, 9 km of electric cables destroyed, and transportation delayed by 24 hours (Yang, Di, and Huang, 1991). On average, sandstorms happen on about 10–25 days per year, damaging property and human health. The 1982 governmental archive reported that 36 houses out of 176 in Saiwusu township and 85 houses out of 496 in Tugerige township were threatened by moving sand in Hanggin banner. Both townships had to rely on the government Poverty Relief Fund to the tune of 32,200 and 85,200 yuan, respectively, in 1981.
- The strong wind of 18–19 April 1980 moved sand on to the road between Dongsheng and Uxin banner, blocking transportation for over 20 days. In the Ih-Ju League, more than 200 km of road and highway spread over 100 different areas are susceptible to sandification, and sand clearing costs over 1 million yuan every year (Huang and Song, 1986).

Impact through regional linkage

The Ordos Plateau is a major sandy area of the Yellow River catchment. The serious sandification and erosion in the Ordos add greatly to the discharge of silt and especially coarse sandy deposits of the Yellow River. It is estimated that the Ordos produces 10 per cent of the total silt and one-third of the coarse sand discharge of the Yellow River's lower reaches. Historically its gigantic sediment load caused the Yellow River to change its course frequently, causing serious flood damage. Since 1949, hydraulic works have been strengthened and surrounding agricultural and industrial uses greatly intensified. The river has become what is known as a "hanging river": the banks at the lower reaches have been dammed several metres above the

Table 2.6 **Grain input and livestock output in the Ih-Ju League, 1953–1985**

	Grain balance (million kg)		Livestock output (hundreds)		
Year	Sold	Net input	Cattle	Sheep and goats	Pigs
1953	510	987	162	1,435	157
1958	4,339	942	378	1,691	171
1962	3,636	1,692	206	2,621	145
1966	6,964	3,651	338	3,324	159
1978	9,023	9,963	141	3,425	928
1983	10,041	12,575	39	3,035	324
1984	9,422	4,642	15	879	191
1985	10,005	9,077	7	1,328	44

Source: Ih-Ju League Statistics Bureau.

surrounding natural terraces. The risk of overbanking and flooding is high. By adding to the sediment load of the Yellow River, environmental changes in the Ordos have thus exacerbated the flood hazard in the river's lower reaches.

Economically, the environmental impacts of the Ordos on other regions were not notable, as exchanges between the Ordos and outside areas were not significant. Output of animal products was small, and a net import of grain was recorded (table 2.6). In drought years, the region depended on the national government for grain and financial support; imports of grain from outside the region generally went up, and livestock output declined.

Conclusion

This chapter has discussed environmental changes since 1949, including sandification, degradation of vegetation, and soil erosion and degeneration. The Ordos Plateau is a fragile environment that is easily affected by human disturbances. General trends of change are marked by rampant degradation between 1949 and 1978, and a halt or even improvement after 1978.

Since the Ordos Plateau is vulnerable to environmental degradation owing to its high dependence on the environment and a lack of buffer zones, the impacts of environmental change on the society are significant. They include adverse effects of chronic environmental degradation on agricultural productivity and economic well-being,

and damage to properties and economic activities owing to hazardous events caused by accumulative degradation.

Are environmental changes in the Ordos Plateau caused by human or natural factors? From the analysis of the physical sensitivity of the area, it is apparent that physical features have contributed to the degree and extent of environmental degradation. Human factors, however, are the triggering forces for environmental degradation, as well as determining forces for environmental improvement. Without studying the roles of societal factors involved, the mechanisms and trajectories of environmental changes cannot be understood. From the next chapter onwards, relationships between key societal factors and environmental changes will gradually be unfolded through the analysis of culture/land relations, human driving forces, environmental awareness, and societal responses to environmental changes.

3

Culture and land

Researchers have identified culture as an important factor for its impacts on human perceptions and behaviours. Aspects of culture such as religion and beliefs have been examined, and their impacts on the environment recognized (Tuan, 1968; Rockwell, 1994). These studies have also shown that environmental degradation may happen under different religions and beliefs, suggesting a difficulty in analysing the role of culture in environmental change, and also, perhaps, the importance of regional contexts in understanding the role of culture.

This study regards culture as a filter for most socio-economic processes, i.e., both human driving forces and societal responses. In addition, culture serves as a base for understanding a society and its land-use practices, economy, and politics. The discussion of culture-land relationships in this chapter emphasizes land-use practices, and values and beliefs related to land and land investment. With the focus of this research on overall regional environmental trajectories, differentiations within the region are not discussed in detail, although differences between Han (Chinese) and Mongolian peoples are mainly analysed in this chapter. These differences are, however, important for understanding subregional variations. Beginning from human history prior to 1949, I trace the continuity of cultural factors,

then discuss cultural characteristics of the Han and Mongolian peoples, and finally depict people-land relationships within both cultures.

Human history

A long-term historical perspective is necessary for an understanding of the cultures, nationalities, and human land-use practices of the area. The long view not only accounts for past human activities contributing to the present environment of the Ordos, but also helps in understanding the present society – environmental impacts and human driving forces, societal vulnerabilities, and societal responses to environmental changes.

Humans first inhabited the area 35,000 years B.P. in the Wuding watershed in the south (Xia, Li, and Ma, 1985). It was the home of several northern nomadic peoples, such as Xiongnu (Hun), Tujue, and Dangxiang, and later Mongol. Archaeological investigations have discovered relics and sites from the Paleolithic, Neolithic, Bronze, and Iron Ages.

The first written records dealing with the area date back to the Zhou dynasty, especially the period of Warring States (475–221 B.C.). During the late Warring States period, Zhao, one of the seven major states at the time, occupied most of the Ordos Plateau and set up one *jun* (an administrative unit equivalent to a prefecture or province) called Yunzhong (Shi, 1980). Though some scholars believe that farming developed in the area before the Zhou dynasty from the practices of local people, most maintain that the area remained nomadic until the Hans immigrated and began practising cultivation after the Warring States period (Jiang, Huang, and Liu, 1986; Shi, 1980; Zhu, 1986).

Having unified China, the Qin dynasty (221–207 B.C.) became strong enough to extend its power to the frontiers, including the Ordos Plateau. After conquering the area, the Qin central government brought in Han people to reclaim and cultivate the east of the Ordos. Four *juns* in the Ordos and the adjacent area were set up to administer central authority (Shi, 1980). Farming began to cover a significant area.

The Western Han dynasty (206 B.C.–24 A.D.) continued the frontier consolidation policy by wars or royal marriages. Cultivation was strengthened. More *juns* were set up (six in all), and more Han people moved in. According to records in *Han Shu* (*Han Book*), from 127 B.C. to 111 B.C., more than 1,425,000 people moved into the

Ordos and the adjacent areas. Population reached its first peak (Wang, 1982), and cultivation so flourished that the Ordos was named ''Xin Qin-Zhong'' (New Central Qin), indicating a trend of development similar to the central China farming area (Shi, 1980).

From the Eastern Han dynasty (25–220 A.D.) to the end of the Northern dynasty (581 A.D.), governmental power declined and central control over marginal areas was lost. Population and cultivation declined. By the end of the Eastern Han dynasty, with peasant unrest, the Han government completely lost power in the Ordos Plateau. The nomadic peoples (mostly Xiongnu) retook the area, and the Han people moved back inland. Cropland was abandoned and grassland returned. In 407 A.D. the nomads set up their own state of Xia, governing the Ordos and the adjacent areas, and grazing was practised as the sole economy.

In the Sui and Tang dynasties (581–907 A.D.), the Han government reoccupied the Ordos Plateau, settling people, stationing an army, and promoting reclamation. The *Xin Tang Shu* (*New Tang Book*) reported a population of 132,924. Because of a policy that exempted people from taxation for the first five years of reclamation, farmers generally abandoned their land by the fifth year and moved to new land (Jiang, Huang, and Liu, 1986). The environmental effects followed. The *Xin Tang Shu* recorded the occurrence of sandification, and according to the sketch maps of Wang (1982), sandy land in the Ordos expanded during this period. In terms of the relationship between the Han and Mongolian peoples, the Tang may have been the first liberal government: it allowed six Xiongnu *zhous* (administrative units similar to *juns*) for the nomads along with four Han *zhous*. The nomads ''lived in the round woollen tents, followed water and grass, practised grazing and hunting, ate meat and dairy products, and wore leather clothes'' (*Jiu Tang Shu [Old Tang Book]*). The Tang government gave them autonomy and required annual tributes of animal products.

Another, and the last, nomadic period for the area extended from 903 A.D. to 1368 A.D. In 1038 A.D., the nomadic people in north China established their state of Xixia, which coexisted with the Han dynasty state of Song and the Manchu dynasty state of Liao. They ''grazed cattle, horses, asses, sheep, and goats, and lived on them; they did not know cultivation, so their lands were without crops'' (*Jiu Tang Shu*). In 1271, the Mongols set up their first powerful state, Yuan (1271–1368), dominated the Ordos and other Mongolian areas, and unified all of China. Livestock grazing developed further in the

Ordos. *Yuan Shi* (*Yuan History*) described the Ordos and the adjacent areas as a continuous lush pastureland. Communication and trade with Han areas became important, and the Ordos became more connected with the Han people.

In the Ming dynasty (1368–1644), the Han people took control. Farming was practised only on the southern edge of the Ordos. The Qing dynasty (1644–1911) and the Minguo regime (1911–1949), both weak and corrupt, presided over socio-economic and environmental decline, which shows up in population data: at the beginning of the Qing, the Mongolian population was 206,500, but by 1933 it had fallen to 93,133 (Sui-Yuan Government, 1934a).

At the beginning of the Qing dynasty, a Manchu government, the Great Wall marked the boundary between farming and grazing, with agriculture forbidden in a 25 km strip along the wall. Han people were not permitted to go north of the Great Wall. The aim of the policy was to separate Han and Mongolian people and thus to prevent their united rebellion. Beset by natural disaster and political decline, however, the people in northern Shaanxi lived poorly and often migrated illegally to the Ordos to make a living through cultivation. In 1697, Han men were permitted to cultivate north of the Great Wall, but they had to return to their homes in winter; women were still banned from migrating. Owing to this restriction, reclamation expanded only slowly in the southern and eastern parts of the Ordos.

A swift expansion of farming began after the middle of the nineteenth century, for which the corruption of the Qing and Minguo governments was responsible. Detailed data on this reclamation will be discussed in chapter 4; here I provide only the general social and political background. Toward the end of the Qing dynasty in the late nineteenth and early twentieth centuries, the government was at its weakest. The ''war indemnity'' payments imposed by unequal treaties signed with foreign countries (Japan, for example) and increasing military expenses left China bankrupt. In order to increase tax revenue, the Qing government opened the Mongolian area and permitted Han people, including women, to move into the Ordos. The Qing government set up the ''Reclamation Affairs Company'' to enforce official reclamation, and every banner had to pledge the area of reclamation to the company. (At the beginning of the Qing, the Ordos was divided into seven banners, which form the basis of the present administrative arrangement.) According to the Ih-Ju League Agricultural Regionalization (1990), from 1901 to 1931 the total open area

was 171,181 ha, with 41,140 ha reclaimed. In the Minguo period, the reclamation policy was continued. According to Jiang, Huang, and Liu (1986), the Taolimin area between Hanggin and Otog banners was designated a "new opening area," and was then expanded southward toward the Mu Us sandy land, thus opening up a large area of pastureland. By 1949, accumulated reclaimed land had reached 911,000 *mu*, and overreclamation had occurred (Cai, 1988; Chen, 1988; Wang, 1982).

As a frontier region between central China and the northern minorities, the Ordos Plateau frequently suffered from wars, which occurred during most periods of political upheaval. This is another factor destructive to the environment. For example, in the Xixia period, in a war against the invading Liao state, Xixia soldiers feigned retreat to entrap Liao soldiers, and burned pastureland every 30 *li* (15 km) behind them to cut their way back. The destruction of pastureland as a result of wars has been far-reaching (Wang, 1982). Wars were usually preceded by the stationing of an army, whose food needs often resulted in land reclamation that exerted direct effects on the environment.

In general, the overall shift in control, people, and land-use practices have been very much shaped by the changing power and policies of the central state. The long history of use provides not a pristine but a humanized background to this study of modern impacts, and many relevant factors have their origins far into the past in the Ordos Plateau. The reclamation activities of the Qing and Minguo were particularly detrimental to the environment, as will be discussed in detail in chapter 4.

Han and Mongolian culture

Traditionally, Han people cultivate the land and Mongolians graze livestock. These traditions have played key roles in their general cultures. In this section, I analyse major elements of both Han and Mongolian cultures, emphasizing their land-use practices – what they do and (especially) how they do it – in order to understand how they interact with their environment. Because my field research and data collection emphasized environmental changes and their social-political dimensions, culture did not undergo systematic in-depth investigation. Therefore, the analysis that follows is incomplete and possibly imbalanced in the account of Han and Mongolian cultures, as more literature is available for the former than the latter. I begin

with Han society and culture, and then discuss Mongolian culture through comparisons.

Traditional Han society is considered a ''peasant society'' with ''grain culture'' (Fei, 1987 [1939], 1985). Over thousands of years, simple farming as its mode of production formed the basis of the culture and social structure. In his *Peasant China* (1947) and later in his *Narrative of My Social Investigation* (1985), Fei identified several characteristics of such a culture, including a close people-land relationship, sedentary settlement, a high regard for farming and a low regard for commerce, and so on. Lack of mobility is an important factor for understanding traditional Chinese society. Because of farming practices, people settle on land, produce for subsistence, and form a clearly localized community. People within a peasant society are acquainted with one another, and they communicate through social codes instead of economic and commercial ones. Commercial activity is considered immoral. Subsistence farming generation after generation on one piece of land forms traditions that are powerful and closely abided by, and that maintain the order of the society. The dominating Confucian idea of social hierarchy came out of this cultural inclination, and further enhanced its rigidity by advocating that to ''restrict oneself to obey social ethics'' is moral. Buddhist religion in China is more of a life philosophy and culture than a ritual belief, and its doctrine of passive acceptance fits well into mainstream Chinese culture. The conservativeness of Chinese culture and its impact on the environment will be further discussed in chapter 4.

The Han people originated in the Yellow River valley and began farming 7,000 years ago (Zhao, 1992), using mostly their hands and simple tools and practising slash-and-burn farming. Until after 1949, farmers in the Ordos were still using ploughs and hoes, cattle, and hands and depended on natural fertility. Throughout China, areas of irrigation and rain-fed farming have developed different land-use traditions: intensive and extensive, respectively. Some authors (e.g. Elvin, 1982; Perkins, 1969) have praised Chinese farming as being intensive, efficient, and highly adapted to the local environment, but this is only true in most river valleys where the environment is favourable. In the Ordos and adjacent north China, thousands of years of extensive cultivation have been based on the reality that the land was ample and poor and the population sparse.

Before going into the details of the land-use system of Han farmers, I turn to an example of a village whose farming system demonstrates the major characteristics of traditional farming, although with

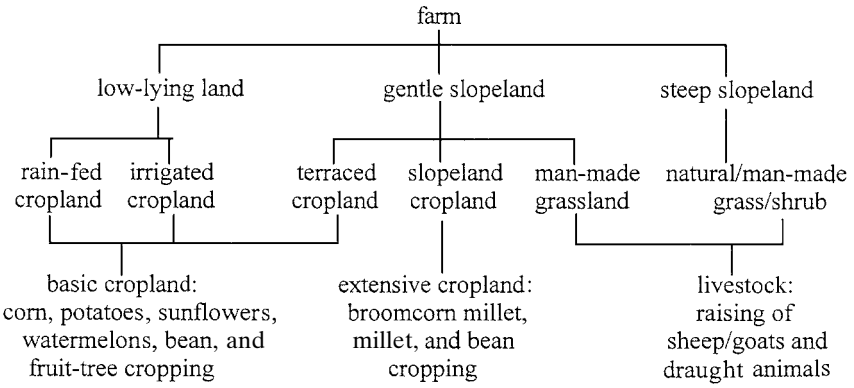


Figure 3.1 **The farming system in the Ordos Plateau**

many changes embedded (fig. 3.1). The site is Xuexiaopo natural village of Andinghao administrative village in Shagedu township, Jungar banner, and the data were collected in the spring of 1991. There are 230 people in about 50 households in the village. The total farmland is 1,200 *mu*, with about 350 *mu* of flat, low-lying land in the valley, 150 *mu* of terraced land, and 700 *mu* of slopeland. Slopeland cropping occurs mostly on the gentle slopes, as the villagers returned 250 *mu* of steep slopeland to herb cultivation (alfalfa and *Astragalus adsurgens*) after 1978. Corn, broomcorn millet, millet, beans, potatoes, sunflowers, watermelons, castors, and apple and pear trees are the principal crops. Their cropping strategy is first to arrange task grain (50 kg of corn and broomcorn millet per person in 1991), then staple grain for consumption over a period of 12 to 18 months, and lastly cash crops such as watermelons, sunflowers, and castors. They assign high-yielding cropland to corn, watermelons, and sunflowers, and low-yielding slopeland to sunflowers, broomcorn millet, millet, castors, and beans. All slopeland is cultivated every year without fallow or green manuring, and the only cropping measure for fertility maintenance is rotations with nitrogen-fixing beans. Farmers apply more effort and fertilizers to flat cropland. Our interviews show that, on every *mu* of flat cropland, they apply 5,000–6,000 *jin* of organic manure as base, 70–80 *jin* of chemical fertilizer for base fertilizing, and another 50–60 *jin* of castor oil residue and 20–30 *jin* of chemical fertilizer for growing-period fertilizing. On slopeland, however, fertilizer application is very small: only 300 *jin* of organic manure and about 40 *jin* of chemical fertilizer. Chemical fertilizer is predom-

inantly nitrogen; phosphorus fertilizer is not applied as it is expensive to purchase.

Animal husbandry is another important practice. The villagers have 5,500 *mu* of man-made herbs and *Caragana* shrubs and raise a total of 800 sheep/goats and 30 mules, donkeys, and horses. Mules, donkeys, and horses are used mostly as draught animals, whereas sheep and goats are for manure gathering and cash income.

Traditionally, Han farmers in the Ordos depended on the natural fertility of the land and practised shifting agriculture. They usually opened one piece of land, dispersed seeds, applied minimal care (weeding and soil loosening), and then waited for harvest. The acreage farmed was the most important factor in determining the amount of harvest. Soil fertility was not a concern because, after natural fertility was depleted within three to five years, farmers would move to another piece of land and begin the same cycle. This practice, which requires a large land area per capita so that farmers can always have good land to cultivate, probably prevailed in the Ordos prior to 1949. Shifting cultivation does not necessarily cause soil erosion and vegetation degradation if practised by a small population and accompanied by fallow or natural regeneration of vegetation that allows replenishment of soil fertility for another period of cultivation. It may have been rather harmful for the Ordos Plateau, since the fallow land might be quickly eroded and sandified under the dry and windy natural conditions. When population increased and per capita land declined, the sowing-fallow system gradually deteriorated, with shorter and shorter fallow periods and increasing harm to the environment. For example, in the early period of reclamation in the Qing dynasty, the cultivation period for one piece of land was two to three years (Jiang, Huang, and Liu, 1986). The Ih-Ju League Agricultural Regionalization (1990) indicates that in 1908, 9,002 *dan* (measuring unit for grain used before 1949; equal to one hectolitre) of grain that farmers submitted to the Reclamation Affairs Company as a tax included 34 per cent of wheat, 13.6 per cent of broomcorn millet, 1.7 per cent of millet, 38.5 per cent of beans, and 11 per cent of castors, indicating a high percentage of bean cropping that is favourable for soil fertility recovery. In 1949, the cultivated area accounted for only about one-quarter of the total reclaimed land, with the other three-quarters left fallow or designated for green manuring (Ih-Ju League, 1990). After the 1950s, however, the land gradually underwent continuous cultivation until not only was the fertility depleted but the surface soil was also gone, as illustrated by part of the Jungar banner. The bean-

cropping area was diminished from 4.0 per cent in 1950 to 1.8 per cent in 1986. The seriously degraded land had to be abandoned, by then a wasteland incapable of natural replenishment. Where only the loess soil matrix remains, or, in the worst case, where the bare rock is exposed, soil regeneration is nearly impossible over the human time-span.

In the Ordos, the farming area in the north-east is hilly gully land with uneven loess deposits over sandy bedrock. Slopeland covers a majority of the area. The flat river valley land is of high quality and high yielding, and is the pearl in the hands of farmers, who usually build their houses close to these lands and devote most of their labour and manure to them. Slopeland is usually far from home and gets less care and fertilizer. Though terracing is sometimes used, slopeland cultivation is still practised. Contour cultivation has slowed the loss of fertility and topsoil, but, without more substantial protection measures, slopeland is still not suitable for cultivation. Even protected, it usually would not be worth the labour and money input for its small yield. As a result, slopeland is only back-up land for farmers. In much writing on farming practices in the Ordos as well as other parts of north China, the phrase ''extensive cultivating and low yielding'' is usually used to explain the cause of environmental degradation, as if intensive cultivation on slopeland would have been better both economically and environmentally, whereas in fact, without terracing, slopeland suits no cultivation at all.

At this point a question arises: how can farmers use the slopeland? The answer is to plant herbs, to raise livestock, and to develop animal husbandry. Here the importance of the Han tradition of cultivation becomes apparent: they are not used to the idea of feeding animals and then themselves, instead of producing directly to feed people. The government policy of ''grain first'' during the Cultural Revolution greatly reinforced traditional farming and delayed possible adaptive changes in land use. Most farmers hold a small stock of livestock and raise them mostly for manure gathering in order to fertilize their cropland. Pigs are important for farmers' animal husbandry, but they represent more a sideline than a major form of production. For farmers, the conception of the usefulness of land is that it produces crops. They inherited their way of living with ploughs and hoes from their ancestors; in addition, they are unfamiliar with the techniques of livestock care and grazing.

Traditional land-use practices have produced much discussion and many defences. In Africa, for example, indigenous farming techni-

ques have been considered suitable for land protection and forces for change have drawn criticisms (Blaikie, 1989; Galaty et al., 1981). In the Ordos Plateau, the situation is similar but my assessment is different. Traditional farming methods were suitable for a long period of time for the Ordos Plateau, a society and environment that changed relatively slowly prior to 1949; but such suitability is not a static concept. With the dramatic population and economic changes since 1949, traditional land use has become unsuitable without adjustment. Chapter 4 clearly demonstrates the harm that traditional land use has inflicted on the local environment.

Mongolian people, on the other hand, came originally from the semi-arid grassland of north Asia, and their traditional land use has been raising livestock and grazing on grassland. Their traditional way of life is to follow grass and water; high mobility is an essential prerequisite. Although some supplementary agriculture was needed to offset the shortage of winter feed, farming remained very limited for Mongolians, since the immobilization of too many people to attend to farming would upset the nomadic system (Lattimore, 1962). As a nomad society, Mongolian culture, unlike Han, lacks tight bounds of tradition and its naturalist inclination is clear in its literature (e.g. folk songs). The original Mongolian religion deified nature and ancestors, from which harmonious people-nature and interpersonal relationships can be inferred. Later, especially after the Yuan dynasty, Lamaism began to have profound effects on Mongolian religion and culture and further imbue the idea of destiny or fate.

Domesticated animals are important for the Mongolian people. The basics of food, clothes, and transportation came mostly from domesticated animals – sheep, goats, camels, horses, or cattle – and the Mongolian gauge wealth by the numbers of these animals possessed. Unlike Han farmers, they moved their camps and livestock following good pastureland, building no stable settlements. They left themselves more comfortably in the hands of nature. Generally, they moved every season according to the availability of pastureland. When one pasture was grazed short and sparse, they moved their flocks to another. The lives of both people and livestock cycled with nature. Following the seasonal pasture cycle, livestock were full in the summer, fat in the autumn, exhausted in the winter, and dying in the spring.

Animal husbandry and human improvement of pastureland were not among the traditional concepts of the Mongolian people, who valued the mobility of both people and livestock. Even in recent

years, when the local government proposed shelter raising, they resisted on the grounds that ''shelter raising is nonsense; the livestock would die; even our ancestors could not raise livestock without grazing'' (interview with Otog shepherds, 1992). Pasture protection was not a concern, and cold-season additional feeding was not provided, nor was pasture improved or fine fodder cultivated. Both a migratory way of life and the lack of farming skills hindered any efforts towards vegetation construction. Since improved pasture and fine-fodder cultivation were advocated, especially after 1978, most Mongolian shepherds have to learn either from governmental extension workers or, if they have the money, from hired Han farmers. Most shepherds I interviewed in Uxin banner hire long-term or short-term Han farmers for fodder-crop cultivation. Throughout the banner, Sharli and Taoli *sumu* have the best supply of fine fodder and the highest income because they are close to the Han farming area in the south Wuding River valley. Interviews in Heihadai township, Jungar banner, show that the Mongolians who settled in farming areas are not doing so well as Hans in farming.

Like the Han people's extensive farming, Mongolian grazing practices did not initially cause environmental problems because of their sparse population. After 1949, with the improvement in social and economic conditions, their population quickly increased. Census data show that the total population of the Ordos was 411,747 in 1949 and had nearly tripled to 1,184,148 by 1989. Two shortcomings of natural grazing quickly became apparent. First, migratory grazing is highly susceptible to natural hazards and unfavourable to pasture construction and social development. Dependent upon natural pastureland and mobile camps, it is at odds with efforts towards pasture improvement and efficient provision of public goods (such as schools, medical services, and animal husbandry services). Second, with the population increase livestock numbers also increased, and natural grazing proved to be very destructive to pastureland. As a result, the Chinese government has promoted sedentarization of nomadic people in the north. One report in *Ren Min Ri Bao* (*People's Daily*, 26 September 1992) shows that half of the nomadic people in northern China have settled. In the Ordos Plateau, nearly 100 per cent of the Mongolian shepherds have settled or half-settled, using all-season sturdy houses as bases supplemented by seasonal grazing camps. Their daily existence has changed from the monotony of ''tea for breakfast, dry grain for lunch, and meat for dinner'' to a diversified diet and a richer life. Especially since 1978, they have begun to have

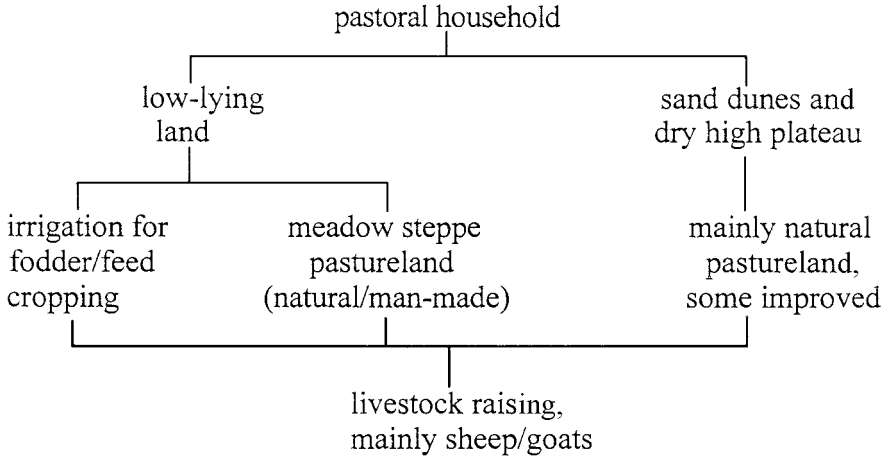


Figure 3.2 **The pastoral system in the Ordos Plateau**

vegetables and fine-cooked dishes on their dinner tables, commodities such as furniture, watches, radios, and lately television sets in their houses, and motorcycles and mechanical equipment for transportation and production. Their livestock also often have shelters. Traditional natural grazing has begun to change, but the negative effects are still traceable. Overgrazing still occurs, and because of the shepherds' inadequate agricultural skills, winter forage and fine feed are still lacking in most grazing areas.

Some examples of present-day livestock grazing (fig. 3.2), though displaying elements of changing land-use and settlement patterns, still give a sense of the scale and mode of traditional Mongolian grazing and way of life. My fieldwork in the Uxin *sumu* of Uxin banner shows that a typical shepherd household of six has 1,800 *mu* of pastureland and 300 sheep/goats. They settle close to their pastureland and surround their houses with a small area of cultivated land on which they plant fodder crops, herbs, and trees (the area varies with the availability of irrigation). Each household has one well. Economic activities centre on raising animals, and income comes mostly from sheep/goats' wool/cashmere and meat. On the Otog highland pasture, a typical household pasture is larger, several thousand *mu*, and sheep/goats number 300–400. The typical settlement pattern is one house and an animal shelter separated from the next house by about 10 km of pastureland. Five to six households typically share one well.

In the past, both Han and Mongolian peoples maintained their

traditional land use and way of life by following suitable land, relevant government policy, or both. Before 1949, whenever a Han central government controlled the Ordos area, Han people would move in and practise farming. When the Han government lost control and a nomadic state occupied the area, nomadic people would take over and practise grazing and the Han people would emigrate. Since 1949, it has been mostly the state and local governments that have directed land use within the area. When they designated an area for farming, the Han people would move in, and when they designated an area for grazing, the Mongolian people would move in. In Uxin *sumu*, I was informed that, in the early 1950s, no Han people occupied the *sumu*, but they later moved in because of the ''grain first'' policy imposed upon the area. Both peoples have tenaciously clung to their own ways of life for the most part, but some have stayed in areas designated or suitable for other land uses and have gradually changed their way of life. In Uxin banner there have been cases of Han people adopting a grazing life; they can cultivate forage and fine fodder better than most Mongolian people. Since 1980, such blending has become even more significant, as migration has become increasingly difficult because of the allocation of land-use rights under the Household Responsibility policy. People have gradually adjusted their land-use practices according to land suitability, rather than tradition.

One way that culture accounts for environmental change is through land-use practices. The important question is not what farmers and shepherds do – i.e., the Han farm or the Mongolians graze – but how and where they do it, whether the practice is compatible with the environment of the locale, how the society is affected, and whether it is capable of responding to environmental changes. In the past, traditional land-use practices of the Han and Mongolians were in harmony with the environment; although land degradation occurred, the land was allowed sufficient time to recover and society was not adversely affected. Under the new social, political, economic, and demographic conditions of the modern period, however, the traditional mode of land-use practices has been a driving force of environmental degradation (see chapter 4).

Now both cultures are undergoing changes. From being traditional peasants and nomads, Han and Mongolian people are entering a modern society in which not only their land-use styles but also their beliefs and values are changing. Research on this transformation would be both difficult and interesting; I can give here only some examples of the changes. Both Han and Mongolian peoples have

added elements to their land-use systems which consider the environment and promote economic development. Han people, for example, have converted much of the steep slope cropland to herbal and shrub plantation for grazing, and animal husbandry is beginning to account for a large part of their total income. In 1989, its share had gone up to 39.4 per cent according to one official sample by the Ih-Ju League Economic Statistics Bureau. Mongolian people have developed irrigation and fodder-crop cultivation for better balanced and less vulnerable animal husbandry. The average shepherd household in the Mu Us sandy land has about 10 *mu* of cultivated land. Most people I interviewed in the Ordos, both Han and Mongolian, consider the change of land-use practices to be largely positive; this conflicts with the conclusions of researchers who argue that the change is negative for Mongolian shepherds (e.g. Williams, 1996). Both Han and Mongolian peoples have begun to perceive land less as a cultural symbol and more as a source of economic income. For farmers, a large acreage of cropland is no longer an asset if it does not produce much, and shepherds do not retain livestock if they fail to produce cash income. How the changes in values and beliefs will affect the environment still remains to be seen and to be studied.

Culture and the land

People-land relationships have been an important aspect of both Han and Mongolian cultures. Analysing them will also help understand human perceptions of both environment and environmental changes.

For traditional Han farmers settling on one piece of land and practising subsistence farming, there are two important cycles: the seasonal cycle for farming and the birth-and-death cycle of people. Locality is also very important, and outmigration is limited. People have a strong loyalty to community. In Laozi's words, the ideal Chinese society is small and self-sufficient:

> . . . Cockcrow is close
> and dogs' barking heard,
> where folks grow old
> and folks will die
> and never once
> exchange a call.

Land carries the symbolic meaning of home and roots, a symbol of tradition since it was also their ancestors' land. People grow out of

the land and return to it ''like tree leaves returning to their roots.'' The land is the place for regeneration not only of people but also of society and culture. Only when compelled should people leave their land. In the Ordos, moving folk songs capture the sadness of leaving the homeland:

> The vast Gaoliang on the sandy land is my beautiful home,
> how can I stop missing you when I leave you to roam;
> Uxin is the place that gives me life,
> how can I leave you and still survive;
> the pleasant Gaoliang is so comfortable,
> how can I go to a strange place without feeling miserable?
> . . .
> I am forced to leave my home,
> but where can I move my ancestors' tomb;
> having left my land in the south,
> I only wish to go back, not far forth. . . .

Such is the ''pull'' force that commits Han people to protecting land. First, they want to keep the land to hand over to their descendants; and second, they want to maintain the ''*di qi*'' (quality of land) for a healthy life. Although this traditional inclination has been greatly affected by land tenure and institutional changes since 1949, land is still a deeply held value and caring for land is still a moral imperative. Recently, although economic betterment is sought, people still show the most respect to ''those who become better off from land and hard work'' and not those improving by turning to other vocations.

There are also ''push'' forces that may induce land abuse and environmental degradation. Farming has been the basis of the society, but in the social hierarchy peasants have low status: ''outstanding scholars would become gentry,'' and ''the wisdom users rule and labour users are ruled.'' The closer people are to the land, the lower they generally are in social position. This produces a dilemma for farmers: they are closely linked to the land but in social status this linkage is a liability. Thus they tend to leave the land for higher social positions whenever possible. This dilemma makes farmers humble and passive when their life tied to the land disappoints them. The widespread saying is ''it is not promising to scrape the earth.'' Farmers dislike what they do and despair for a better living; therefore they look up to somebody or something else.

This emphasis on the social symbolism of land begins to change as the economic value of the land gains in importance, since farmers can

gain from the land economically even if not in prestige. In recent years, with a greater stress on a better economy, farmers have begun to see land as socially valuable through economic gains. The results are, however, still limited. In an interview, one farmer in Heihadai township of Jungar banner stated that ''It is not prestigious and promising to plough the land. The richer are those who go out and perform skilled jobs or work in coal mining. This land cannot make us rich.'' Farming thus often becomes dishonourable both socially and economically. This is one of the reasons that farmers do not pay greater attention to the land. As long as there are other opportunities for economic income and social mobility, farmers tend to leave environmental degradation unchecked; the fact that townships in Jungar banner which have rich coal resources and coal mines invest the least in environmental protection bears this out.

The push and pull factors can be illustrated through analysing family budgets. My interviews show that most farmers spend money first for food and shelter, then for social status, and only thereafter for reinvestment in production and environmental protection. This is supported by other studies of farmers' family budgets. An investigation into rural China by Deng (1992) shows that social status and ritual ceremonies are given priority in farmers' spending; only for these do they borrow money. The authors demonstrate that poor farmers tend to spend even more on weddings and ritual activities than do the rich, presumably to raise their social status. The spending patterns of farmers in Heihadai township of Jungar banner bear out these generalizations.

Whatever money is left after basic food expenses is spent first on housing. This is important both practically and socially. Practically, better housing is needed, especially for each generation to have (probably) one separate bedroom. Socially, it is also a sign of wealth. The next priority for spending is marriage, a ritual for both family extension and social status. The cost can be as high as 10,000 yuan (compared to 4,000–5,000 yuan before 1980), equivalent to about 10 years' income for an average farmer in the Ordos. This money is used for purchasing clothes, furniture, and other household equipment (mostly electronic) and for the wedding ceremony. The poorer the family is, the more they need to spend on their son's marriage in order to attract a daughter-in-law.

This has negative effects on the family's future development and on the position of women. It perpetuates, in particular, the inferior social position of women. Most families are still dominated by men. Women

do all the housework, child care, and livestock raising. Men work mostly outside on the farm or tree plantation. If a family has more than two adult women, the young ones usually spend more time working outside on the land. Women's work is less strenuous but more time-consuming than men's. Owing to political advocacy for women's equality during recent years (the famous slogan is ''men and women each support half the world'') and the economic reality that women are an important source of labour and cash, the social status of women has improved a great deal since 1949. In family decision-making, especially family budgeting, women in many cases are no longer left out.

The next item in the family budget of farmers is tobacco and liquor, another indicator of social status. Farmers see tobacco and liquor as powerful media in social life and enjoyable items in personal life. In 1990, an average person in Jungar spent 24.12 yuan on tobacco and liquor; in 1991, 40.04 yuan (unpublished local broadcasting, 1992).

Sending children to school usually receives high priority, raising social status constituting one of the important reasons for many people. Today, obtaining a college education is the only viable way for people to leave rural areas, live in cities, and enjoy better social status. Population movements are closely regulated in China, and people in rural areas cannot easily move to cities if they do not have education diplomas. Generally, a high-school diploma is necessary for people to secure employment in local towns in industrial and commercial sectors, and a professional diploma (involving two to four years at college) or university education is almost always required for employment in local cities or cities outside the area. The ''brain drain'' caused by this outmigration of educated people is serious. Since teaching quality and school conditions are poor in rural areas, children are at a disadvantage competing with their city counterparts in the national entrance examinations. Therefore, some people feel that they are wasting money in sending their children to school. I have heard people say ''if you cannot enter college, going to school is useless.'' This reflects the perception of some farmers who see education merely as a means of upgrading social status by leaving rural areas instead of better supporting farming. Although the perception of education is changing and the effects of agricultural education by government extension services are increasing, some farmers still believe that farming is primarily a continuation of cultural traditions and needs no modern education.

Investment in production and environmental protection is usually

the last item in the family budget of farmers. The lack of emphasis on environmental protection in the coal-rich areas suggests that people rate economic gain higher than farming tradition and land quality.

Mongolian culture also shows close people-land relations. A primary difference from Han culture is that Mongolian culture also emphasizes people-animal relations. They consider themselves linked to pastureland and tied to domesticated animals, and see animal grazing as their way of life. As one folk song indicates, they value the harmony of land-animals-people on the vast pastureland, and enjoy a simple life with peace and happiness:

> In Ejin Horo where cooking smoke lingering
> is our lovely home place
> where Madar Oasis and Mangshahai spring
> are livestock's drinking place;
>
> Shari greenland and Xibor River
> are beautiful and fertile
> where around the running water
> are scattered sheep and cattle;
>
> Five elm and willow
> are on the Jigenxili highland
> where under the shadow
> is our ancestors' resting land;
>
> This peaceful land
> is home of singing birds
> where the beautiful pastureland
> is full of livestock herds.

The Mongolian people place less emphasis than the Han on the hierarchy of social status and stick closely to their animals' grazing life. They see their own future on the land and from the land, and they see better pastureland and livestock as the only way to improve their life. The majority of Han people, by contrast, see their future as outside the land. This cultural difference deeply affects attitudes and efforts towards environmental improvement.

Interviews on family budgets show that Mongolian people reinvest substantially in pastureland protection and animal grazing. It is estimated in Uxin banner, for example, that they reinvest 50–70 per cent of their net cash income in animal husbandry, which is higher than Han farmers' reinvestment in farming. Official statistics show that in 1988 and 1989, farmers spent 30 per cent of their total net income (material included) on production with environmental protection

Table 3.1 **Shepherds' budget in Baolehaoxiao *gacha*, Otog banner, 1953–1985 (yuan per capita/%)**

Year	1986	1987	1988	1989	1990	1991
Total income	927	1,389	2,155	1,853	1,300	1,393
household %	90	87.9	93	90.6	91.7	91.6
collective %	0.6	0.5	0.4	0.2	0	1.1
other sources %	9.4	11.6	6.6	9.2	9.3	7.3
Net income	525	866	1,733	1,400	894	935
investment in production %	75	58.3	28.2	36	73.4	46.7
Total expenditure	987	1,360	1,942	1,940	1,529	1,589
production %	40	37.1	25.2	26	42.9	27.5
tax %	0.6	0.4	0.8	1.4	2.1	2.3
collective %	1.6	1.7	1	1	1.9	2.6
living %	44.7	39.8	52.1	53.8	48	51.3
entertaining %	5.3	9.2	10.6	12.2	9.9	11.7
other expenses %	8.8	11.8	10.3	5.6	6.2	4.6

Source: Unpublished statistics of the Rural Survey Office, Department of Agriculture of China (1992).

included, whereas shepherds spent 36 per cent. Other data indicate a similar ratio of investment in production within total income, and, since shepherds have a much higher total income, the absolute difference is still higher. For instance, in 1988 and 1989, farmers' per capita total income was 727 and 708 yuan, whereas shepherds' income was 1,357 and 1,084 yuan respectively. Data provided by the Rural Fixed Station Survey Office sponsored by the state Department of Agriculture (table 3.1) show the sources of income (88–93 per cent coming from household activities), and expenditure structure based on total income, in Baolehaoxiao *gacha*, Otog banner. Table 3.1 shows that the amount of investment in production is significant, ranging from 28 to 75 per cent of total net income and reaching 400–600 yuan per person during 1986–1991. My interviews in other pastoral areas show that shepherds are willing to spend more than 10,000 yuan cash for iron wire in addition to the necessary labour for pasture fencing, since they believe it to be the basic infrastructure for animal grazing. They may then spend about the same amount of money in digging wells and buying mechanical equipment for forage-crop cultivation in order to increase supplementary forage and winter feed, which has proved to be necessary not only to increase livestock production but also to protect pastureland. They also actively invest labour in sandy land revegetation to increase the amount of their

pastureland. Some people (both Han and Mongolian) ascribe the high investment of the Mongolians in production and environmental protection to their leading a simple life and having low everyday expenses, which may in fact be contributory factors, along with the fact that they have a closer relationship with the land culturally, socially, and economically, as compared with the Han.

Another practical reason for the closer link of shepherds to land is the scarcity of other economic opportunities, such as working in the city or changing to work as skilled labourers, because they lack the fluency in Chinese language required for those jobs (though most of them speak some Chinese). In this sense, most shepherds are tied to the land with little chance of escape.

This restriction, however, does not make shepherds humble, nor do they try as hard as Han farmers to advance their children socially through schooling, although children who can go out of the area for higher education are still considered promising. My interviews suggest that shepherds take education seriously, but schools are few and conditions poor, partly owing to the low density of settlement. Schools are usually far away, and children have to board and live away from their families from primary school onwards. This causes problems, especially for small children who need their parents' care. Middle schools (both junior and senior high) are few and lack sufficient space for all primary-school graduates; thus many children have to drop out of school. This problem is discussed further in chapter 4.

The Mongolian view of gender differs from that of the Han people. I do not have data or survey material on this issue, but my interviews suggest that Mongolian women have higher social status than do Han women in their traditional society. This may have something to do with their way of life and social division of labour. For Mongolians, grazing animals and tending herds are the major economic activities in which women play a major role. In addition, as mentioned earlier, Mongolian society is less hierarchically structured than is Han society; accordingly, women may be more appreciated for everyday grazing activities. I was also informed that in population control, Mongolian people, who are allowed to have two children per couple as part of the favourable policy toward ethnic minorities, lack the craving for a male baby of the Han Chinese and have less difficulty accepting the birth quota.

It is evident that, in addition to land-use practices, the other way in which culture accounts for environmental change is through people-

land relations and traditional values, which directly affect land investment and indirectly affect education and population strategies. These cultural differences produce intraregional variations within the general trends influenced by political and economic forces. For example, land investment that aims at high productivity or land protection profoundly affects land and environmental quality. In the farming area, investment in good crop varieties, surface filming, and fertilization not only helps to increase yields but also facilitates the conversion of slopeland to shrub and herbal plantation, which is both an economic and an environmental measure. In the pastoral areas, investment to improve livestock breeds and the building of shelters helps to reduce pressure on pasture, while pasture enclosure and improvement themselves are powerful environmental measures. In addition, all these affect the regional and local economy, a major underlying force in environmental changes. (Chapter 4 includes a discussion of the indirect impacts of education and population on the environment.)

Conclusion

This chapter has explored the impacts of culture on the environment in the Ordos Plateau. It is important to realize that both Han and Mongolian cultures instil a high valuation of homeland, which enhances good care of the environment. Both cultures, however, especially Han, contain ingredients that induce misuse of land and spawn environmental degradation. Both cultures lack sufficient capacity for adaptation to protect the environment under the changing socio-economic and political situations. In particular, culture affects the environment through land-use practices, people-land relationships, and values that affect land investment. For land-use practice, it is important to understand where and how certain practices occurred, their compatibility with the environment, and their environmental and societal impacts. Traditional styles of extensive farming and grazing that did not cause degradation under the sparse population in the past now pose environmental threats in a changed socio-economic context with the growth in population since 1949. People-land relationships and attendant values extensively shape the differences in land investment, educational, and population strategies among the Han and Mongolian peoples, which in turn structure their broader relationship with the environment.

Culture alone cannot protect the environment, nor does it alone constitute enough force for environmental degradation. Culture affects the environment by way of its interaction with other socio-economic and political aspects of the society. In the next chapter, I analyse human driving forces, keeping in mind that they interact with each other and with aspects of culture explored in this chapter.

4

Human driving forces of environmental change

This chapter deals with what and how human forces have contributed to environmental change in the Ordos Plateau. It is important to understand that human factors, both negative and positive, combine with the characteristics of the environment to determine the net force and results of environmental change. Moreover, since certain societal factors may have both positive and negative environmental effects at the same time, driving forces cannot be clearly separated from societal responses, and vice versa. While attempting to discuss negative forces that drive environmental degradation, leaving their positive impacts to chapter 6 on human responses, this chapter acknowledges the interaction between driving forces and societal responses in the discussion.

As recognized by the global-change community (Jacobson and Price, 1991; Stern, Young, and Druckman, 1992; Turner et al., 1990b), human causes of environmental change consist of proximate human activities and underlying human driving forces. Proximate human activities such as cultivation, overgrazing, and fuelwood collection in semi-arid areas (Shen, 1981; Yang, Di, and Huang, 1991) are direct agents of environmental change in the Ordos Plateau. For example, overreclamation contributes to both grassland conversion and degra-

dation, and overgrazing accounts for a large share of grassland degradation (Ih-Ju League, 1990).

Underlying the proximate activities are human driving forces, including population change (Ehrlich and Ehrlich, 1990; Meyer and Turner, 1992), attitudes/beliefs (Rockwell, 1994), economy and economics (Hosier, 1988; Leonard, 1989), technology (Commoner, 1971), resource institutions (Emel, Roberts, and Sauri, 1992; Jodha, 1992), and political structures (Blaikie, 1989; Blaikie and Brookfield, 1987). These are the forces which induce the proximate activities that, in turn, change the environment. Their impacts on the environment vary by location and by scale of enquiry. Global-level analyses have often taken population increase (P), affluence (A), and technological (T) change to be the primary drivers of environmental impact (I) (i.e., the I = PAT model – see Ehrlich and Holdren, 1971; Ehrlich and Ehrlich, 1990), while regional-scale studies have noted that these forces can sometimes have only minor or even positive effects (see Boserup, 1965; Meyer and Turner, 1992). Context and interactions with other socio-economic factors are probably critical to the role of population (Arizpe and Velazquez, 1992). Most studies recognize the potentially profound impact of property institutions (e.g. communal versus private), but here too the conclusions are often contradictory (see for example Hardin, 1968; Jodha, 1985; Ostrom, 1990; Picardi and Seifert, 1976; Wade, 1987). Disagreements frequently have political or philosophical underpinning, as when Malthusians emphasize the role of population increase and Marxists attribute the primary problem to capitalism.

Moreover, forces may also vary in their importance at different scales of study. Globally, it has been difficult to include government policy and resource institutions in modelling efforts, yet regional studies have often ranked them among the most important forces of environmental change (Jodha, 1985; Johnson, 1993; Potter, Brookfield, and Byron, 1995). While it at first appears inconsistent that under either affluence or poverty, communal or private property regimes, socialism or capitalism, etc., the environment can be degraded, detailed study of the regional contexts can resolve the problem by revealing the subtle relationships between the environment and society that condition the operation of each potential driving force. Without such in-depth regional studies, any generalization about human driving forces is suspect. All of the widely accepted assertions about human driving forces require scrutiny and testing in regional settings.

In *Regions at Risk*, Kasperson, Kasperson, and Turner (1995) provide a rich comparative study of human dimensions of environmental change at a regional level. It shows that each region (among nine case areas), according to its own political, historical, and socio-economic context, has a unique set of human driving forces. The role of each force also differs. For example, in the North Sea, the key driving forces of marine pollution are common-pool resource institutions, affluence, and technological capacity; whereas in the Nepal middle mountains, the major drivers of degradation are population increase, poverty, commercialization, and policy intervention. Forces external to a region may be significant, or in some cases more important than internal forces. This observation presents a significant departure from findings at a global level and indicates the importance of regional approaches to the study of human driving forces.

This chapter provides a regional study of human driving forces of environmental change within the rich historical, political, and socio-economic context of the Ordos Plateau. I first discuss proximate activities, emphasizing the biophysical mechanisms and the link of these activities with environmental change. Then I investigate human driving forces underlying these activities: political, demographic, cultural, technological, and economic. By studying the close interplay of human and environmental factors in the Ordos Plateau, I hope to reveal the intricate link between the society and the environment from a regional perspective and contribute to the ongoing debate by answering some of the questions posed by the global-change research community.

Proximate sources of change

To understand environmental changes, it is important to recognize the proximate human activities that directly induce them. In the Ordos Plateau, proximate human causes of environmental degradation include overreclamation and mismanagement of cropland, overgrazing, and excessive collection of fuelwood and medicinal herbs. Road construction and coal mining, disturbing land surface, are others. Each activity brings about certain physical and ecological changes or chains of changes. All of them begin by destroying or degrading vegetation in certain ways; soil erosion and sandification usually follow.

Overreclamation

In the semi-arid environment of the Ordos, land suitable for cultivation is very limited. Dryland cultivation is appropriate only in areas with more than 300 mm of annual precipitation or in river valleys with somewhat less rainfall. On loess hills, cultivation should be practised only on gentle slopes (less than 20 degrees), and on sandy land cultivation is appropriate only with irrigation. Past practices have far exceeded these limits, however, causing serious environmental degradation.

Modern farming practices can be traced back to the middle Ming dynasty and especially the Qing dynasty (chapter 3). Rapid conversion of pasture to cropland began in the early twentieth century. Drawing on the work of Zhao and colleagues (1958) and my own field research, I outline the reclamation periods and areas in the Ordos in fig. 4.1. Three periods of extensive conversion can be identified. Beginning with the establishment of the Reclamation Affairs Company, the first stage of large-scale pasture conversion extended from 1901 to 1911. Between 1902 and 1908, such conversion amounted to 146,700 ha. It continued more slowly thereafter, with 115,600 ha opened between 1915 and 1928. In 1930, the area of cultivation totalled 253,300 ha.

The second period of conversion peaked in 1932 under the Guomingdang regime. According to the *Analysis of the Mongolian Economy of Cha-Sui Region* (Sui-Yuan Government, 1934a) and *Report on the Counties of the Sui-Yuan Region* (Sui-Yuan Government, 1934b), 307,533 ha was newly opened to cropland at this time, raising to 1,880,000 ha the total cultivated area. Cropland accounted for 37 per cent of the total area of Jungar banner. By 1949, total cropfield area in the Ordos was 607,800 ha (Ih-Ju League, 1990), while the total land that had been converted exceeded 1,300,000 ha (including subsequently abandoned fields).

The third reclamation period, 1956 to 1972, includes three phases of expansion, governed largely by policy changes. The years 1956 and 1957 saw the first expansion, as cropland in Uxin, Otog, and Ejin Horo banners increased by 6 per cent over 1955 levels. The second expansion, the most significant in terms of area, occurred during 1959–1961, when total cropland increased by 23 per cent in the Ordos and by 36 per cent in the abovementioned three banners. Both episodes of reclamation took place mainly in areas with more than 250 mm of annual precipitation, particularly between the Hobq Desert

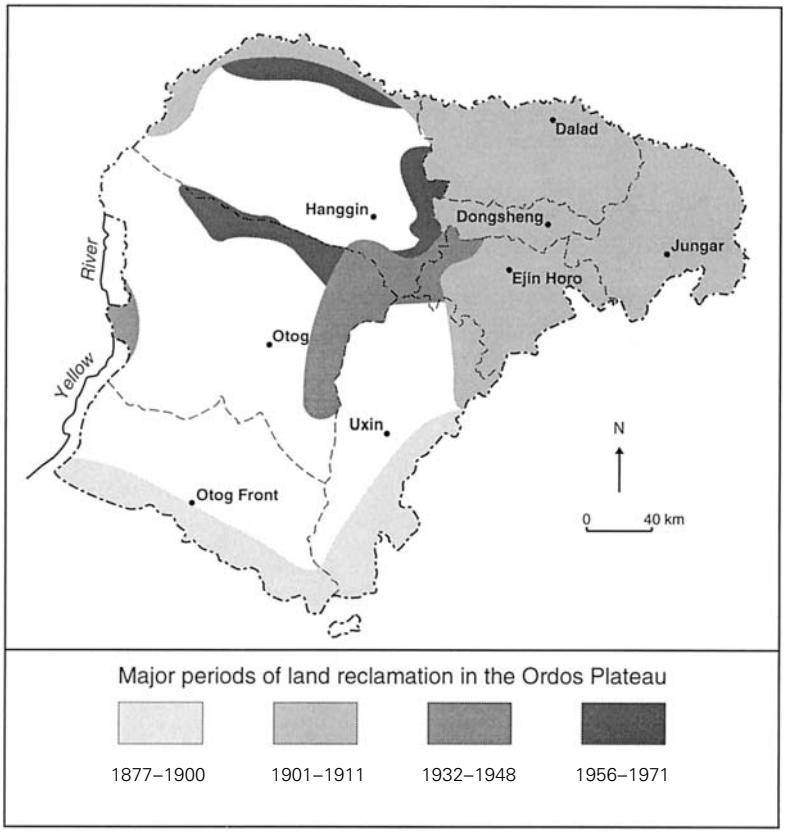


Figure 4.1 **Major periods of land reclamation in the Ordos Plateau**
Sources: Data compiled from field interviews, Ih-Ju League (1988), and Zhao et al. (1958).

and the Mu Us sandy land. Improper reclamation in the League during 1958–1964 covered an estimated 2.96 million *mu* (government archive). Much of it was the work of migrant farmers. People travelled distances of more 100 km from home in the growing season to sow and harvest crops. For example, in Otog banner in 1965, migrant farmers cultivated 250,000 *mu* (30 per cent) of the cropland. The banner government later had to close some of the cropland and relocate some people to avoid long-distance farming. The third expansion took place in 1970–1972. Though less significant than the others in terms of area, it was more harmful because it pushed cultivation westward into dry areas with less than 250 mm of annual precipitation, such as Gongqirige, Ih-Us, and Shanghaimiao *sumu*. Since

labour was scarce in these areas, ''migration cultivation delegations'' were organized, travelling tens and hundreds of kilometres to these areas to convert high-quality pasture into cropland. For instance, five townships and more than 30 villages in eastern Otog formed such delegations to open the pasture of Gongqirige; Chengchuan and Erdaochuan farmers from east Otog Front banner migrated to cultivate land in Shanghaimiao. Serious erosion and sandification quickly turned the cultivated areas into bare land, and moving sand even threatened people's houses. Though the situation changed after 1974, the impacts have persisted through the 1990s, and those lands have yet to recover fully. In general, it is estimated that of the area newly sandified between 1949 and 1989, 42.9 per cent is the product of overreclamation and inappropriate cultivation (Ih-Ju League, 1990).

Many researchers have studied the mechanisms by which overreclamation induces environmental degradation in dry and windy areas (Huang and Song, 1986; Zhu, 1990). Destruction of soil cohesion and vegetation protection generally reduces land surface friction and greatly increases erodibility; simultaneous losses of vegetation cover and soil surface crust are particularly harmful in wind erosion areas (Zhong and Wu, 1990). Moreover, cultivation leaves the land exposed in winter and spring when the wind is strongest, thereby exacerbating the harmful effects. Erosion on unprotected cropfields can be 70 times higher than that on pastureland (Shen, 1981). Cropland serves mainly as the source of eroded soil. Transport of depositions on to the surrounding area causes further land degradation. One unit area of eroded cropland may produce as much as three units of sandification.

Overgrazing

Animal husbandry in the Ordos has long emphasized livestock numbers rather than maintenance and productivity of pastures. Shepherds are opportunistic: they build up their herds in good years in order to survive the bad years. Overstocking usually results. For shepherds, moreover, livestock number is a sign of wealth. The government has also encouraged overgrazing by using livestock numbers as the major indicator of pastoral development. The overculling of high-quality and more palatable species gives them no opportunity to regenerate, and the trampling of pasture degrades soil texture and destroys the protective crust of land surface, facilitating sandification and vegetation degradation. As a result, pasture and soil deteriorate.

Table 4.1 **Overreclamation and overgrazing in Ejin Horo, 1950–1980**

Year	1950	1960	1970	1980
Overreclamation %	250	350	200	157
Energy utilization/crops %	1.3	0.92	0.69	1.1
Usable pasture (ha)	46	36.6	39.6	34.1
Pasture biomass (kg/ha)	2,625	2,325	1,650	1,500
Livestock carrying capacity (million sheep units)	57	40.5	23.3	26.1
Actual livestock (million sheep units)	56	65.5	65	80
Overgrazing %	−1.8	61.7	179	207

Source: Adapted from Cao (1988).

Table 4.2 **Estimated overgrazing in 1985**

Sources Place	Li et al. (1990) %	Ih-Ju League (1990) %
Ih-Ju League	57	38
Hanggin banner	53	4
Otog banner	59	13
Otog Front banner	30	−4
Uxin banner	51	9
Ejin Horo banner	196	159
Jungar banner	212	360
Dalad banner	66	88
Dongsheng city	208	244

Serious overgrazing has been obvious since the late 1950s. Table 4.1 shows the trend of overreclamation and overgrazing in Ejin Horo from 1950 to 1980. From 1960 to 1970, both overgrazing and pasture degradation increased quickly. From 1970 to 1980, pasture degradation slowed because of improvement efforts, but overgrazing continued under the stimulus of the market economy. This trend is common to all of the Ordos. The Animal Husbandry Department of Jungar banner estimated that overgrazing was 15–25 per cent in the 1970s. Li and colleagues (1990) and the Ih-Ju League Agricultural Regionalization (1990) give different estimates for overgrazing, but both indicate that overgrazing in 1985 was most serious in the eastern Ordos (table 4.2). From 1985 to 1990, overgrazing in the east was mitigated, but in the western high plateau, especially in Otog, it was accelerated by higher wool prices. For example, in Otog the theoretical carrying capacity is 750,000–800,000 sheep units, while the actual

number has been around 1 million since 1985 (interview with Otog Statistics Bureau, 1992).

Overcollection of fuelwood and medicinal herbs

Before 1978, farmers and shepherds depended mainly on natural vegetation for fuelwood. Of the pasture shrubs, *Artemisia ordosica*, *Salix psammophila, S. cheilophila*, and *Caragana korshinskii* are the main objects of fuelwood collection. According to the official estimation (Ih-Ju League, 1990), in the late 1970s, of the 190,000 households in the Ordos, 130,000 (70 per cent) used these species for fuel. If each household needed 350 kg of fuelwood per year, the total required was about 455 million kg of shrub biomass, equivalent to the production from 2,000 km^2 of good pasture. On average, 1,000 km^2 was sandified by fuelwood collection each year. In some areas in western Ejin Horo and south-east Hanggin, *Artemisia ordosica* was depleted, leaving only *Cynanchum komarovii* to be collected. Serious sandification followed.

After 1978, as transportation and the economy developed, more households burned coal. But there are still households (fewer than 25 per cent by estimates in 1990) that, lacking either money or transportation, collect shrubs from pasture. Some officials at the Jungar Department of Agriculture (interview, 1992) believe that the effects of shrub collection in the northern part of the Hobq Desert are becoming more serious. Past collection has stripped bare the edge of the desert, and people now go into the central part to harvest the sparse vegetation.

Excessive gathering of medicinal herbs is another serious problem. The Ih-Ju League is rich in these resources, with a total of 378 species (Ih-Ju League, 1988), 112 of which are purchased nationally. Collection of *Glycyrhiza uralensis* roots and *Ephedra sinica* stems is important in terms of resources available and amount purchased; the negative effects of their collection on the environment are also significant.

Digging of *G. uralensis* roots began in the Qing dynasty. Before 1949 the amount collected was modest, allowing *G. uralensis* to regenerate and expand. Since the 1970s, especially since 1979 with the stimulation of national commerce, root digging has greatly intensified. Of the 4 million kg of *G. uralensis* root collected in 1985, 2 million were purchased by the medical department of the League and the other 2 million sold to adjacent areas. The growing area

shrank from 1.2 million ha in 1949 to 387,600 ha in 1983, while total biomass dropped from 500 to 180 million kg (interview with Grassland Study Station, Ih-Ju League, 1992). Beginning in 1982, with money invested to protect and restore the resource, the *G. uralensis* growing area increased somewhat (to 415,999 ha in 1985), but the situation remains critical.

The way in which *G. uralensis* roots are dug contributes to soil erosion and sandification. *G. uralensis* grows mainly in the western Mu Us sandy land. Digging of each root makes a pit of about 1 m^2 in area and 1 m deep, and the dug-out sand covers about another 1 m^2 around the pit, thereby directly damaging 2 m^2 of pasture. On average, 60 *G. uralensis* plants are required to provide 1 kg of root. The annual production of 2–4 million kg of root thus causes 240–480 km^2 of direct pasture destruction and loosens 120–240 million m^3 of sand, causing further degradation by its transport and deposition. Intensively dug pasture has about one pit per 4–5 m^2, and becomes ungrazable for livestock. Though pit restoration is now required by the grassland-protection laws, these laws are not well enforced.

E. sinica has experienced similar destruction. Since it regenerates slowly, overgathering in both quantity (10 million kg/year) and manner (overcutting of above-ground stem) is depleting the resource rapidly and, at the same time, seriously degrading pastureland.

Overhunting and other activities

Harmful insects and rodents are another source of environmental degradation that should not be overlooked. It is estimated that the clawed jird (*Meriones unguiculatus)*, merely by its digging of holes, has caused the sandification of more than 300 km^2 of pasture. The total forage reduction is equivalent to an amount capable of feeding 1 million sheep each year. In Otog, clawed jirds dig out 84.6 m^3 of sand every year for hole building on every hectare of pasture, causing sand erosion 8 cm deep.

Uncontrolled hunting of some species has increased the population of rodents by sharply reducing the numbers of predators. Foxes and vultures are important checks on the rodent population. Every year, a fox can kill 1,500–3,000 rats and a vulture can eat 600–800 rats. Excessive hunting of these predators has contributed to the increases in the rodent population. Ih-Ju League government officials concluded, from their incomplete sampling, that the External Trade Department of the League purchased 97,600 pieces of fox fur and 4,335

pieces of eagle and vulture hide from 1965 to 1978. Weasel hides were also purchased.

Road construction and coal mining also have their effects. The area disturbed is small, but the impact is serious. Along a road a band 60–100 m wide is severely disturbed. Coal extraction, a minor source of landscape transformation in the past, will probably become significant in the future as open mining increases.

Underlying driving forces

Underlying the proximate sources are the driving forces of change: factors in society that either drive or accelerate human proximate activities that, in turn, degrade the environment (Kasperson, Kasperson, and Turner, 1995; Turner et al., 1990b). In other words, driving forces link to environmental changes through proximate activities. An analysis of driving forces is necessary to understand environmental degradation in society.

In the Ordos Plateau, the main driving forces of environmental degradation are population (number and quality of life), cultural values, economy (economic capability and economics), government policy, and resource-use institutions. Most of these factors will be dealt with again in the discussion of societal responses, since under different circumstances they may have positive impacts upon the environment. Technology is not explicitly considered here as a driving force but only later as an element in societal responses (see chapter 6). This is because, in the study period (since 1949), significant technological change did not accompany rampant environmental degradation (before 1978) but rather occurred along with environmental improvement (after 1978).

The following discussion addresses each of the driving forces of environmental change in the Ordos, concluding with some remarks on their interaction and relative importance.

Population and quality of life

Population increase

Human demand for resources is among the direct forces that drive environmental changes. All else being equal, human demands (such as food needs and fuelwood requirements) tend to increase proportionally with population growth. To moderate the negative effects of

population increase, socio-economic improvement, political intervention, education, and technological advances are required.

Over the historical period, the population in the Ih-Ju League has changed tremendously. The Western Han dynasty saw the first peak, with maximum densities approaching 10 people/km^2 in the south-east Ordos (Yang, 1991). A comparison with the figure of 13.5 people/km^2 in 1989 indicates that environmental conditions in the earlier period might have been quite favourable to feed so many people under a less advanced technology. With the decline of farming, population decreased. The Tang dynasty witnessed a second peak. From the Song to Ming dynasties, the area was sparsely populated. From the middle to the end (1911) of the Qing dynasty, the population stagnated at about 200,000. In 1949 there were 411,747 people in the Ordos (Ih-Ju League Statistics Bureau).

Since 1949, with the improvement of socio-economic conditions, the population has grown rapidly (table 4.3), and the population density has risen from 4.7 people/km^2 in 1949 to 13.5 people/km^2 in 1989. Human labour and activities, meanwhile, have increasingly altered the natural environment. The rate of population growth, however, decreased over the period. In the 1950s, the total population growth rate was 4.3 per cent annually while that of the rural population was 3.61 per cent. Immigration from outside the region accounted for about 30 per cent of the total increase. In the 1960s, the

Table 4.3 **Population growth, 1950–1989**

	Total population		Rural population	
Year	number (thousands)	growth rate[a] (%)	number (thousands)	growth rate[a] (%)
1950	427.7	–	418.6	–
1954	513.6	4.52	493.2	4.18
1959	627.9	4.12	572.1	3.03
1964	721.0	2.82	666.1	2.14
1969	824.3	2.72	761.3	2.71
1974	946.2	2.80	850.1	2.23
1979	1,028.3	1.68	907.9	1.33
1984	1,116.0	1.65	971.5	1.36
1989	1,184.1	1.19	–	0.36[b]

Source: Ih-Ju League Statistics Bureau.

a. Five-year average of annual growth rate.

b. For 1985–1986 only.

overall and rural growth rates dropped to 2.77 per cent and 2.93 per cent respectively, and immigration was insignificant (5 per cent). In the 1970s, the two growth rates further decreased, to 2.24 per cent and 1.78 per cent, respectively, and net outmigration was significant (14 per cent of the new increase). In the 1980s, with the introduction of population control, the growth rate fell sharply at the end of the decade (to 1.19 per cent). Overall, from 1949 to 1989, the population increase came largely from within the area through a high birth rate (3.5–4.2 per cent per annum before the mid-1970s); immigration accounted for only 8.9 per cent of the total increase from 1949 to 1985.

Social factors largely accounted for the high rate of population increase. Underlying pro-naturalist policies in the 1950s and 1960s was the ideology of population as ''the great human labour resource,'' as if labour could produce without the input of necessary natural resources. Malthusian theory and related concerns about population-resource relationships were criticized as bourgeois. Once the population issue acquired political meanings, further debate was discouraged. Pro-population policies, plus medical services that spread over rural China, led to a rapid population increase (also see Zhang and Wang, 1986). Medical services and hygiene programmes are beneficial (see Kapp, 1974), but can also lead to problems when poorly coordinated with other socio-economic forces. After the 1970s, population growth rate dropped sharply with the policy on population control, the effect of which will be discussed in chapter 6.

The density and composition of population vary across the region (fig. 4.2). The League is mainly composed of Han and Mongolian people. The three eastern banners and Dongsheng city are farming and farming-pastoral transitional areas. Population density is high and Han people are the dominant group (over 90 per cent). The four western banners are dominated by grazing. The environment is harsh and population density is low. Many Mongolian people, originally nomadic minorities, have lived there and maintained their traditional land uses. This pattern of population differentiation, in turn, influences the pattern of environmental change. With other socio-economic variables in the Ordos spread relatively evenly over space, higher population densities cause greater environmental deterioration, as is the case in Jungar banner. As chapter 3 shows, ethnicity also affects environmental changes by maintaining certain land-use styles. Han people, while bringing agricultural techniques, modern ideas, and new dynamics (e.g. linkages with areas outside the region) to

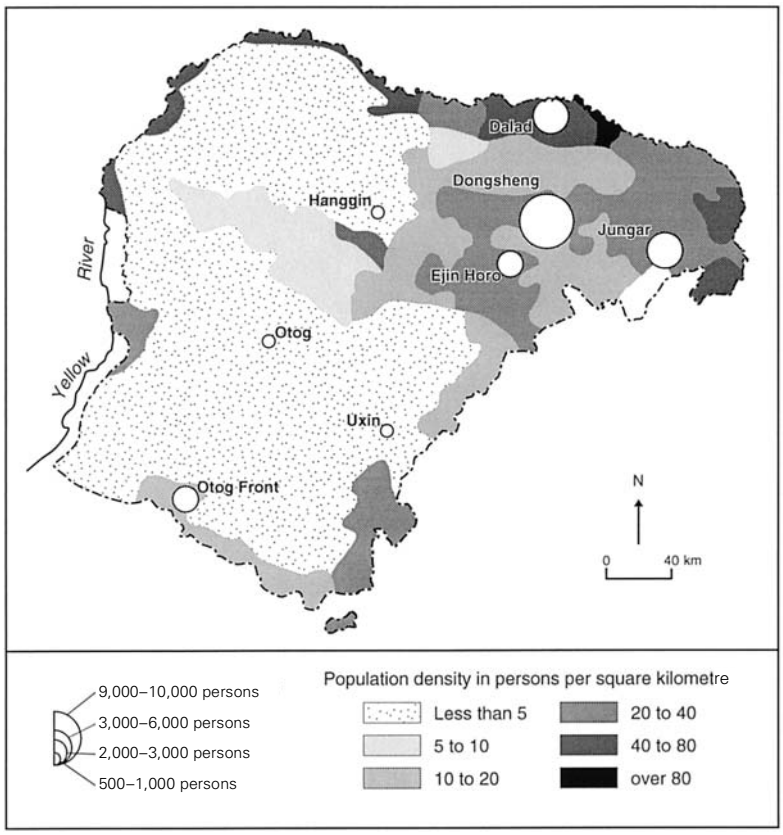


Figure 4.2 **Population density in the Ordos Plateau**
Source: Adapted from Ih-Ju League (1988).

this area, at the same time also drove environmental damage through land reclamation.

In short, the high rate of population growth has been a powerful driving force of environmental deterioration. Since 1978, new policies of population control and economic planning have ameliorated the situation.

It is worth mentioning here that the Ordos is not as densely populated as some of the other environmentally problematic semi-arid areas in China and around the world. Many other semi-arid sandy lands in China have over 40 people/km^2; by comparison, the density of 13.5 people/km^2 in the Ordos is not high. In other places in the world, North Africa has 80–150 people/km^2 in areas with less than 300 mm of annual precipitation. Some sandy areas of India with less

than 500 mm of annual precipitation have 50 people/km^2, and the Mediterranean dry belt is populated by more than 45 people/km^2. Population in the Ordos, although more than in its own past, has thus not presented such an obstacle for the environment as in many other semi-arid regions in the world. In other words, population increase has not rendered environmental restoration impossible in the Ordos.

Quality of life

In the Chinese media, the phrase ''quality of population'' is frequently used to indicate a cause of rural (including environmental) problems in China. ''Quality of the labour force'' is particularly often mentioned in economics (e.g. Li, 1991). Given the vagueness of the former term and its potential insensitivity to the conditions of local people, I use ''quality of life'' to refer to the opportunities for education and social development that are important not only for their effect on human ability to cope with life overall, but also for their indirect impacts on environmental change. Specifically, I am concerned with factors beyond economic measures that affect both the quality of life and human relations with the environment.

Education is the aspect of quality of life on which I focus in this section. I will not dwell upon the link between education and the environment in general, except to say that access to education is as important in the Ordos as it is in the rest of the world. As the League is designated as a ''poor area,'' the educational goal was to universalize primary-school education by 1990. The basic requirements for schools are ''no dangerous classrooms; every class has its classroom and every student has a desk and a chair'' – conditions that were met only in 1988. Schools are few and conditions are still poor. Most villages in the farming area have primary schools, but many pastoral villages do not. In the latter case, small children have to live at school away from home, which is difficult for both children and parents. Middle schools are few in the countryside, and students usually have to go to the city or towns to enter high school. There are only seven middle schools in the whole of Jungar banner. Students from far away have to board, which adds to the financial burden on the family and is also very inconvenient. As a result, only 77 per cent of primary-school pupils continue on to junior high school, and 36 per cent of junior-high graduates enter high school.

The quality of teachers is inadequate (table 4.4). Community-run schools are generally not encouraged, owing to the lower teaching standards and poor instructional quality. Of the 17,114 teachers and

Table 4.4 **Conditions of schools in the Ordos Plateau**

Place		School numbers[a] Total	Senior high	Junior high	Primary	Teacher qualifications High[b] (%)	Primary[c] (%)
Ih-Ju League		1,365	22	57	1,314	18	58.1
Cities and towns		58	19	5	35	–	–
Rural areas		1,307	3	82	1,279	–	–
Banner	Dongsheng	95	8	1	86	31.6	61
	Jungar	329	2	5	322	18.5	58.7
	Dalad	259	2	37	247	11.4	60.9
	Ejin Horo	192	2	15	189	12.4	55.9
	Otog Front	88	2	6	84	10.7	43.8
	Otog	154	2	9	147	22.3	55.3
	Uxin	92	2	4	90	11.9	65.4
	Hanggin	156	2	10	149	18.3	57

Source: Ih-Ju League Statistics Bureau

a. Some schools have both junior and senior high education, thus the total number of schools is less than the sum of all schools.

b. Percentage of high-school teachers with professional college or university education;

c. Percentage of primary-school teachers with high-school education.

staff in the League, 60 per cent are not government-hired, which means that they are farmers or shepherds as well and have their own land and herds to tend. They generally have poor qualifications, receive low pay, and enjoy low welfare. In the whole League, according to the standard set by local government, 36 per cent of teachers in primary schools, 70 per cent of teachers in junior high schools, and 64 per cent of teachers in senior high are not qualified (*Eer Duo Si Bao* [*Ordos Daily*], 28 November 1989). People with higher education do not want to work in rural areas because of the poorer conditions. The ''brain drain'' is also very serious, as it is in most rural areas in China.

According to the 1982 and 1984 population censuses, the educational situation in the Ih-Ju League, though better than in 1964, was still poor (table 4.5). Farmers and shepherds attain lower levels of education than workers, and females lower than males. In 1982, for example, the illiteracy rate was 33 per cent in the countryside and 11 per cent in towns and cities. The illiterate and quasi illiterate included 44 per cent of women and 23 per cent of men.

The low level of education, particularly of farmers and shepherds,

Table 4.5 **Education levels in the Ordos Plateau**

Year	Place	University or college %	Senior high %	Junior high %	Primary school %	Quasi illiterate and illiterate[a] %
1964	Ih-Ju League	0.12	0.52	2.4	19.19	43.63
1982	Ih-Ju League	0.24	4.68	14.27	26.61	32.9
	China	0.6	6.62	17.76	35.36	23.5
	Inner Mongolia	0.57	7.46	19.3	32.77	22.4
1984	Ih-Ju League	0.24	4.67	14.27	26.6	32.86
	Cities and towns	1.3	11.64	19.73	18.47	8.26
	Rural areas	0.04	3.2	12.71	26.92	35.81
	Dongsheng	1.15	11.11	21.72	25.74	22.52
	Jungar	0.12	3.93	12.76	25.49	36.85
	Dalad	0.15	4.36	15.27	26.74	32.36
	Ejin Horo	0.12	3.39	12.48	24.08	37.94
	Otog Front	0.04	2.41	9.73	25.95	35.11
	Otog	0.21	4.14	14.3	29.78	30.87
	Uxin	0.19	4.24	12.13	26.43	33.08
	Hanggin	0.14	4.07	13.44	29.42	31.47

Source: Ih-Ju League Statistics Bureau
a. Based on people aged over 12 years.

affects human behaviour, ways of life, and perceptions of the environment and has a profound impact on environmental patterns and potential for change. Lacking education, people tend to stick to traditional ways of life rather than accept new thoughts and technology. The high birth rate that prevailed before the 1970s, although affected by social problems (such as the scattering of shepherds' dwellings, scarcity of labour, and lack of old-age support), received support from the cultural view that more children will produce greater family happiness. In farming and grazing, lack of education discourages change and enhances traditional practices of extensive land use, thus reinforcing overexploitation and environmental degradation (chapter 3).

One family I interviewed can be used to illustrate how the educational situation limits choices in human life beyond economic measures. I do this for two reasons. First, education and other choices in life are essential measures of societal development, without which a sustainable environment may be unachievable over the long run. Second, this family represents the near-future direction of pastoral

development in the Ordos; the restrictions on them suggest future limitations in the Ordos.

The Mongolian pastoral family of Balajinima and Arlatengzhagesu (Chinese translation of the mother and father's names, respectively) in Chaganmiao *gacha*, Uxin *sumu* is a model family in pastoral development and revegetation activities. I identified them from a report in the *Eer Duo Si Bao* (21 April 1989), which portrayed them as rich and worry-free in devoting themselves to revegetation, application of fine pastoral techniques, and helping other shepherds in Aomei sheep breeding. Obviously they are among the most admired in the area.

Balajinima has a family of four: the couple and two children, their daughter Narengaowa and their son Gelatai. They have 430 *mu* of pasture, cultivate 10 *mu* of corn, broomcorn millet, and potatoes, and raise 100 sheep. They have a complete array of machinery: mower, grass cutter, four-wheel tractor, and diesel pumping machine; a well and irrigated land; a windmill (although the electricity is unreliable); a radio; and a 14-inch black-and-white television set. The couple taught themselves how to read Chinese (since most publications are in Chinese) and thus learned farming and pastoral techniques from books, radio, and television. After 1978, they began to work on sheep breed improvement, fine-forage storage, and disease prevention. Having invested in pasture enclosure, wells, and machinery, they practise rotational grazing and store green forage for winter. Their good breed of Aomei sheep have already reached the fourth and fifth generation with stable features, producing more and better extra-fine wool and meat (while also requiring better care). They adopt improved varieties of corn and use surface filming (i.e., covering the cropfield with a thin film of plastic to prevent excessive water evaporation) and other cultivating techniques; their corn yield is twice as much as others. The banner government has given them several awards, which they proudly hang on their wall.

Their income is the highest in the area. In 1988 when wool prices were at their peak, their family income was around 20,000 yuan. More recently, with the dropping prices and more taxes/fees, their income decreased to 6,000 yuan in 1992.

The exemplary parts of the story were fully covered by the *Eer Duo Si Bao* report. What follows is the other part of the story, important but not covered. When I brought the copy of the *Eer Duo Si Bao* with the report about them, they told me they had not seen it. Like other shepherds, they do not subscribe to newspapers; theirs is

simply not an information society. Furthermore, newspapers do not cover economic activities well and many shepherds (excluding Balajinima's family) are illiterate. Most villages subscribe to local newspapers, but when they arrive their contents are no longer news; it takes seven days to deliver newspaper from the League centre, Dongsheng, and more than 20 days for newspapers to arrive from outside the area. Because of poor transportation and communications, people have to go more than 50 *li* (25 km) to send a letter.

When I asked about the difficulties in their life, they mentioned two: the education of children, and support for techniques in farming/grazing. This is true not just for them, but also for most other shepherds in the area. The first is their family priority. Their daughter Narengaowa, 13 years old in 1992, had just graduated from primary school but did not pass the entrance examination for middle school. It is a local regulation that students who do not pass the examination cannot retake it. The reason is a lack of capacity in middle schools to accept more students. Balajinima told us that:

> There is a primary school in the *sumu*, but kids have to go to Wulantaolegai *sumu* (several kilometres away) for middle school. Even so, the entrance rate is very low. Around here there are only two who passed the test and can go to middle school. We have the money to pay her tuition, room, and board, but we have no way to find a school for her. She is too young to give up education, and too young to become a shepherd. From our experiences, we know how important it is to go to school, even to be just a good shepherd. I have a sister who lives in Baotou [a big city north of the Ordos]. I want to see if she can help my daughter to enter school there. We are willing to pay anything we have for our children's education with no regret, since we know how important it is. We just hope we can find a school for her.

During the interview, I was deeply touched by the sincerity of the shepherds and deeply disturbed that their lives are so much affected by precarious factors (natural and social) beyond their control. When many people, even local leaders, say ''the shepherds are rich,'' they do not see how hard shepherds have to struggle to combat environmental hazards such as drought and sandification, and confront social difficulties such as lack of opportunity for education and access to modern technology. Their choices are greatly restricted by the area's generally poor conditions in education, transportation, communications with the outside world, and so on. Although not the direct cause of environmental degradation, this situation pervasively affects the environment through population growth, approaches to resource

management, and environmental perception and behaviour. Without social sustainability, environmental protection cannot be secured.

Attitudes and beliefs

The constraints of tradition

I have found it a challenge to explain to the English-speaking world the meaning of *bao shou* (conservative), which is used frequently in Chinese literature to explain, albeit only partially, why the land is ill-managed and the environment degraded. This term is also used, especially in public media (such as *Eer Duo Si Bao*), in the case of the Ordos Plateau. Superficially, it denotes a lack of change and an obstinate adherence to the undesirable elements of tradition: close-mindedness, short-sightedness, submisiveness, and provincialism, including a whole set of values and behaviours such as complacency, lack of aggressiveness, lack of self-confidence, and fear of change. The term is also used with an implicit frustration that people should be wise enough to change. Apparently, the term has ideological connotations: that ''progress is good, and dynamics and flow are favourable for a society.'' The reasons why people perceive and behave ''conservatively'' are beyond the scope of this analysis, except to quote the words of Lao She, a respected Chinese writer: ''The laziness of farmers is not their fault; it is life that disappoints them again and again.''

The Ordos is a relatively closed and inaccessible area, and conservative ideas are strengthened by the isolation and poor education. The thoughts of farmers and shepherds come not from modern science and technology, but from experience and oral instruction by their older generations. School education began in 1934, when the first primary school was founded in the area. Before 1949, it was chiefly lama religion that guided human behaviour. According to the *Report on the Western Four Banners of the Ih-Ju League* (Sui-Yuan Government, 1939), the lama temple was regarded as the highest school, and being a lama was considered the most honorable occupation. Some 60–70 per cent of young men were lamas, leaving only a small number of working labourers, mostly women, for grazing. The predominance of lama doctrine prevented the adoption of outside perspectives and culture.

After 1949, though education developed quickly with the help of the national government, educational conditions remained rudimentary and schooling was not considered important. Adherence to tra-

dition did not loosen much, and people were often suspicious of new ideas and technologies. For example, the introduction of new farming techniques (such as surface filming) and crop varieties (such as corn) or the advertisement of new pasture-management methods (such as construction of man-made pastureland) always encountered strong resistance in the beginning.

Since 1978, greater political openness and market development have brought to the Ordos new ideas and modern sciences that run counter to traditional customs. The knowledge horizons of farmers and shepherds have been very much broadened. Farmers have gradually adopted new farming techniques, such as surface filming and watershed management, and shepherds have realized the importance of constructing pastures and controlling the numbers of herds. But when it concerns further development, the area is still not accessible. For example, *Sailx psammophila* is an important shrub for environmental protection on pasture and cropland. In Manlai township of Dongsheng city, in order to encourage the planting of *S. psammophila*, a timber-production plant was planned using this shrub as material. But because of a lack of information about the timber market, the plan called for the production of a kind of synthetic timber that was already outdated. This makes the marketing of the product problematic in the future.

Submissiveness and a lack of self-confidence tend to dampen hopes for change and a better future. Although many factors (including the corruption implied in the conversation reproduced below) are beyond the control of the people, passiveness hampers people's determination and constancy in environmental protection. The following conversation with an old farmer from Deshengxi township, Jungar, illustrates this passivity:

Question: We heard that recently the government is extending shrub planting to control soil erosion. What results do you see?
Answer: Oh, nothing really, except for harm, we cannot graze sheep any more.
Question: What do you think about soil control?
Answer: We have to do it; how can we not? The government requires us to devote certain time; if not, there is a fine.
Question: Are there any subsidies for revegetation?
Answer: Not much. I heard last year we were given 300,000 yuan. Besides covering tree seedlings, it must have had to cover the meals for the leaders, so there is not much left.

Question: What do you think of the 3153 project [a regional revegetation project; see chapter 6 for details]?

Answer: Are you talking about the pet project of Chen Qihuo [the leader of the League]? They are just projecting blindly in Dongsheng [the capital city of the area]. They want us to raise sheep but in the shelter; where can we find grass? Talking about collecting grass, we can collect one basket and those leaders can barely collect a handful.

Land-use styles are profoundly affected by human history and tradition. Extensive land use was practised for a long time before the 1970s. In cultivation, inputs were low and protection was neglected. When natural fertility was depleted, the cropfield was frequently abandoned. In 1949, abandoned cropfields were estimated to cover more than 731,000 ha. Migrant cultivation subsequently depleted croplands even more quickly. Abandonment in dry years and reclamation in rain-abundant years were both common. In pastureland management, overgrazing originated from the nomadic grazing tradition under the stimulus of increased human needs and economic development. Shepherds focused on livestock numbers rather than net production; therefore, many long-lived breeds of sheep, goats, cattle, horses, and camels were kept on pasture without being culled, growing fat in the warm seasons and thin in the cold, thus wasting energy and increasing pressures on pastureland. The adverse environmental impact of the traditional extensive land use was discussed in chapter 3.

Human perceptions of the semi-arid environment

This section deals with another facet of human attitudes: perceptions of the semi-arid environment. Such perceptions enter into an understanding of the fluctuating nature of the environment. I shall discuss how governments, scientists, and local people perceive the semi-arid environment of this area, and how this affects land resource management. Other aspects of environmental perception and behaviour will be addressed in the next chapter.

The most important physical characteristic of the semi-arid environment is its variability, especially in precipitation. Statistically speaking, precipitation is a random variable that has a large deviation from the mean in semi-arid areas. Yet because randomness and probability are difficult to comprehend (see Whyte, 1990), people are used to thinking in terms of the ''average state,'' a statistical parameter instead of its real distribution. Most scientists and government

officials use this average, thus hiding the feature of fluctuation, as well as the need for managing this fluctuation.

The national government has perceived the environment in what appears to be a constant and linear sense. After 1958, centrally planned agriculture used five-year plans and fixed target yields as the measures for achieving economic goals. There appeared to be no acknowledgement of the need to manage fluctuations. Even as late as 1980, as governmental archives demonstrate with regard to grain and oil crop targets, the concept was still ''once the amount is established (by the upper government), it will remain in effect for five years.'' This policy shows little recognition of agricultural fluctuations. The local government has a better understanding of the local environment, but it still sees fluctuation as something bad and not as something to adjust to positively. Thus, fluctuations have been treated as hazards instead of inherent features of the environment.

Scientific writings about semi-arid environments have often reinforced governmental perceptions. Much of the literature uses average annual rainfall to characterize precipitation, which in fact requires characterization by not only its mean but also its deviation, probabilities, and ranges over different confidence intervals. Fluctuations require particular scrutiny in the management of semi-arid environment, yet they rarely command the requisite attention (but see Jiang, 1989, 1990).

Farmers and shepherds treat environmental fluctuation as fate. In my interviews, I frequently heard them say that ''if we are lucky, we will have enough rain and everything will be fine.'' The good years are taken as normal and the dry years as hazard. There is a sentence widely quoted in the Ordos (and other semi-arid areas of China as well): ''nine out of ten years have drought.'' Since to local people fluctuations are due to fate, they are not subjected to management.

When the environment fluctuates, so do people's livelihoods. To adapt to the drought years, farmers desire more cropland area, which has exacerbated the pressure for pastureland reclamation. For shepherds, the traditional way of dealing with fluctuation is to build up herd sizes, which was further encouraged by government emphasis on augmenting livestock numbers. As a result, pasture is overstocked even in good years. Drought years cause environmental degradation, both directly by driving overexploitation and indirectly through economic decline. Therefore, drought years were (and still are) critical, usually launching new waves of environmental deterioration, the ecological mechanisms of which require further study.

Likewise, strategies for dealing with fluctuation were not built into local economic management. Management strategies suitable for the state of the environment, such as pasture-herd balance and economic compensation between good and bad years, as suggested by Jiang (1990), were not adopted. The Ordos is therefore very sensitive to environmental fluctuation and vulnerable to environmental changes.

Economic restriction (economics)

Both affluence and poverty have been discussed as causes of environmental degradation (Ehrlich and Ehrlich, 1990; Stern, Young, and Druckman, 1992; Turner et al., 1990a). The effects of affluence, mainly in the developed world, need to be ameliorated through changes in lifestyle and more frugal use of energy and other resources; those of poverty, mainly in developing countries, need to be dealt with through further economic development. Although economic development has been widely cited as a cause of environmental degradation, in the Ordos I have found it to be more beneficial than detrimental to the environment. Poverty has been a powerful driving force for environmental deterioration, and environmental problems are fundamentally economic problems.

The links between poverty and environmental degradation are not simple, as much literature indicates. The often-used sentence ''the poorer people are, the more pasture they reclaim; and the more they reclaim, the poorer they are'' in reality implies many intricate linking factors, as shown in fig. 4.3. There are four sequences involved (Kates and Haarmann, 1992; Leonard, 1989).

The first is the continuation of traditional extensive land use under increased population. This induces excessive and inappropriate use of natural resources, thereby leading to degradation. In the second sequence, as the share of resources per person is reduced, poverty limits other choices of resource exploitation. One example is excessive collection of fuelwood. Although rich coal deposits and wind power can provide abundant energy for the Ordos, two major factors prohibited the use of these alternatives to biomass burning prior to 1978. The first was poverty. People did not have enough money to buy either coal or windmills. The second was poor transportation, also a result of poverty. Road construction, though increased significantly from camel routes before 1949 to 3,050 km of highways in 1985, is still very limited. More than 80 per cent of the highway is unpaved and untraversable on rainy days. Farmers and shepherds had to rely

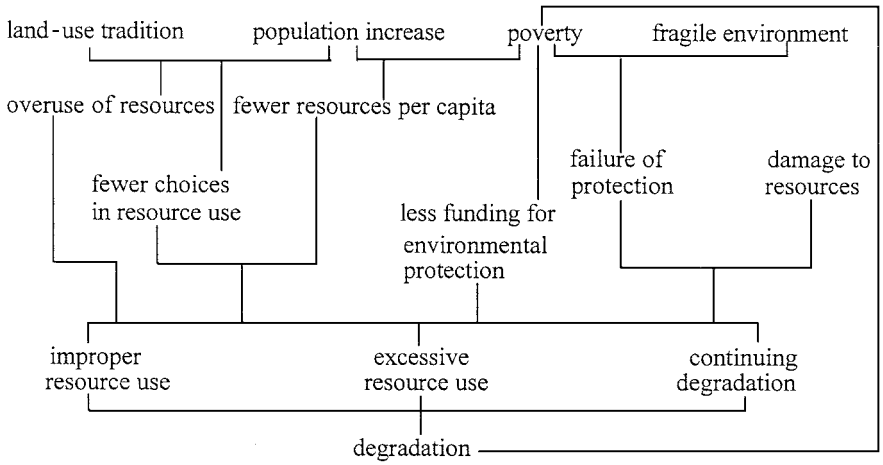


Figure 4.3 **Poverty and environmental degradation spirals**
Source: Adapted from Kates and Haarmann (1992) to suit the Ordos situation.

mainly on cattle and human labour for transportation. This hampered the transport of coal.

In the third sequence, poverty precludes financial investment that could bring about environmental improvement. In highly sensitive environments, environmental protection, and especially improvement of already degraded land, is very difficult to achieve, and financial (labour and material) input is critical. Revegetation in the Ordos is an example. It is not easy to keep new plantings alive in the face of drought and gusty wind until the revegetation reaches the level of self-regeneration. Thus environmental improvement requires at the outset investment of both money and labour, and the maintenance needs are even greater. Economic returns are limited in the short term. Hang-puchuang watershed in Jungar banner is an example of improvement resulting from heavy investment by the national government. According to incomplete statistics, investment for every square kilometre ranges from 2,500 to 20,000 yuan (interview with officials in Jungar banner, 1992).

The fourth sequence combines poverty and ecosystem fragility. Given a high sensitivity to human disturbance and a low capacity for rehabilitation, the environment in the Ordos is easily degraded but not easily restored, as is discussed in chapter 2. Poverty makes environmental improvement even more difficult on the one hand, and, due to economic constraints, induces further degradation on the

other. A vicious cycle between environmental and economic deterioration is thus formed.

All four sequences are at work in the Ordos, where they combine to exacerbate environmental degradation. Some alleviation has occurred since 1978, with increased economic capacity and a reduction in the rate of population increase, but poverty is still an important driving force for environmental degradation.

The economics of environmental protection deserve some attention. Environmental protection, especially revegetation, is not a short-term, cost-effective project; it carries mainly long-term benefits. In the absence of government subsidies or other sources of funding, people tend to shun environmental protection. This is especially true in farming areas. Wangqingta village, Dongkongdui township, next to Heihadai township, provides an example. It is not in the jurisdiction of the watershed improvement programme; therefore subsidies for revegetation are scant and cover only tree seedlings for poor households. Although people want to learn the approach of revegetation from Heihadai, as stated by village leader Kang, ''they are practical about economic gain. Without government investment, it is difficult to mobilize people to act. Revegetation is not like transporting pebbles for the coal mine (for construction), which can earn quick money. There are people who go to the neighbouring Heihadai township to make money by helping their tree plantation.''

Government funding for environmental improvement has been very important. In my visit to the area, many farmers, shepherds, and leaders expressed their need for more ''support'' (funding) and complained about inadequate financial resources for environmental improvement. They say that without such support, ''leaders cannot work smoothly and people cannot act easily.'' Funding and economic capacity have been very important factors. Even Heihadai, now among the better-off townships because of government funding for environmental protection, still worries that if its funding does not continue, it will be difficult to maintain the progress they have made. In areas outside the programme's jurisdiction, a lack of funding and government support means only scattered household planting and little in the way of overall planning and collective organization.

The prices of agricultural products and input materials also have profound impacts on resource management. Before 1978, fixed and artificially low prices and the prohibition of a market economy provided little stimulus for increased production. After 1978, under a market economy, prices became important regulators of production,

Table 4.6 **Price comparisons (cents/jin)**

Material		Price before 1978 (a)	1992 price (b)	b/a
Agricultural products	corn	7–8	20	3
	broomcorn millet	10	40	4
Input material	plough (yuan/one)	10	40–50	4.5
	diesel	30	160	5.3
	fertilizer $(NH4)_2SO_4$	20	70	3.5
	fertilizer $(NH4)_2CO_3$	6	18	3

Source: Field interview.

with significant indirect impacts on the environment. During the early period (1978–1988) of price reform, the high prices of agricultural products mainly produced positive impacts on both economic production and resource management. Negative effects also occurred, of course, overgrazing being one example. In the 1980s, a boom in China's wool mill industry sent wool/cashmere prices soaring and stimulated sheep and goat grazing. Cashmere and wool prices peaked during 1986–1988, making overgrazing very profitable over the short term.

The drawbacks of price reform became evident mainly after 1988, as prices of production materials increased faster than those of agricultural products (table 4.6). At the same time, taxes and fees rose. In the late 1980s, the government started to tax the land, making Household Responsibility a contract system. The government of the Inner Mongolia Autonomous Region decides what kinds of taxes are collected (for the land and property) in the area, and local governments determine tax rates and collect the taxes. At the same time, local governments can collect various kind of fees (e.g. for education, entertainment, and livestock disease prevention). The tax rates I provide here are only approximate figures for 1992 (interview): each sheep is taxed 1–1.5 yuan, man-made pasture 0.3 yuan/*mu*, good-quality natural pasture 0.1 yuan/*mu*, other pasture 0.05 yuan/*mu*; cropland 16 yuan/person on average. There are altogether four major and 33 total kinds of taxes and fees, and the per capita levy reaches over 100 yuan. Most people I interviewed did not fully know what fees were collected. They feel overburdened, and object to government levies. Because of the high prices of production inputs and the taxes/fees, people do not see a path to making money. An outflow of labour has occurred in farming areas, although the Jungar banner

leader Qi believes it to be a temporary problem. In some villages in Jungar, young people have left to work at coal mines or in towns, leaving the villages short of labour and lacking energy for environmental protection.

Policy and resource-use institutions

Policy changes

In China, state government and its extensions cover all urban and rural areas and play important roles in many aspects of social and economic life. In the absence of powerful non-governmental organizations, all policies are made by government and executed through governmental extensions. In the Ih-Ju League, as elsewhere in China, the evolution of policy and political factors either determine or profoundly affect population growth, education, land-use management, agricultural and industrial development, and environmental management. Among the driving forces of environmental change, government policies are the most powerful and effective.

Policy changes since 1949 (table 4.7) can be characterized by the word ''oscillation.'' Political policies, which are the most significant in directing other kinds of policies, fall into four periods. The first is 1949–1957, when state policy emphasized political re-establishment and economic restoration. From 1958 to 1965, policy fluctuated between economic development and political movements. In the disastrous period of the Cultural Revolution in 1966–1976, class struggle was the priority in the country, and economic and related issues were neglected. The fourth period, which began in 1977–1978, when economic reform occurred, is fully discussed in chapter 6; here I deal mainly with the first three periods.

Since 1949, it is obvious that the socialist system and land distribution put the Ordos on a new course of economic development. People, released from their oppressed and exploited position, were able to enjoy the fruits of their own labour. Despite bringing better opportunities for social and economic development, the socialist system in practice led to accelerated environmental deterioration before 1978. This does not mean that the socialist system was or is not suitable for China; what caused problems was rather the actual practices and policies over the first few decades, especially in the 1960s and the first part of the 1970s. Of course, aspects of China's long feudal history and international political relations also help to explain why the

Table 4.7 **Policy changes in the Ordos Plateau**

Year	Political directives	Socio-economic policies	Environmental policies
1949–1951	liberation and political stability	economic recovery, livestock disease prevention, and well digging	
1952	land reform, distributing land to the poor	pastoral development, more care in herd grazing	grass planting
1953–1954	(stabilizing land reform)	solving farming/pastoral conflicts, confirming pastoral dominance	proposed rotational grazing and ban on pasture clearing
1955–1957	cooperative movement	planned economy in farming and animal husbandry, first reclamation	revegetation to combat soil erosion
1958–1960	Great Leap Forward	formation of the commune, collectivizing land management, and second reclamation	control of moving sand
1961–1963	correcting Great Leap Forward	task grain and livestock numbers from state	promoting private tree planting
1964–1965	recovery from Great Leap Forward	balanced farming/pastoral development and correction of overreclamation	protecting pasture, planting *Caragana*, ban on clearing, and closing steep-slope farmland
1966–1976	Cultural Revolution	total control of economic activities, prioritizing grain production, third farming expansion	slopeland terracing and poisonous herb removal (''Learning from Dazhai'' movement)
1978–1988	Household Responsibility	economic reform, balancing of farming/pastoral economy, loosening of central control, population control	emphasizing land suitability, pasture protection, revegetation, and watershed management
1989–present	strengthening Household Responsibility and recollectivization	further freeing agricultural prices and state control, further development of market economy, application of new agro-technology, and population control	continuing pasture protection and reconstruction, revegetation, and soil erosion control

road China took was so rough. I do not pretend, nor do I have the expertise, to analyse the legitimacy of Chinese state policy under the national and international political background. I will try only to trace the effects of policies on human-environment relations in the Ordos Plateau.

The ways in which policies drove environmental damage were both direct and indirect. Direct effects were environmental degradation caused by the three expansions of reclamation under the national ''grain first'' agricultural policy. A discussion of these significant impacts can be found earlier in this chapter.

The indirect effects came from the national political ideology of neglecting economy and sciences, and overemphasizing class struggle, during the late 1950s and 1960s. Two political movements were especially disastrous. The Great Leap Forward, beginning in 1958 and ending in 1961, set up the people's communes and totally collectivized all land management. The collective ''super-pot'' took a literal form: all the commune members ate together in the commune dining halls. The super-pot was quickly abandoned but its spirit was maintained by the Cultural Revolution. Impractical policies and goals did not stop at the super-pot; most other objectives were also inflated. The propaganda in the League in the early 1960s ran: ''within three years, apply fertilizers (manure) of 10,000 *jin* per *mu*, terrace all cropland, semi-mechanize, improve 5 million *mu* of pasture, extinguish water-shortage pasture and poisonous plants, control major livestock diseases, upgrade half the sheep; and within five years, reach 400 *jin*/*mu* yield, revegetate most sandy land, universalize primary and middle-school education, and set up a transportation network'' (governmental archives). None of this work was done within the scheduled time; indeed, much of it still remains to be done.

The second political movement, the Cultural Revolution during 1966–1976, was a national catastrophe that pushed the nation towards the edge of collapse. Effects spread all over China. Under doctrines of ''ideology leads'' and ''class struggle first,'' social and economic development was practically ignored. The ideology of ''humans over nature'' and the propaganda of ''harnessing mountains and rivers'' denied the limits and differing qualities of land as political pressure led people to ignore negative economic and environmental impacts. In the 1972 governmental archives, a report in the League Party committee work meeting entitled ''Hold the route-struggle banner, further conduct the 'Learning from Dazhai' Act, and endeavour to change Ih-Ju farming and animal husbandry'' included

70 per cent of political propaganda, 25 per cent of achievements, and 5 per cent of further measurements. (This ''Learning from Dazhai'' movement during the Cultural Revolution aimed at mass mobilization for agricultural growth and advocated slopeland terracing in farming areas and the removal of poisonous herbs in grazing areas. The exemplar for farming areas was a mountainous village called Dazhai in North China, and for grazing areas the exemplar was Uxin-Ju *sumu*, Uxin banner in the Ih-Ju League.) All together, a sample of government archives suggests that only 5 per cent dealt with agriculture. The logic was that if people lack consciousness of the revolutionary route, the brigade would move from a grain surplus to a grain shortage; if people change, the land would change and so would yields. ''Rearrange Ih-Ju land and water'' was the slogan, while scientific and suitable planning tailored to natural conditions was not a concern.

The same political ideology affected all other socio-economic policies. Agricultural development became a political symbol rather than independent economic activity. It is common in records of this period to find the pronouncement ''Emphasizing farming and neglecting pastoralism is wrong,'' since grazing and farming were political symbols, representing the banners of revolution and anti-revolution at this time. Economic activities changed with the shift of political directions and fluctuations. In the early 1970s the third farming expansion began, adopting the political slogan ''shepherds do not eat sorry grain'' (meaning they have to produce it by themselves). With regard to population issues, since Malthus's population theory was criticized as ''bourgeois'' and counter-Marxist, population control was totally abandoned. Human labour was ''the most precious resource,'' and proper ideology could to conquer everything.

In national environmental protection, only rural hygiene, health services, and drinking water improvement received attention; land-based environmental degradation did not. In the Ordos, local governments issued pasture-protection policies several times (in the early 1950s, 1964, and 1975), but they did not have a significant impact, mainly owing to a lack of national governmental support; poverty also contributed its share. Excessive central government control, politically and economically, severely limited choices by local government and local people. For example, in the 1950s and 1960s, local government pasture-protection policies were not powerful enough to balance the national policy of grain purchase, which encouraged further reclamation. The 1965 governmental archive contains a plea to

reduce the targeted amount of grain to be procured by upper governments. Another example was pasture clearing in the early 1970s. Though Gongqirige people believed that their land was suitable for grazing rather than cultivating, they could not avert the classification of their township (then a commune) as a farming area. Pasture opening followed. Overall, environmental protection in the Ordos before 1978 was only intermittent.

Beginning with rural reformation, the period since 1978 has witnessed the gradual introduction of new economic policies and a market economy. The economy, which has grown quickly, has emphasized environmental control and improvement. The general result has been the mitigation of environmental problems. Policy has stimulated environmental improvement (see chapter 6), but it is also a source of further environmental deterioration. I have already discussed the indirect policy effects that work through economics. A typical example of more direct impact is the destruction caused by conflicting policies on the collection of medicinal herbs. Although regulations on the use and protection of pasture were laid down in 1979, they are not well obeyed because of economic gains from medicinal herb collection. Theoretically, purchase targets for these herbs should be set by the pasture research department, and the digging or cutting method and timing thereof should also be specified according to the needs of regeneration and environmental protection. This is not happening. Pursuing significant economic benefits from the processing of *Glycyrrhiza uralensis* and *Ephedra sinica*, the medical departments of the League and adjacent regions gauge their purchasing capacity instead of the bio-capacity of these herbs and the impact on pasture of collecting them. They even set purchase targets for banners, townships, and/or villages. Researchers in the Pasture Survey Team of the Animal Husbandry Department of the Ih-Ju League have estimated that purchases exceeded resources and pasture capacity in every recent year; the target purchase of *Ephedra sinica* even exceeded its total above-ground biomass. Administrative orders and stimulation of high prices turned out to be more powerful than the regulation of pasture use.

The importance of policy does not mean that it should exceed its limits. Local governments and people either cooperate or resist policy implementation, and local governments are not without some degree of autonomy. The 1954 Constitution of the People's Republic of China recognized the special nature of minority regions and granted more decision-making freedom to these regions. Subjected to ap-

proval by the Representative Standing Committee of central China, they were allowed to manage their own finances and police forces and to formulate special regulations according to their social, economic, and cultural situations (Zhang, 1988). As a result, local governments have become more important in establishing local policies and resource-use institutions. One example is pasture protection. Before 1978, the national government did not realize the importance of pasture protection, but local governments did and sought to protect and revegetate pastureland, with some good results. During the Great Leap Forward and the Cultural Revolution, however, this freedom was withdrawn, and local governments could not resist the national ''grain first'' policy despite its unsuitability for the Ordos. In the 1978 and especially in the 1982 revised Constitution, this freedom was again granted and the autonomy expanded to include economic management. Local government regained the ability to play a major role in economic and environmental improvement.

Policy outcomes are also affected by local people and culture. Chinese traditional culture emphasized submissiveness, group orientation, and respect for power. Central control under the socialist practices before 1978 exploited precisely these characteristics. The hierarchy of traditional Chinese society and the absolute leadership of the modern Chinese state have operated with similar dynamics and restrictions. In other words, state control actually worked through the enhancement of traditional culture. The combination of state and local policies and local people and culture has shaped local resource-use institutions, the topic of the next section.

Resource-use institutions – the fault of the communes?

In the period 1958–1978, when environmental degradation was rampant, the dominant resource institution was collective land use – a special kind of, or quasi, common-property regime. The important production and management unit was the commune, to which brigades and teams were subordinate. Resource management was based on the production team, and property owned by the commune. Land was collectively managed, and planning and circulation was controlled by the commune and upper-level governments. Team members worked together and earned work-points according to their working time.

Absolute equality was one feature of the commune. Every member of the commune was entitled to the same rights in the distribution of property and production. Work-points for each labourer were cumu-

lated by their days rather than their quality of work; products and salary were distributed according to the annual budget of the production team. People who did not work enough days to make ends meet were usually subsidized by the commune. In reality, such absolute equity produced no real equity. Those who were lazy did not receive any less, which frustrated the diligence and creativity of other individuals. The commune thus operated under no incentive for hard-working ethics.

The economy under collectives was centrally planned. The state controlled everything. Through five-year plans, target yield, and procurement, the state and each level of government dictated resource allocation, land use, labour, production, selling, buying, and prices. Task grain and task livestock were sold to the government at the set low prices for central redistribution. The fulfilment of government target tasks became the criterion for achievements. Annual work summaries from local governments usually described the percentage fulfilled over the planned goal: 112.36 per cent for grain production in 1956, for example. Theoretically, the socialist system was to make all citizens their own masters and grant them decision-making rights. In reality, however, the excessive control of central planning allowed no freedom for local people to plan for different crops and livestock.

The early period of the commune allowed private economic activities. From 1953 to 1956, each household was permitted to have between five and eight sheep or goats as well as private tree plantations. During the Cultural Revolution, private economic activity was altogether destroyed in the act of ''cutting capitalist tails.'' The market economy was banned. Private enthusiasm was totally shattered in the commune ''super-pot.''

The result of this resource-use system was social, economic, and environmental decline. Since local resource characteristics and local need were not taken into consideration, land suitability was violated and overreclamation and overgrazing occurred. The extent of economic decline and environmental degradation has been discussed in chapter 2.

In the governmental control and central procurement of agricultural products, farmers and shepherds were not purposefully exploited, as has been the case in marginal/frontier areas in many other countries (e.g. Blaikie, 1989; Susman, O'Keefe, and Wisner, 1983). Overall, the system aimed not at exploitation of economic surplus, but at the perception of what socialism should represent – equality. People also received what they needed from government

redistribution; table 2.6 (see chapter 2) on grain net input from the central government offers evidence to demonstrate this.

It would not be appropriate to conclude that the failure of the system was the fault of the ''commons'' in a generic sense; rather, blame rests on how this commons actually worked. In places where common property rules and institutions actually emerge, this regime sometimes works better than others in helping the poor, reducing risk, and protecting the environment (Jodha, 1985, 1992). In China, there were rare cases before 1978 showing that a collective regime could be very effective socially (equity), economically (efficiency), and environmentally (protection) (Glaeser, 1987). In the Ordos before 1978, however, owing to a lack of decision-making rights, there were actually no local resource-use rules in place, and in a sense no real local common/collective property institutions existed. Compared with the free-access commons (Hardin, 1968), this is the other extreme, one of complete control, and its impacts on the environment are destructive.

The impacts of the excessive control over leaders and local people go beyond the loss of decision-making rights. In the following sections, I examine the impacts on the quality and working ethics of leaders and the values and behaviour of local people. All, in turn, affect the economy and environment.

Impact on leaders

Local government is important in receiving policies from higher levels of government and formulating local strategies and institutions for economic activities and resource management. Good leadership should entail, in the Chinese context, an appropriate combination of state policies and local suitability and local needs. The existing rules call for leaders to treat different situations differently and to care about the need of the masses. In practice, however, this was not done, especially before 1978.

Indeed, the heavily controlled socialist system before 1978 left local leaders no incentives or possibilities for doing better. National and regional upper-level governments issued directives and regulations on what to do and what was right. The upper government selected local leaders according to whether they had fulfilled their assigned tasks. Local leaders thus did what they were told to do, and incurred risks if they acted differently. Eventually, it became habitual among local leaders to ask the upper government what they needed to do, and for more detailed directions. Local leaders thought that upper-government direction would give them ''stronger backs.'' This

became absolutely true during the Cultural Revolution, given that the ''upper government'' they listened to was on the ''revolutionary route.'' Such passivity remained more or less the ethos of the leaders even after 1978 when central control was eased. For example, the minutes of a League ''economic work meeting'' in 1983 recorded questions of what an ''illegal retailer'' was, whether the grain target purchase should be established for a commune, a village, or a production team, and so on.

The quality of leadership was poor because, during the Cultural Revolution, educational criteria were ignored in the selection of leaders. The impacts extend to the present. As the Jungar leader Qi stated, ''People want to live better, but they have little education and need leadership. However, because of the poor quality of leaders, sometimes there are good policies but without good leaders to work on them.'' Now that the upper-level government mainly gives policy guidance instead of dictation, the skill of local leaders in formalizing policy implementation and programmes to fit the local environment and local needs is all the more important.

Corruption is another factor that originated in the past practice of the socialist system. The underlying reasons are beyond the scope of this study, but the impact on local resource use is significant. Local leaders have been the representatives of the socialist system, and their image significantly affects people's trust in the government. In my interviews, I found that people welcome current policies but some still voice objections to the local leaders.

Impact on local people

During the earlier decades, one failure of the Chinese socialist system was to destroy the enthusiasm and decision-making power of individuals. Although the legislation did not specifically exclude individual decision-making power, actual policy execution did. Since everything was planned by the government, all good and bad things were done by the government. This tight control suggested to people that ''the government was hiring them to do its work'' (interview with farmers, Jungar banner, 1992). This perception was further enhanced by the traditional trait of submisiveness. As a result, although people realized the harms of environmental degradation, they did not initiate positive actions for protection.

Such passivity and doubt about government still exist. Many times in the past, government leaders mobilized people to do things that did not achieve good results. The government has still not completely

abandoned the dictatorial approach. For example, in agricultural management and revegetation, species and area to be replanted, livestock numbers and structures, and cropland area and species are still regulated by the local government, although control is much looser. This sends the continued message that people work for the government instead of for themselves. It therefore becomes logical that ''if the government gives money, we will work'' (interview with farmers in Jungar banner, 1992). Although state policy is trying to promote private initiative, people are bound by the old ideas. In Heihadai, before environmental protection achieved good results, people thought the government was ''paying money to harm its people.'' This dependence has impeded the initiation and speed of environmental protection.

The effects of government support for the poor and for environmental protection are also twofold. On the one hand, it helps to relieve difficulties and to promote environmental protection, while on the other hand it foments passivity. Much depends on the overall manner of government administration mentioned earlier. Governmental support for the poor and minority areas has been provided over the past four decades. Before the 1980s, the support was mainly in the form of food and clothes, instead of input for agricultural production; thus poverty was temporarily alleviated instead of eradicated. Eventually, since ''socialism does not allow hunger,'' the poor began to wait for support instead of working hard. In environmental protection, funding in certain programme areas (such as Huangpuchuan watershed in Jungar banner) only makes other areas believe that they too can wait for financial support for revegetation.

Interaction of human driving forces

As has been apparent in the discussion of each driving force, they all interact with one another (fig. 4.4). Take policy and attitudes/behaviour, for example. Government policy affects all other driving forces that induce environmental degradation (through triggering related proximate activities); and attitudes/behaviour are influenced by policy (see chapter 5), economic status, and resource-use institutions while affecting population (through the birth rate). Arrows in fig. 4.4 indicate directions of associations, and show that most driving forces affect and are affected by others. Policy is an exception, which is determined mostly by external factors at the state level, whereas local situations have only minor impacts.

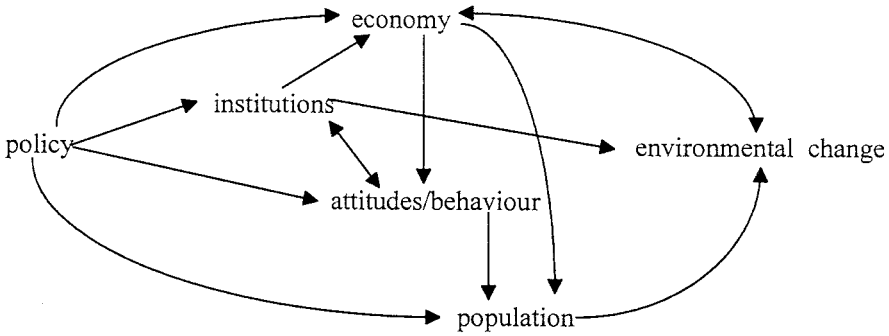


Figure 4.4 **Major interaction between driving forces and environmental changes**

Graph theory allows the analysis of the hierarchical structure of the complex relationships among multiple factors. It first constructs a connection matrix including all the factors involved. Table 4.8 shows the connection matrix corresponding with fig. 4.4, with 1 representing the existence of directional connection or effect (from factors in the column [from item] to factors in the row [to item]), and 0 the lack of it. For example, the cell in column 1/row 2 has a value of 0, indicating that population does not have a direct impact on policy; cell in column 2/row 1 has a value of 1, indicating that policy has a direct impact on population. All factors affect themselves, therefore the diagonal positions have values of 1.

For factor *vi*, $R(vi)$ represents the set of factors that *vi* affects, and $A(vi)$ represents the set of factors by which *vi* is affected. $R(vi)$ thus includes all the corresponding factors in the *vi* row that have values of 1, and $A(vi)$ includes all the corresponding factors in the *vi* column that have values of 1 in table 4.8. Table 4.9 is thus created. To simplify things, I use the following numbers to represent each of the driving forces: 1 represents policy, 2 population, 3 economy, 4 attitudes/behaviour, 5 resource-use institutions, and 6 environmental change. In table 4.9, the factor that can meet the following requirement lies at the deepest level in the hierarchy:

$$R(vi) \cap A(vi) = A(vi)$$

In this case, it is factor 1 – policy. The next step is to remove factor 1 from the matrix and go through the above step again to identify the factor(s) in the next level. Eventually, the hierarchical levels of all the interacting factors can be identified this way. The final hierarchical

Table 4.8 **Connection matrix of human driving forces**

		To item j					
	Vij	policy	population	economy	attitudes/ behaviour	resource-use institutions	environmental change
From item i	policy	1	1	1	1	1	0
	population	0	1	0	0	0	1
	economy	0	1	1	1	0	1
	attitudes/ behaviour	0	1	0	1	1	0
	resource-use institutions	0	0	1	1	1	1
	environmental change	0	0	1	0	0	1

Table 4.9 ***R*(*vi*) and *A*(*vi*) sets in table 4.8**

For factor *vi*:	$R(vi)$	$A(vi)$	$R(vi) \cap A(vi)$
1 policy	1, 2, 3, 4, 5	1	1
2 population	2, 6	1, 2, 3, 4	2
3 economy	2, 3, 4, 6	1, 3, 5, 6	3, 6
4 attitudes/behaviour	2, 4, 5	1, 3, 4, 5	4, 5
5 resource-use institutions	3, 4, 5, 6	1, 4, 5	4, 5
6 environmental change	3, 6	2, 3, 5, 6	3, 6

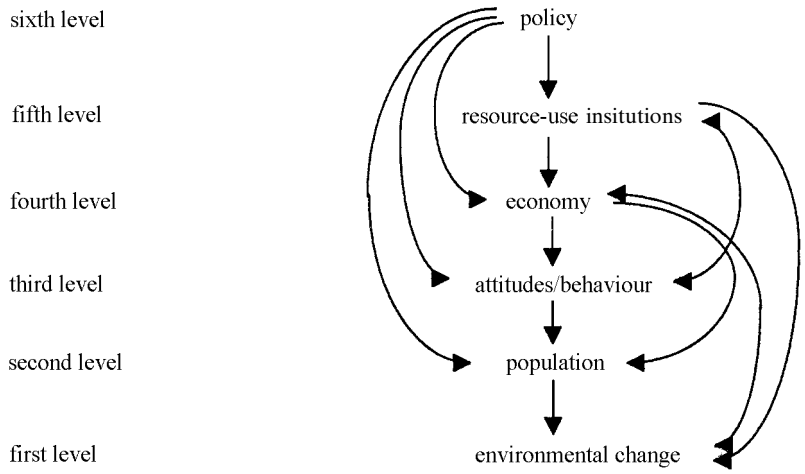


Figure 4.5 **Hierarchical structure of human driving forces**

structure of fig. 4.4 is thus derived and shown in fig. 4.5. The deeper in the hierarchy, the more primacy the factor has and the more power it has in determining (or explaining) the behaviour of the entire hierarchical structure.

The hierarchy has six levels, ranging from environmental change (level 1) to policy (level 6). The hierarchical structure implies that the higher the level of a factor, the deeper it is in the structure of relations, and the more likely it is to offer the characteristics of the entire structure. In other words, the deeper a factor is in the structure, the more primacy it has in explaining environmental change. The factors at the shallower levels serve more as consequences or accelerating forces. The structure (fig. 4.5) derived from graph theory corresponds with the qualitative analysis found early in this chapter.

Policy is at the deepest level (level 6) and serves as the most primary factor in relation to environmental change. Analysis of the impacts of policy verifies this finding. Policy affects all other socio-economic factors at the second to fifth levels, thus determining the trajectory of environmental change. Since in the Ordos Plateau policy is largely an external force, this finding confirms one observation in *Regions at Risk* (Kasperson, Kasperson, and Turner, 1995) that external forces can play more important roles than internal ones.

The factor at the fifth level is resource-use institutions, a derivative of policy under the Chinese political system that affects attitudes/behaviour and environmental management (therefore change). Lying at the fourth level is economy. Determined by policy and resource-use institutions but affected by environmental change, economy affects environmental change both directly (through poverty and economics for environmental protection) and indirectly (through its impacts on attitudes and especially economic behaviour, and influences on population change). Attitudes/behaviour lies at the third level; they do not induce environmental change directly, but indirectly through their relations with policy, resource-use institutions, economy, and population.

Population appears to lie in the shallowest level of explanation, as it is determined by the other factors deeper in the structure. This agrees with the finding of Arizpe and Velazquez (1992) that the links of population with the fabric of the society are very important for the exact role of population in environmental changes, and that population serves as an accelerating force. Other societal factors have greatly mediated the role of population change in environmental degradation.

Just as socio-economic and environmental conditions change over time, so do the relationships among them. The hierarchical structure depicted here characterizes the typical relationships during the major part of the study period, especially during the 1950s–1970s. Since the 1980s, the Ordos has undergone significant socio-economic and environmental changes. As the government decentralizes, relinquishing its primary role in the creation of policy, the role of local participation becomes more important. The evolving structure of environment-society relationships has yet to be studied.

Conclusion

This chapter has examined human driving forces of environmental change in the Ordos Plateau since 1949. The key forces identified, in

descending order of primacy, are government policy, resource-use institutions, economy (poverty and economics), attitudes and behaviour, and finally, population. These driving forces trigger proximate activities such as overreclamation, overgrazing, and overcollection of fuelwood and medicinal herbs, thus leading to environmental degradation. They also perpetuate environmental degradation by preventing efforts towards improvement.

The overall trajectory of environmental change, however, is decided not only by human driving forces but also by societal responses. The next two chapters will deal with these positive forces in the Ordos.

5

Societal awareness

How people perceive, and behave in response to, environmental degradation are important in understanding responses from individual, group, and societal levels. This is not to say that as long as people perceive or accurately diagnose environmental degradation they will initiate positive responses, as the latter also depend on other factors (e.g. state policy) in a society (Kasperson, Kasperson, and Turner, 1995; White, 1964). However, perception is an important step towards action, and behaviour is an important element in forging purposeful response.

This chapter discusses human perception of and behaviour towards the environment. It examines how people in the Ordos Plateau, and especially farmers, shepherds, and government officials, view and respond to the environment and environmental changes. Focus on groups and individuals (scientists, each level of government, and local people) highlights some of the regional contingency that operates within broad socio-economic and political structures. It is clear that human perception and behaviour are strongly linked to changes in government policy; understanding these linkages not only assists in grasping the local contexts of behavioural and cultural norms but also helps in associating groups and individuals with social structures.

Environmental perception

Different groups – scientists, national government, local government, and local people – betray distinct perspectives on the natural environment. In the sections that follow, I probe the underlying norms, perceptions, and behaviours of each of these groups and analyse the implications for environmental change. The focus is on local people.

Scientists

In academic circles, sandification in the Ordos first received attention in the 1930s. In the 1940s, Ge (1942) noted the enlargement of the desert and the expansion of sandy land in the area. Since 1949, many research programmes and surveys have been carried out in the Ordos. In the late 1950s and early 1960s, a geographical survey conducted under the supervision of the Chinese Academy of Sciences recognized the problems of sandificaion, soil erosion, and the degradation of vegetation, and pointed out the damage caused by widespread overreclamation and fuelwood collection (Beijing University et al., 1983; Huang and Song, 1981; Ih-Ju League, 1988).

Since the late 1970s, with the revival of scientific research after its 10-year stagnation during the Cultural Revolution, the Ordos Plateau has attracted further study. The 1980s witnessed the establishment of the Sixth Five-Year (1981–1985) Inner Mongolia Remote-Sensing Survey Programme, and the Seventh Five-Year (1986–1990) Loess Plateau (with the Ordos Plateau included) Integrated Research Programme. The remote-sensing survey focused on environmental background analysis and resource survey, and recognized and measured grassland degradation (Li et al., 1990). The loess plateau research plan dealt mainly with sandification in the Ordos Plateau, and analysed its impacts on the society (Yang, Di, and Huang, 1991). The two studies clarified ecological processes, proximate causes, and impacts of sandification, soil erosion, and vegetation degradation and investigated remedial measures.

As environmental awareness has grown in China, the environmental problems in the Ordos have become increasingly recognized in the scientific community (Huang and Song, 1986; Zhu, 1990). The cause of environmental degradation is largely attributed to human activities such as reclamation, overgrazing, and biomass burning. What is lacking, however, is systematic research into the underlying driving forces and societal responses to environmental change. Both the ori-

entation of geographical study that neglected human geography (except for regional planning) and a lack of political freedom before 1978 in China have contributed to this gap.

Governments

Changes in environmental perception by national and local governments are best discussed in relation to state policies, the focus of the next chapter. This section is limited to profiling general government attitudes toward the environment and environmental changes.

Science was slow to influence policy in China, and the dominant state ideology has long viewed nature as merely an asset for production. Thus the national government came rather late to an understanding of environmental problems. Since 1978, national policy has been reoriented toward economic development, and environmental problems have been viewed largely as obstacles to this goal. The state has become aware of the consequences of neglecting ecological conditions, and thus has given great emphasis to the suitability of local areas. Ideologically, it is their economic significance that draws government attention to environmental concerns, at least initially. Such is especially the case in the Ordos, whose environment is closely tied to its agricultural economy. Propaganda advocating ''planting trees and grasses, and developing animal husbandry'' appeared in the early 1980s both as a common rhetoric in popular media such as television and newspapers, and as a guide for the regional development policy of north-west China, including the Ordos Plateau. Pasture protection and prohibition of land clearance were strongly advocated, and environmental regulation became more and more stringent.

Local governments, both in the Inner Mongolia Autonomous Region and in its subordinate Ih-Ju League, recognized the importance of pasture protection in the early 1950s. They issued various regulations to protect pastureland and develop animal husbandry. Given autonomy and more freedom in decision-making by the national government, the Mongolian region implemented policies that favoured Mongolian customs and pastoral production, and promoted revegetation as well as measures to control moving sand. From 1952 to 1955, under land reform and the cooperative transformation of agriculture, the development of animal husbandry and the protection of pasture were the foci of Ih-Ju League policy. Local government regulations banned pastureland reclamation and overcollection of fuelwood, and promoted rotational grazing, planting of trees, shrubs,

and grass, and the demarcation of fuel-collection areas. In farming-grazing transitional areas, grazing was designated as the preferred activity.

Soil and water conservation were first recognized in the 1953 Agriculture Plan of the Ih-Ju League, which advocated pasture enclosing, basic field building, and steep-slope protection (government archive). Despite endorsement by local government, monitoring and compliance fell short, owing to inadequate resources, a lack of concrete programmes, and an absence of central governmental support. Although local governments had a better understanding of the importance of environmental protection to the local economy, they had other pressing priorities, such as implementing upper-government directions for political security. Influenced by national policy and political atmosphere, and especially by the central government's withdrawal of regional autonomy during the Cultural Revolution, local governments did not insist on, nor did they have the power to maintain, policies that favoured the environment (chapter 4).

Since 1978, with central state policy taking an economic course, local autonomy has been restored. Local policies of pasture protection, prohibition of land reclamation, and pastoral measures again became dominant.

Environmental perceptions of local people

The perceptions and behaviour of local people play a key role in mediating, under different state policies, the organization of local society, the articulation of values, and how policy actually works. They thus contribute profoundly to shaping the trajectory of environmental change.

Rooted in Chinese culture, the Chinese people have long believed that human beings are part of nature. The Mongolian people, originating in nomadic tribes, link their lives very closely to the variability of nature. The term ''nature'' connotes not only the natural environment but also phenomena that happen or that are related to it, such as environmental hazards and degradation. Just as nature is considered to be given rather than to be pursued, so is environmental degradation. Ideally, harmony with nature is desired; but this is to be achieved not by seeking intervention but by acceptance or adaptation. The attitude ''what will be will be'' is also part of the Chinese conception of nature. For the Ordos Plateau, much of the population holds Buddhist beliefs which emphasize a passive acceptance of the

''present life'' while projecting hope into ''the next life.'' What nature does to people is the result of their own morality. This cultural orientation deeply affects environmental perception and behaviour.

It is hard to say whether Chinese tradition sees nature as having intrinsic value. For Taoism, the answer might be yes, but for the dominant Confucianism, the answer is clearly no. Social hierarchy has been the core of mainstream Chinese culture, which emphasizes the power relationship between superior and subordinate, between father and son, and between man and woman. All cultural codes derive from one's relationship with others. With this cultural inclination, in the early period when population was sparse and conflict between nature and society was not so obvious, harmony was still possible. It became less so as the population quickly climbed and other drastic socio-political changes occurred. Nevertheless, the profound socio-economic changes that occurred after 1949, in sharp contrast to the persistence of the feudal system for over 2,000 years, may have overwhelmed other (including cultural) factors in their impacts on human environmental perception and behaviour.

Local people first became aware of environmental changes during the 1950s and 1960s through drought, enlarged sandy land, increasingly sparse pasture, and mounting soil erosion. From their experiences, they understood the harmful effects of environmental deterioration on both everyday life and the agricultural economy. Drought has long been an important signal of change for local people. In my interviews, when talking about the environment, most people mentioned drought and its harmful impact on sand movement, vegetation, and agriculture. Some believe that ''it is getting drier, water in the valley is gone, rainfall is less, and winter is warmer,'' which is true in part, although rainfall over the past 40 years has not shown a significant decline. As for the reasons for land degradation, most people, consistent with their emphasis on drought, consider natural variability to be the major cause. This perception of causation may have profoundly affected their fatalistic attitudes toward environmental degradation.

Prior to 1978, it was passivity (rather than seeking harmony), working together with social-political factors (discussed in chapter 4), that determined attitudes toward environmental degradation. People in the Ordos were not sanguine about the possibility of environmental improvement. The centralized social system afforded few choices and encouraged passivity. It is ironic that the concept of ''man over nature'' was imposed and even politicized during the Cultural Revo-

lution, but it failed to enhance rational human environmental action. Massive combat against nature (aiming at environmental transformation) was promoted as an aspect of the socialist system in China, although with voices louder than actions. When political coercion was relaxed, traditional ways reasserted themselves; these movements quickly shrank and people went back to previous patterns of extensive grazing and cropping without much care. As they earlier accepted a capricious nature, the Ordos people also accepted environmental deterioration. One could suppose that if political radicalism had not emerged, and if the Ordos had been given more political freedom and economic incentives (as it has now), adaptations might have brought forth cultural changes and measures for environmental protection. This did not happen until after 1978.

With the social and political changes since 1978, environmental perceptions in the Ordos have gradually changed. This is not to suggest that attitudes toward nature have been fundamentally altered, since the current clearly utilitarian view of the environment is not far from the Confucian negligence of intrinsic nature. Attitudes towards environmental changes, however, have changed greatly in a number of respects. People no longer accept environmental degradation as their fate, and they appear to have become more optimistic about the difference they can make given suitable political and economic conditions. The greater confidence in environmental protection measures appears to arise less from direct cultural adaptation than from such non-cultural forces as economic transformation, policy achievements, political mobilization, popular media, and, finally, the beneficial results of environmental improvements. As Wu Zhaojun, director of Uxin Forestry Department, puts it:

> Shepherds have known the harm done by sandification for a long time but have rather lacked confidence about making improvements. Only after revegetation maintenance was enhanced and the result was good have they gained that confidence. They are practical and see only the actual results; theory cannot persuade them. (Interview, 1992.)

Since 1978, environmental awareness has risen sharply in the scientific community, on the governmental agenda, and in the popular media. Different levels of government in the Ordos have strengthened public policy and programmes for environmental protection (see chapter 6 for a detailed discussion). Policy demonstrations at early stages of implementation have also played an important role in changing people's perceptions.

One example is the change in outlook toward man-made pasture in pastoral areas. Mongolian people have a long history of natural grazing and depreciate the role of man-made pasture. Before 1978, fine winter feed was mainly imported from outside the area, and herbal winter forage was chronically short. High death rates among the herds were the inevitable result. Since the early 1980s, the government has promoted human-constructed pasture through such approaches as education, demonstration, and financial credit. For example, local government established an experimental programme for constructed pasture, and advocated it through both technical assistance and financial aid (details are discussed in chapter 6). Attitudes toward human-constructed pasture gradually changed, and shepherds now increasingly use it as an indicator of good management in the pastoral economy. The revegetation demonstrations conducted by local government have likewise been successful in changing people's perceptions of the possibility of environmental improvement. These actions have enhanced local environmental awareness, particularly through their evident economic benefits.

The media also play a role in shaping human perception. In China, it is usually assumed that the function of the public media is to inform and educate the people. Therefore, every regime communicates its ideology through television programmes, newspapers, and broadcasts. The two important local media, the local newspaper *Eer Duo Si Bao* and local radio, have covered environmental protection measures extensively, although both advocate environmental protection more in terms of economic logic than of ecological principles. The *Eer Duo Si Bao*, launched in 1949 and published in both Chinese and Mongolian editions, covers local people and events closely and is widely distributed throughout the Ordos. Since 1978 it has covered local policy reform, economic development, and environment-related issues. Table 5.1 shows articles related (directly or indirectly) to environmental issues, based on all issues published during the eight sampled months in 1991–1992. In April 1992, for example, articles clearly related to the environment totalled nine, with the topics ranging from greening the Ih-Ju League and combating sandification to watershed improvement and land management (table 5.2). Environmental concerns and measures are also finding their way into articles about agricultural economy.

Local radio broadcasting was set up during the Cultural Revolution and still operates in some of the area. Deputy director Han of the Jungar Propaganda Department told me that broadcasts are available

Table 5.1 ***Eer Duo Si Bao* statistics of articles on environment-related issues**

Month/year	Economic and environmental policy	Technology application and environmental improvement	Environmental protection	Total
June 1991	1	5	1	7
July 1991	1	4	3	8
October 1991	1	6	0	7
November 1991	4 (2 feature)	3	1	8
January 1992	2	9	1	12
February 1992	0	11	1	12
March 1992	1	2	4	7
April 1992	2	2	5	9

Table 5.2 **Titles of articles covering environmental issues, *Eer Duo Si Bao*, April 1992**

- Progress in forestry techniques in the League
- Hurry up greening the Ih-Ju League
- Tree plantation is taking a new lead
- The sandy land of Uxin is wearing green
- Fourteen years of aerial sowing have improved 750,000 *mu* of sandy land
- Open the black underground [coal] and construct the green surface [vegetation]
- Success in sandification control along Baotuo-Shenmu railroad
- Pasture improvement is the key to better living standards
- Change of Ulanshabartai township [subtitles: Combat sand for survival; Conserve water for food and shelter; Hard working for better life)

in most (19 out of 25) townships for five hours every day. The programmes include ''news,'' ''friend of farmers,'' ''lovely Ordos,'' ''information service,'' ''cultural events,'' ''advertisements,'' and ''music.'' The station has eight reporters and about 100 correspondents, most of whom are farmers and shepherds. Of the 120 reports (which I read at the Broadcasting Department) broadcast between January and April 1992, about one-third covered agriculture and animal husbandry development, revegetation, tree plantation, watershed management, irrigation, and application of farming and pastoral technology. Environmental consciousness is closely tied to economic development. Sample titles of broadcasts are listed in table 5.3. One of their aims is to ''educate'' local people in economic transformation. Good examples set by farmers and shepherds are greatly emphasized, in the belief that ''Farmers believe in actuality instead of talk. As

Table 5.3 **Examples of local broadcasts in June 1992**

- Buertaohai township carrying out ''Two-Wing One-Body'' policy and improving the poor sandy land
- Heihadai township is maintaining watershed improvement and the ecological environment is moving into a good cycle
- Shagedu township is enhancing its service system to promote animal husbandry
- Shirliancheng township is planning to expand 3,000 *mu* of irrigated cropland
- Improve production conditions and improve basic cropland
- Farmers are increasing investments in agricultural production
- Party members are leading people toward greater prosperity in Dalu
- Shagedu township is taking new measures against poverty

long as they can see tangible benefits, they will be willing to make efforts to bring them about.'' (January 1992 broadcast.) Because the exemplary individuals, villages, and townships are all close by, people find their stories tangible and relevant, and therefore more powerful in changing perceptions and behaviour.

However, local people's environmental concerns and perceptions are still very much related to, and restricted by, their economic status. O'Riordan (1981) argues that a hierarchy of values exists for personal priorities, from survival security to social status and community and environmental concern. He maintains that in advanced industrial societies, people of high socio-economic status are more knowledgeable and concerned about environmental issues and they can afford to expend effort on environmental protection without serious risk to their political power, income, and daily life. But the priorities of the poor are more often the necessities of life, such as food, shelter, employment, and education, and they pay a much higher price if they attempt to improve environmental quality.

The situation in the Ordos reflects the poor and their concerns as discussed by O'Riordan – poor not so much in comparison with the rich in the area (since wealth is not greatly polarized) but poor in the whole area. Environmental deterioration is still considered chiefly an economic problem instead of a threat to overall quality of life. Therefore, it tends to attract people's attention when the problem is directly related to their economic well-being. For instance, in Uxin *sumu*, shepherds worry that the smoke pollution coming from the nearby alkaline chemical factories will damage their pastureland. In comparison, the potential effect of coal burning on the global climate is not of concern. When the choice is between economic and environmental quality in the short term, economy almost always wins. For

instance, overgrazing by livestock and overcollection of medicinal herbs are still widely accepted practices in the Ordos.

Given the socio-economic situation in the Ordos, it is not practical for people to consider the recreational value of the physical environment. In our interview with Qi Fengshan, leader of Jungar banner, he described the local view of the vegetation policy as suitable and as providing the basis for people's survival. However, he also implied that planting to beautify the land is ''superficial,'' whereas revegetating for economic reasons is ''practical.'' This sentiment represents the prevailing idea in the area. Furthermore, the effects of environmental degradation on human health and well-being are not considered an issue. Partly owing to familiarity with the windy-sandy environment and partly to a lack of alternatives, local people accept the environment, including its hazards, as ''their own'' in which they were born.

Environmental behaviour of local people

The environmental behaviour of local people follows the trend of environmental perception. Environmental behaviour has obviously changed in the course of changing political and economic situations. The primary and most important reason for the change, it seems, is the rationale of seeking growth and averting risk. In other words, environmental behaviour is governed mostly by the trade-off between economic benefit and loss. This linkage is not likely to change before people reach a certain level of well-being.

In relation to government policies, how programmes define individual economic gain is a significant determinant of individual behaviour. The revegetation programme in the area provides a case in point. The tree-planting programme launched in 1979 by the national government offered fiscal subsidies for tree, shrub, and herb plantations in the Ordos but did not specify the future use of the plantations, which, implicitly, belonged to the public. People claimed subsidies for the areas they had planted at the end of the year. Once the subsidy was claimed, however, the plantings were destroyed through neglect or even deliberate vandalism, so that the area could be replanted and subsidies claimed again. The reason can be found in the economic rationale: what people cared about was the secure, if short-term, benefits from the plantations, not the long-term uncertain gains from the use of future trees and grass. After the Household Responsibility policy was implemented and both livestock and pastureland were distributed to each household in the early 1980s, and

especially after user rights were guaranteed for 30–50 years, such shortsighted, environmentally destructive behaviour disappeared. Since future economic gain was guaranteed, people began carefully tilling the plantings on their allotted lands. Over time, even when fiscal incentives were not available, people still sought more opportunities to plant trees, shrubs, and grass. By the late 1980s, with the integration of centralization and privatization, both collective security and enthusiasm for private interests emerged, and people apparently became more able and willing to improve the management of their land.

In terms of the linkage of human behaviour with perception, both tend to betray the same tendency, but the relationship between behaviour and perception is only secondary and in practice works mostly through other factors such as institutional arrangements and economics (Tuan, 1968; White, 1964). Past experience in the Ordos suggests that human behaviour may change while leaving perception unaffected. When behavioural change is accompanied by changing perceptions, however, it is more stable and its maintenance requires less political and economic pressure. Examples include the impacts of differential accessibility to towns or cities and varying levels of education on environmental perception and behaviour. My interviews in Jungar banner show that the villages and townships closer to the banner central town enjoy better access to information, and therefore tend to accept new ideas and techniques more readily and are more enthusiastic about environmental improvements. They enact environmental protection measures more willingly and promptly. Education also appears to make a difference in the willingness to take environmental measures: people with higher education tend to value the environment more highly and take measures more seriously. My interviews showed them to have a better understanding of both the economic benefit of environmental protection and the technical procedures (such as cropland filming and man-made pasture cultivation techniques) involved. Given suitable political and economic conditions, the enthusiasm for environmental protection, coming along with economic transformation and confidence about environmental improvement, generates lasting and self-perpetuating effects.

Environmental behaviour does not stand alone; it is a part of overall behaviour. Here I want to show one example of how general behaviour, including environmental behaviour, is influenced by the exemplary role of community leaders. In the Ordos, where modern-

ization is taking place only slowly and traditional culture is still dominant, the role of leaders is especially important. In the following case, the explanation of behaviour lies in what leaders did, what people believed, and what they followed.

Andinghao village near the central town of Jungar banner has 130,000 *mu* of land, 1,080 people, 278 households, and 8,000 sheep and goats. Lying outside the key protected watershed, the village, like many others in Jungar, reaps few advantages from national investments. Nonetheless, it has not lagged behind in socio-economic development and environmental improvement, and over the past 20 years has consistently pursued environmental protection and economic growth; 80 per cent of the land has been environmentally controlled and every natural village has a plan for further environmental improvement. (In the Ordos Plateau, each village may consist of several natural villages, physically separated from each other but forming a tight community. These natural villages were formerly production teams under the pre-1980 commune system.) In agriculture, improved varieties of crops and breeds of livestock have been adopted, and farmers pay close attention to land surface filming and fruit-tree planting. The standard of living in this village is relatively high: during the late 1980s, grain production exceeded 1,000 *jin*/person and annual income was 500–700 yuan/person. About 90 per cent of the households have built new houses and bought television sets. Awareness of the importance of education and agricultural techniques came rather early. The broader horizons provided by proximity to the banner centre, access to television, and emphasis on education have reinforced their behaviour.

In my investigation of the reasons for this progress, everyone cited the role of the village leader Hou Qingliang. Interviewing him in the summer of 1992, I was deeply impressed by his sincerity and honesty. Early on, he realized the importance of economic growth and environmental protection and determinedly led the whole village in this direction. His statement about the role of leadership explains his rationale:

> Leadership is important in directing people to the right road. People need to have leadership. Leaders need to play the role of organizing, helping people to solve their problems, and disseminating information from outside. This village has always retained its leadership even when many other villages dismissed theirs after 1978. Under Household Responsibility, the task of leaders is not getting lighter but heavier.

His foresight and down-to-earth style have won the trust and respect of village people. His spirit infuses that of the village. Under his influence, leaders in the village not only undertake experiments prior to the application of agricultural programmes, but also contract to help the poor in technical applications. The whole village has followed Hou's inspiration and altered their behaviour accordingly.

Perception, behaviour, and government policy

Policy has been a very important factor in inducing changes in human perception and behaviour under the centralized socialist political system of China. Ross (1988) identifies three policy implementation approaches in China, namely bureaucratic-authoritative, campaign-exhortation, and market-exchange approaches. The first is top-down policy implementation governed by democratic centralism and emphasizes political and ideological conformity; the second seeks to transform popular values through political participation and mass mobilization; and the third involves relaxing central controls and the role of government, increasing decentralized processes, and promoting material incentives and self-interest. Ross also suggests that these three approaches are generally applied, respectively, in state, collective, and private management, with the last approach the most effective.

As regards the Ordos, I suggest that even after 1978 the first two approaches, which have always been important in policy implementation, have remained important. Some differences exist, however, between national and local implementation of government policy. Although national policy always stresses the transformation of values, local policies place more emphasis on economic results and behavioural enforcement. Chinese national policy usually provides sketchy guidance and much exhortation. Instructions on implementation, which the national government provided before 1978, are now left mainly to the local government, particularly with respect to how best to mobilize local people and carry out the policy. Local government, when implementing national policies, pays more attention to economic effects and the distribution of costs and benefits. As a result, Chinese national policy usually combines top-down policy direction, ideological education and exhortation, and market-exchange approaches. Local policies are also not without political emphasis and ideological exhortation, although they are not so strong as in the execution of national policy. When the three approaches are suitably

combined, they can be very effective in both directing human behaviour and shaping human perception. The North China Revegetation (also called the Three-North Shelter-Belt Construction) programme provides one example.

The origin and results of the programme are discussed in chapter 6; this section deals only with its implementation. Launched in 1979 by the national government, this programme has enjoyed extensive local support. Personnel in the League and banner-level governments are assigned to be in charge of programme execution. Moreover, local governments have also attached their own revegetation programmes to this national programme and diverted local funding toward it. Policy implementation has drawn on all viable approaches to facilitate this programme. Initially, politicization of the programme came from the national government. Since then, the programme has become a task of the local governments and their institutions, and its fulfilment is one of the criteria by which the upper-level government judges the political performance of lower-level government. The programme has therefore become a focus of local resource mobilization. In the planting season, most government and institutional personnel either spend time in the area for which they are responsible for planting or go to villages to help villagers plant. Each village has a concentrated time period for revegetation, during which most people are mobilized. Most villages stipulate the number of days that one labourer must spend on revegetation; those who fail to fulfil this requirement are fined.

Ownership change also accompanied the revegetation programme. In the beginning, trees planted belonged to the public and no clear ownership was established. Realizing the negative effect of this on private enthusiasm, the League government established clear private ownership (i.e., the trees belong to those who planted them), replacing the previous ambiguous public ownership, in order to ensure effective results. Later, recollectivization (collective planning and management while ownership still remains private; details are discussed in chapter 6) appeared, which further enhanced the mobilization of both labour and financial resources.

Media propaganda carries forth the same ideology: revegetation is the morally correct thing to do. Ideological exhortation is not the most effective tool for implementing policy, but it is useful when combined with other approaches, especially market incentives. Revegetation subsidies are important. In the Huang-puchuan watershed management programme carried out in conjunction with but

separate from the North China Revegetation effort, funding has been comparatively substantial (see further discussion in chapter 6). Most other areas have enjoyed less funding. Early on, the project covered not only seeds and seedlings but also part of the labour costs. Later, local government policy extended the planting area with the same allocated money, while using administrative measures to mobilize labour. Though only seed and seedling expenses are now covered, revegetation continues.

These policy implementation measures, together with ongoing economic transformation and the positive economic and environmental results of the programme, have altered people's attitudes toward the environment. In interviews, I found that people in the Huang-puchuan watershed believe deeply in the environmental and economic benefits of pine-tree plantations even though the economic benefits have not yet become apparent. Overall, policy has become an important factor in people's everyday economic and cultural lives, working first through their behaviour and subsequently affecting their perceptions.

It is in the nature of centralized policy to combine all kinds of resources – physical and mental, human and natural – in its implementation. Centrally planned and persistent, the Chinese socialist regime has an amplifying effect, thus aiming to do something good, it can achieve something even better (though at the same time, a negative policy is also magnified, such as the disastrous effects of the Cultural Revolution). For environmental protection, especially for watershed management (which requires a great deal of coordination for the best results over an entire area), collectivized management can be quite beneficial, as I shall demonstrate in chapter 6.

The aim of these policies is to change people's perceptions and behaviour. Rarely can human perceptions be changed directly, however. Although exhortations may modify or accentuate the hierarchy of human values, such as from basic food and shelter needs to desires for social status, they cannot by themselves force a leap or drastic alterations. Changes in behaviour, indeed, are more often the result of policy execution or the experiences of external controls, rather than preceding changes in attitude. In some cases, such as population control and restrictions on livestock numbers, behaviour changed in ways contrary to prevailing attitudes. Population control has run strongly counter to both the traditional Chinese culture of having large families and the incentives produced by the low levels of economic status, public welfare, and old-age security in the area. The same is true in many parts of rural China. From a national perspec-

tive, however, most Chinese believe that population control cannot be postponed until people are prepared for it. Using the words of local leaders, ''We will have to do it, be it population control or revegetation; die first and then revive,'' meaning that although it is very difficult at the beginning, these policies will create a better situation in the future. In scientific parlance, the vicious cycle of poverty, social instability, and environmental degradation has to be broken, and the initial effort of breaking it, wherever it starts, will be difficult and painful. Again, here, the logic of ''the part'' and ''the whole'' is applied. What might not be entirely a good thing from the individual's standpoint is moral if it brings benefits to the area and the country. It holds that Chinese culture and politics have not gone beyond totalitarianism toward postmodern concerns.

At the same time, human perceptions do change gradually, although usually out of concurrent social and economic transformations. Taking again population control as an example, people started to accept the policy instead of following their cultural orientation. In my interviews, most women expressed a preference for two or three children rather than the four or five that were the rule 20 years ago. An old lady in Heihadai township in Jungar banner stated, ''It is better this way [having fewer children]. We [her generation] have been carrying the sun on our back [working all day in the field] and raising children for all our lives, and we do not want the young generation to do the same.'' Tree planting, man-made pasture, and feed cultivation have witnessed the similar shifts of behaviour and perceptions. As chapter 4 shows, people were not ready to accept the idea of building an environment for agricultural development, thus policies on tree planting in the east and man-made pasture and feed cultivation in the west and south ran into objections initially. Policy enforcement and economic incentives encouraged people to modify their behaviours in these activities, and their perceptions changed accordingly after they witnessed the beneficial results.

This is not to argue that policy can disregard local input so long as it is well-intended. A lack of public participation exists in the Ordos as well as in other parts of China, but the results need careful analysis. There is a rich literature about respecting local perception and indigenous techniques in environmental protection (e.g. Batterbury, 1996; Richards, 1985, 1993; Rocheleau, Benjamin, and Diang'a, 1995), yet when full participation and understanding are not possible, and when local practices and indigenous techniques are at odds with environmental protection, as was the case in the Ordos Plateau, po-

litical measures and enforcement can be both effective and significant. This approach to policy execution has been practised in China for several decades. Usually, suitable policies can finally affect human perception. The process, however, means that people change their behaviour first and then their perceptions. This differs from the normative procedure that environmental perception is precedent to environmental behaviour (also see Tuan, 1968). Perceptions and attitudes are derived from the group of which one is a member and from the group's world view (Douglas and Wildavsky, 1982); these views tend not to change easily. Behaviour, however, is more readily affected by circumstances, as in the case of the Ordos by policy orientation and economic outcomes.

Political factors and economic concerns can drive environmental behaviour, but usually not very successfully if totally detached from environmental perception. People's perceptions do indeed affect how they act (White, 1964), although not exclusively. For this reason, research in person-environment relationships and human perception in recent years has helped in understanding and implementing public policy in developed countries (Aitken et al., 1989). In risk management, perception has been a useful guide for managers (Fischhoff, 1985). Understanding of human perception can aid public policy-making to guide human behaviour, as is apparent from studying the past policies in the Ordos Plateau. When the policies and their implementation approaches are sensitive to the positions of local people in the hierarchy of human needs, and to human beliefs and values, they are usually more likely to achieve the projected results. On the other hand, when policy orientation is remote from or in conflict with perceptions, it may well fail, as in the case of the shelter-raising advocacy in animal husbandry in Ejin Horo. The local government experimented with shelter-raising of livestock and tried to persuade shepherds to adopt it for better ecological outcomes. The proposal, however, disregarded the mobility that shepherds assume to be necessary for livestock, an attitude that is derived both historically (from their long-standing grazing practice) and culturally (from their emotional ties to livestock). This perception prevented their accepting the scheme, which, in the end, had to be dropped.

Conclusion

This chapter has discussed human perceptions and behaviour regarding the environment and environmental changes. Human envi-

ronmental perception is related to cultural values of land, ideology, and an understanding of the arid environment. Human behaviour towards the environment, however, is not always based upon or even directly related to perception, since it is deeply affected by such factors as economic gain, policy orientation, and moral coercion. The link between perception and behaviour is thus weakened, and intermediate variables or other determinants become important.

The dominant relations between environmental perception, behaviour, and government policy in the Ordos can be summarized as follows.

Government policy and environmental behaviour

The foremost linkage is that government policy affects and even shapes environmental behaviour. In China, government policy has deeply penetrated many aspects of local people's lives, from family planning to social organization, and from economic activities to political mobility. Methods of policy implementation, such as political emphasis, resource mobilization, and fiscal subsidy and credit, aim to guide human behaviour. Policy adjustment and programme reformulation in policy implementation also aim to guide human behaviour better. Economic gain serves as an important filter between policy and environmental behaviour, since it is an important incentive in policy implementation.

Government policy and environmental perception

Policy implementation through ideological exhortation and early-stage programme demonstration can play an important role in changing human perception. Moral exhortation of policy, though not very successful when used alone, works well when combined with economic and environmental programmes. When governmental policy emphasizes economic transformations that help upgrade the economic status of local people, perception may change gradually. Perception influences government policy by setting thresholds as to what will be readily accepted by policy targets (e.g. farmers and shepherds). When policy goes beyond the bounds of perception, it will often not work in the absence of strong political coercion – which, of course, imposes other political costs.

Perception and behaviour

The assumption that perception is the paramount determinant of behaviour has not been borne out in this research. Rather, the relationships between the two appear more complex. The link between perception and behaviour is weaker and more indirect than is often assumed in policy treatment. Under the strong influence of government policy, behaviour can change first, as discussed earlier. When beneficial results are the outcome of the changed behaviour, perception change may gradually follow. When perception changes first, however, as has become the case in cropland and pasture protection, it makes the associated change in behaviour easier and (perhaps) more stable.

This chapter has dealt with human environmental perception and behaviour, emphasizing responses to environmental changes at an individual level. The next chapter will focus on responses at a societal level. It is important to note that responses at the two levels are closely related, as can be seen in the discussions of both chapters.

6

Societal responses to environmental changes

Since the Conference on the Human Environment in Stockholm in 1972, there has been increasing awareness of environmental change and increasing effort in environmental protection and improvement. Environmental change has entered the agenda of international politics (Qu, 1989; Soroos, 1994). Various international (Haas, 1990; Ingram, Cortner, and Landy, 1990; Morrisette, 1989), national, and regional (Meo, 1988; Yang, Di, and Huang, 1991) responses have evolved, attempting to improve society's relationship with the environment and avert adverse trends of environmental change.

Societal responses to environmental degradation refer to the societal factors that aim either to slow down environmental degradation or to improve an already degraded environment (Kasperson, Kasperson, and Turner, 1995). The study of societal responses to environmental change has evolved rapidly over the past decade (Stern, Young, and Druckman, 1992), and has drawn heavily on the literature on responses to environmental hazards (Kasperson, Kasperson, and Turner, 1995; Kasperson, 1992). Broadly defined, environmental degradation meets the definition of a hazard as a ''threat to humans and what they value'' (Kates, Hohenemser, and Kasperson, 1985) and as the outcome of interaction between natural events and human-use systems (Burton, Kates, and White, 1993).

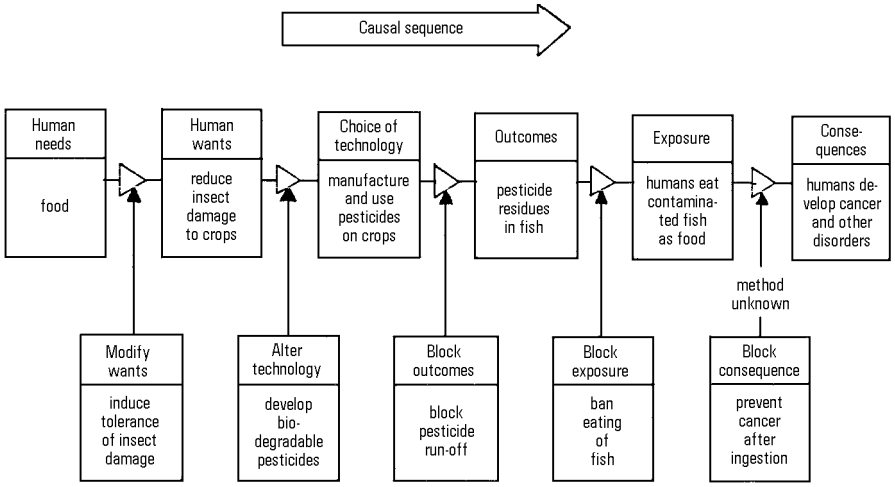


Figure 6.1 **Management of pesticide hazards**
Source: Hohenemser, Kasperson, and Kates (1985).

According to Burton, Kates, and White (1993), human responses to hazards can be grouped into two kinds: adaptation and adjustment. Adaptation is mainly long-term response, embedded in the evolution of the society and culture. Adjustments, by contrast, are mainly short-term measures, incidental or purposeful, more directly related to environmental degradation and its societal impacts.

In the study of the human dimensions of environmental change, where environmental degradation is closely linked with society, the processes of risk management and risk mitigation (Hohenemser, Kasperson, and Kates, 1985) suggest a useful framework for defining societal responses. As fig. 6.1 suggests, along the chain from human causes to the consequences of such hazards, each link provides a potential point of societal intervention in mitigation of a hazard or its consequences.

Likewise, in the mechanisms of environmental change, human driving forces occur at the beginning of the process, leading to proximate activities, and then to environmental change, and finally to its human impacts (fig. 6.2). In reality, human impacts usually affect human driving forces, thus a loop of interaction is formed. The three major links provide three major categories of responses that correspond with different theoretical traditions of understanding. O'Riordan (1986) identifies three theses regarding human responses. The "transition thesis" from White (1961, 1964) represents responses

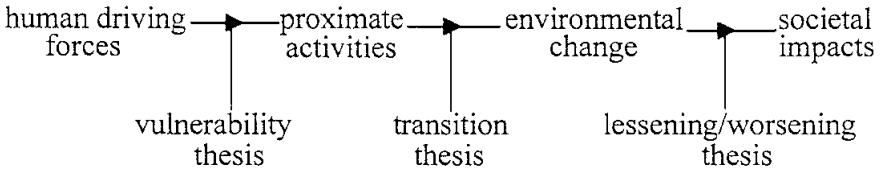


Figure 6.2 **Diagram of human dimensions of environmental change**

evolving from ''folk'' knowledge through technological and managerial to ''mixed'' adjustment, including technological, behavioural, and political measures. This perspective focuses on the link between proximate activities and environmental changes but omits the important role of societal vulnerability. The second thesis is that of ''lessening and worsening,'' which addresses the link between environmental change and societal impacts and the reduction or increase in future impacts through modification of societal dependence. The third is the ''vulnerability thesis,'' dealing with the human sources of environmental change (Dow, 1992; Liverman, 1989). This thesis originates from the structural view that hazard arises from the acts of humans and is the product of capitalism and development pressure (Susman, O'Keefe, and Wisner, 1983; Watts, 1983). It can be extended in environmental studies to include all the driving forces. These three theses, by linking human driving forces with environmental change and societal impacts, nicely span the range of environment-society relationships and offer a broad base (broader than the adaptation-adjustment approach) for the study of societal responses.

Levels of responses range from individual to community, mass media, corporations, scientists, government agencies, and NGOs (Clark Group, 1991). Although individual responses are obviously important (Burton, Kates, and White, 1993), structural or policy responses merit searching attention. The relations between individual response and structural factors also need to be explored, such as the effect of economic policies on environmental protection and the impact of policy formulation and implementation on environmental protection (see Anderson and Thampapillai, 1989).

In the Ordos Plateau, whereas environmental responses exist at all levels, governmental policy has been particularly important under the Chinese centralized political system with a single-party government. Past socialist practices have adopted a generally top-down decision-making process. Government policy has deeply affected all other participants and extensively shaped all other societal institutions and

all three theses of responses as noted above. Effort from individual and group levels is not usually significant if not incorporated into the societal and policy levels.

For this reason, this chapter on societal responses deals principally with policy interventions at the national, regional, and local levels. Since all other socio-economic and technological factors, and their changes, are closely linked with policy, they are discussed in this fashion. National policy and the Chinese road towards environmental protection are discussed first to reveal the broad directions of policy interventions. Regional and local policy responses to environmental degradation are then discussed, with a detailed analysis of their linkage with the environment. The ways in which policy has affected society and responded to different types of environmental degradation need to be studied from historical, political, cultural, and regional perspectives. The effects of policy interventions on the environment in the Ordos Plateau are mediated by their linkages with regional contingencies, such as culture and perception of the environment, which have already been discussed in chapters 3 and 5.

Policy responses to environmental change in the Ordos Plateau embody the three theses discussed above. Demographic and socio-economic changes, when positive, contribute to mitigate vulnerability (i.e., vulnerability thesis), thus reducing the negative human driving forces; they also act to filter and temper the negative impacts of environmental degradation on society, which conforms to the lessening/worsening thesis. The last, the transition thesis, is brought about in technical measures of environmental improvement that aim to reduce the adverse impact of human activities. All three theses are linked with each other in their working and are apparent in the following analysis of the role of policy.

This chapter concentrates on the period after 1980. Positive forces towards the environment existed throughout the study period before 1978, but only intermittently. Since the 1980s, following the overall trend of political and socio-economic changes in China (Ross, 1987), the Ordos Plateau has undergone tremendous changes, and environmental degradation has largely been halted and even reversed in some cases. Policy interventions have been the dominant form of societal response. By either moderating the driving forces of environmental deterioration or repairing degradation that had already occurred, they have slowed down, stopped, or even reversed the regional trajectory of environmental decline in the Ordos Plateau.

National policy after 1978

Three kinds of policies affect environmental change: political, socio-economic, and environmental. Political policies are those core policies that determine the general political direction and the discourse of the whole area; all other policies either centre on or derive from them. They directly reflect political and ideological changes of the state, and affect all the social, economic, and environmental aspects of society. The Household Responsibility system, for example, induced changes in all other policies. Socio-economic policies affect aspects of the context of environmental change, such as economy, population, education, science, and technology. These policies affect the environment by changing either driving forces or societal responses. Pastoral development and population-control policies are examples of this type. Environmental policies are those that directly focus on environmental protection and improvement, such as the programme for revegetation in the Ordos since 1979.

Beginning with the Third Plenum of the Eleventh Central Committee in 1978, power in China has shifted from ''revolutionary modernizers,'' or radicals, to ''managerial modernizers,'' or pragmatists (Ross, 1988). The government changed from autarchy to openness and paid more attention to the social and economic needs of the people. This ideological change was followed by changes in state policy of all three kinds.

The new regime of Household Responsibility began to take shape in 1978. The introduction of decentralized production in some poor rural areas of China during 1978–1980 produced good results. The state government then assumed responsibility for direction and applied the policy throughout rural China in 1980. The central measure taken under the Household Responsibility regime was to distribute production materials, livestock, crops and pastureland, and tools to each household in equal shares for each person in a village. With the privatization of production activity and decentralization of economic management to the basic unit of the household, the government's role became one of guidance rather than control.

According to Liu (1992), the aim of this rural reform is more decentralization and a loosening of government control than privatization. The gradual return to producers of decision-making rights on production, circulation, distribution, and consumption greatly stimulated productivity. Privatization subsequently created its own prob-

lems: a loss of economies of scale and a deterioration in public facilities. A degree of recollectivization was therefore instituted on a base of private management and authority.

Economic development is embedded in the Household Responsibility system. Agricultural policy has been very prominent on the governmental agenda. Since 1949, China has paid much more attention than did the former Soviet Union to rural/agricultural development. The reasons for this lie in China's long history as a peasant society and in its having a large population to feed. In the interests of political stability, each regime has made rural policy a priority; thus economic reform began in the rural areas. The current regime regards agriculture as the base of the national economy. Agricultural development policies, regulations, and measurements include raising prices of agricultural products, providing input subsidies, reducing grain procurement, and promoting modern agricultural techniques. Animal husbandry has been encouraged in north and north-west China. Since 1992, government control has been further relaxed and only a few agricultural items are subject to governmental procurement. Prices were even further opened to regulation by the market. Although the effects of a market economy need further investigation, the state considers it ''a road leading away from poverty'' (*Ren Min Ri Bao* [*People's Daily*], 30 June 1993). It is safe to say that the market economy has brought major changes to China.

The Agricultural Technique Extension Law, passed in 1993 by the state, promotes modern agricultural and pastoral techniques. This law makes governments at different levels responsible for the diffusion of agricultural techniques. In cooperation with private producers, experiments with and demonstrations of these techniques under suitable conditions have produced significant economic, social, and environmental benefits.

Population control began in China in the early 1970s, but only became effective due to strong enforcement after 1980. In cities, a couple can have only one child, whereas in the countryside, two are allowed in certain situations. A minority couple (Mongolians included) can have two children, or in rare cases three. This policy and strong coercive measures brought the population growth rate down to 1.16 per cent in 1992 (*Ren Min Ri Bao*, 12 March 1993).

With a greater appreciation of the importance of the environment, China has passed many environmental laws and regulations, including those on overall environmental protection, forestry, grassland, and land management, since the late 1970s. The grassland law pro-

hibits grassland destruction and reclamation and promotes protection and improvement. The agriculture law issued in 1993 pays particular attention to environmental quality. Its chapter 7, devoted to agricultural resources and environmental protection, requires suitable management according to concrete environmental conditions and advocates integrated environmental and socio-economic benefits. It also mandates watershed management and soil erosion and sandification control, and prohibits steep-slope reclamation.

Two national-scale environmental programmes have played an important role not only in stimulating environmental concern but also in achieving environmental improvement. One is the North China Revegetation Programme, initiated in 1978 to protect north China's semi-arid and arid lands from desertification. The programme had received 323 million yuan of national and local governmental funding by 1992 (*Ren Min Ri Bao*, 2 March 1993). The programme was designed to spend 40 billion yuan (one billion equals 1,000 million) over 70 years to create 35 million hectares of human-made forest (shrub and grass vegetation was later added). By 1992, protected forest covered 13 million hectares and other forest 12.6 million hectares, while vegetation coverage increased from 5 per cent in 1978 to 9.1 per cent in 1992. Protected farmland reached 1.1 million hectares, and improved pastureland 9 million hectares, while grain yield increased by 10–30 per cent over the same period of time.

The other project is the Eight Watersheds Environmental Management Programme. Four of the watersheds are in the Yellow River catchment. This programme, which began in 1983, selected eight seriously eroded watersheds around China in which local governments could be supported in making improvements. One of the watersheds is Huang-puchuan in the Ordos Plateau. By 1988, the total improved area exceeded 20,000 km^2 and soil erosion had been reduced by 50 per cent (EDRPRC, 1992).

The Chinese road to environmental protection: Linking environment with economy

This discussion begins with a general overview of relationships between economy and environment, and then moves to the Chinese road to linking environment and economy, as defined by the official *Environment and Development Report of the People's Republic of China* (EDRPRC, 1992). A review of the literature indicates two general positions in economy-environment relationships. The first

considers environment and economy as separate and in conflict. Neoclassical economists conceive environmental consequences largely through ''economic externality'' and believe that internalizing this extra cost in economic activities and prices would do much to secure environmental protection (Rees, 1985). Socio-economic development (economic growth plus distributive justice) takes an environmental issue as an add-on ''react-and-cure'' factor instead of the integrative ''anticipate-and-prevent'' approach in sustainable development. In this view, the environment is considered as separate from the economic system, and the economy is a means of ameliorating environmental problems.

The second position, by contrast, considers environment and economy in an integrated way, and believes that they need to be dealt with together (Bartelmus, 1987; Leonard, 1989; WCED, 1987). In the report *Our Common Future*, the World Commission on Environment and Development (WCED, 1987) considers integrating environment and economics in decision-making as one of the key strategic imperatives, as ''they are both equally relevant for improving the lot of humankind.'' The report goes on to say that:

> Environment and development are not separate challenges; they are inexorably linked. Development cannot subsist upon a deteriorating environmental resource base; the environment cannot be protected when growth leaves out of the account the costs of environmental destruction ... environmental stress and patterns of economic development are linked one to another ... thus economics and ecology must be completely integrated in decision-making and lawmaking processes not just to protect the environment, but also to protect and promote development. (WCED, 1987.)

Where the Chinese road of environmental protection stands between these two polarized positions is hard to judge. According to the basic principles in Chinese environmental regulations discussed in this section, it appears to reflect the second position: it takes a preventive approach and sees economy and environment as integrated. But situations often prevent people from realizing both economic and environmental benefits, especially when long-term environmental protection and short-term economic gain are at odds. As an old Chinese verse puts it:

> I like fish
> and bear's paw,
> however I cannot have both.
> I then give up fish
> and choose bear's paw.

For China, economic development is the ''bear's paw'' and environmental protection the ''fish.'' (Developed countries that have had enough bear's paw may well choose the fish.) This favours development; however, it is not necessarily detrimental to the environment, since economic development is critical to successful environmental protection, as the view of the WCED indicates.

Environmental protection in China began in 1972 after the Stockholm UN Conference on the Human Environment of the same year. A state Environmental Protection Agency was established soon after. Since 1978, environmental protection has ascended to the status of state responsibility, and progress in environmental and pollution control has accelerated.

In the official *Environment and Development Report of the People's Republic of China* (EDRPRC, 1992), national environmental policy is characterized as ''the Chinese road,'' and comprises 12 rules.

1. Economic development and environmental protection need to be planned, conducted, and developed simultaneously for combined economic, social, and environmental benefits. Environmental protection measures must accompany economic and social development in order to promote a sustainable, stable, and coordinated development of the economy.
2. Environmental protection needs to be incorporated in national short- and long-term economic and social development planning, in which environment and economy should be balanced.
3. State-wide land management needs to be progressively planned; opening, utilizing, improving, and protecting land resources should be considered at the same time.
4. Population control is a basic state policy. Reduction of the birth rate will reduce pressure on the environment.
5. The environment and natural resources provide basic conditions for economic development. In agricultural, industrial, and other sectoral development, environmental protection should focus on a rational and efficient use of natural resources. Favourable policies in economy and technology need to be promoted for environmental protection and natural resources' conservation.
6. Environmental protection organizations at all levels of government need to be strengthened, with each level of environmental protection organization taking principal charge and the economic and managerial departments cooperating in environmental protection.
7. In the enhancement of management and prevention measures

and the execution of the ''polluters pay and users protect'' principle, active participation of central and local governments, economic departments, enterprises, and the people needs to be secured.

8. Environmental protection should be formalized in environmental laws, regulations, and standards, so that environmental management becomes systematic, standardized, and scientific.
9. Encouraging scientific research in environmental protection and developing environmental protection enterprises will build environmental protection upon advanced technology and equipment.
10. Establishing and completing an environmental monitoring and information network is necessary in order to follow environmental conditions over time.
11. Education and propaganda must be promoted in environmental protection to raise the environmental awareness and education levels of the general public and increase the number of experts in environmental sciences and technology.
12. Communicating and cooperating internationally in environmental protection and human advancement are important.

It is clear that in each of these rules environmental concern does not stand alone; rather, it is closely connected with such concerns as economy, society, and human advancement. The core goal of environmental policy is to integrate environmental protection into economic and social development, with economic development given priority and environmental protection seen as an indispensable part of it. The reason is simple: environmental protection in the end advances human well-being and therefore should not be in conflict with economic development.

The economy is the central concern. ''China is a developing country. In order to be strong and realize socialist modernization, we must give priority to national economic development; every other policy must centre on economic development.'' In China, as in other developing countries, ''poverty and underdevelopment are the principal reasons for environmental degradation, and people are trapped in the vicious cycle of poverty, overpopulation, and increasing environmental destruction. To end this cycle, economic development that eradicates poverty is the key approach'' (EDRPRC, 1992).

The report cites agricultural land degradation, dwindling of forest resources, water shortage in north China, depletion of coastal0. fisheries, industrial pollution, and urbanization as being among the most challenging of pressing environmental problems associated with eco-

nomic development. It is noteworthy that with regard to forests, the emphasis is on the imbalance of resource demand and supply, and not general deforestation or loss of biodiversity – a typical human-centred view. Regarding the coal-based energy structure, the report mentions the need for technological breakthroughs and the problem of air pollution in local areas, and not global warming – a typical local view. Both are characteristic of the Chinese road to environmental protection.

This leads to the question of how environmental issues are constructed as problems. The basic Chinese assumption is that environmental degradation is an obstacle to economic development and therefore needs to be addressed along with economic development. The priority is the economy, through which the Chinese see environmental problems. Indeed, the economy is both the reason for identifying and the means of addressing environmental problems. Environmental problems are both viewed through an economic lens and tackled through economic systems. The phrase ''combined economic, social, and environmental benefit'' implies that trade-offs will be made when necessary. It explains what kinds of environmental issues receive emphasis on the government agenda, and what kinds are left out. Consistent with this economic emphasis, those problems showing greatest direct and near-term negative impacts on the economy, and which are capable of being addressed most cost-effectively, or both – such as ''three waste'' (solid, gaseous, and fluid) pollution in industry and soil erosion in agriculture – are the obvious priority.

In the Ordos, the pressing environmental problems that *already* (instead of *potentially*) harm the economy and society, such as loss of pastureland, soil erosion, and sandification, have drawn the most attention. These problems are the most closely connected not only with the economy but also with people's everyday lives. The widely discussed environmental issue of global warming is not a concern of people in the Ordos although coal mining is increasing considerably in the area. Among the two kinds of global environmental changes, systemic and cumulative (local in domain) as classified by Turner et al. (1990b), the latter is the main concern of the Ordos. Global warming, on the other hand, is considered mostly a problem of the developed world, which has both caused it and now advocates its abatement – in both cases mainly out of its own needs and priorities (see Agarwal and Narain, 1991).

The Chinese approach to environmental issues is somewhere between those of economic domination and environment-economy in-

tegration. The reasons for the high priority of the economy lie in China's low economic status and therefore its craving for economic development in order to ''move the country forward.'' According to Marx, the material base determines ideology. Political changes in Eastern Europe are considered by Asimov and Pohl (1991) as driven more than anything else by ''hunger for a better life,'' a cry for the material satisfaction promised by the former system but never granted. In discussing the curbing of carbon dioxide to reduce the risk of global warming, the authors state that:

> Few third-world people are going to be willing to abandon their hopes of making their own life better for the prospect of some abstract future good – not while they can see every day, on their little black-and-white television set, that the rest of us are enjoying copious qualities of these things already. (Asimov and Pohl, 1991.)

Thus, even after people meet their basic food and shelter needs, they still have much to desire for a better life, especially if they judge by world standards. Therefore, economic development is likely to be the priority of China for a long time, as with many other third world countries.

The institutional characteristics of environmental policy in China reflect and strengthen the utilitarian understanding of the environment and economic emphasis in environmental protection. My focus in this section is on rural environmental policies, which affect the state of the environment significantly in the Ordos.

Chinese environmental protection organizations (fig. 6.3) and their jurisdictions demonstrate one important fact: administrative institutions for environmental management exist mainly for industry, urban areas, and enterprises, whereas rural environmental issues such as soil erosion and vegetation degradation are left chiefly to the national sectoral departments (such as the Department of Hydrology and the Department of Agriculture), and to local government and its departmental branches. An article by the former administrator of the Chinese Environmental Protection Bureau, Qu (1990), on Chinese environmental problems and policy makes clear the industrial bias in administration. In my fieldwork in the Ordos, I found that the local environmental protection branches of government deal only with urban and industrial pollution and not at all with rural environmental problems. It is mainly the local government – its agriculture, animal husbandry, and forestry branches and its scientific committee – that deals with environmental protection and improvement through poli-

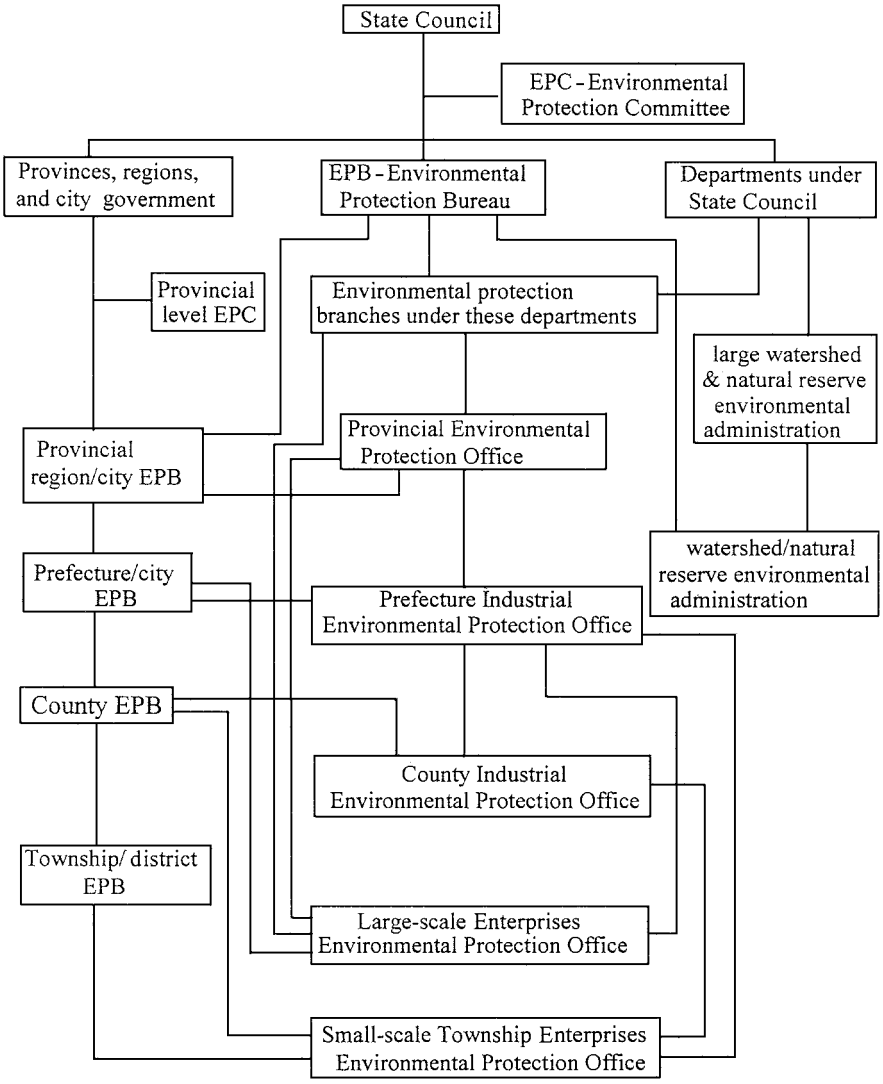


Figure 6.3 **Chinese environmental management agencies**
Source: EDRPRC (1992).

cies (mainly economic in orientation) and programmes (funded by local or upper-level governments or government departments), which in many cases are embedded within other (e.g. economic) regional policies. In short, environmental problems in rural areas are not only constructed through an economic lens, but also addressed mainly by economic administrators.

Appropriate economic policies and measures do have great positive impacts on rural environmental protection and improvement. In many cases, they produce better environmental results than policies and programmes that are specifically environmental. These economic policies deal directly with the forces that drive environmental degradation. Many economic policies in rural areas can be at the same time powerful environmental policies. Consequently, economic process and policy are particularly important for environmental protection in rural areas like the Ordos.

Overall, Chinese environmental protection has predominantly centred on economy and human needs. The rights of the environment *per se* have not received attention. The deep ecologist's view of the environment is a fairy-tale and not reality, and intergenerational equity in resource use is rhetoric rather than strategy. Over the past two decades, however, Chinese environmental protection has achieved some notable results. In the rural areas, where environment and economy are linked more closely than in urban areas, this economic-centred environmental policy is better accommodated and has proved to be very effective. Indeed, the Ordos Plateau offers a case in point.

Regional policy and its change since 1978

Before 1978, societal responses to environmental changes were weak. The evolution of state policy and the role of policy as a human driving force have been described in chapter 4. Here, I will only briefly discuss environmental policies and their effects before 1978. Policies on *Caragana* plantation and pasture protection first emanated from local government following the land reform of 1952. In 1956, the Ih-Ju League Governmental Notice 76 required the establishment of hydraulic and water protection committees, charged with revegetation, soil control, and combating drought. Although environmental protection was formalized in local government at the end of the 1950s, subsistence needs and the Great Leap Forward movement overwhelmed these efforts and encouraged the first two farming expansions. The early 1960s witnessed a resumption of environmental protection and a reassertion of pastoral development. In 1964, the Ih-Ju League issued a ''Tentative Regulation of Pasture Management,'' which banned reclamation and ''irrational'' collection of fuelwood and medicinal herbs, advocated shrub planting, and assured the ownership and management of the people's communes. The measures were, however, incoherent and small scale. The Cultural Revo-

lution, starting in 1966, submerged all other regional policies and diminished environmental protection. Good effects did emerge from the Learning from Dazhai movement to promoted slopeland terrace and pasture closure, but on a much more modest scale than official claims asserted.

Responses became stronger and more consistent after 1978, and they are the focus of this section, which takes up three kinds of policies – political, socio-economic, and environmental. The character of environmental protection in rural China, as expounded earlier, makes political and socio-economic policies especially important since they affect driving forces in the political, economic, and social domains.

Debates have long held sway over whether economic and environmental problems can be successfully addressed at the same time (Leonard, 1989). It has been established that, in the Ordos, not only can these problems be tackled at the same time, but it is those policies that address both economic and environmental problems, or those that address economic problems while having positive effects on the environment, which are the most effective in affecting environmental protection. Policies concerned only with environmental issues often do not bring anticipated results. One example is the policy of returning steep-slope cropland to pastureland, which did not work effectively because of economic constraints. Pasture construction on slopeland requires a lot of investment, in both capital and labour. Only with economic gain through an agricultural project for enhancing basic cropland and better using tree, shrub, and grass plantation could slopeland be reverted to pasture and soil erosion controlled.

This is not to say that environmental policies are not important. In combination with political and socio-economic policies, they are effective in mobilizing resources and promoting environmental measures. The three kinds of policies have worked together to change the overall trajectory of environmental changes since 1978.

In the Ordos, regional development policies have evolved under the Household Responsibility system since 1978. In the eastern farming areas, both cropland user rights and production materials (tools included) were distributed to each household in 1980–1982, with the guarantee that the distribution would not change in the short term. In pastoral areas, two stages of reform occurred. From 1981 to 1984, livestock was allocated to households, with the pasture still collectively owned. This ‘‘dual system’’ persisted for a time but had

obvious shortcomings. A pasture ''super-pot'' was harmful to the environment since it encouraged overgrazing. The second reform divided this ''pot'' and distributed pastureland to households in 1986–1988. As this second reform was described, ''now the land has a lord'' (*Eer Duo Si Bao*, 2 February 1989). This system is called ''double responsibility'' and is practised in other pastoral areas in China.

The reforms also radically decentralized economic activities and management down to the household level. Before 1978, and especially during the Cultural Revolution, household economic activity was cut off as a ''capitalist tail,'' and family income came almost totally from the collective economy. By the late 1980s, however, more than 90 per cent of family income came from household management, and the collective economy had nearly vanished (indeed, it accounts for less than 1 per cent of family income; see table 3.1 in chapter 3). Governmental control was, at the same time, greatly relaxed. For instance, grain procurement was no longer the target of the regional economy. In fact, in 1991 task grain in Jungar was 10 million kilograms whereas the actual selling amount reached 20 million kilograms, which is the local storage capacity.

This rapid privatization of the economy soon created problems. The low efficiency arising from restriction of economic activities to a small scale hampered economic growth. Collective facilities were broken down, and watershed management was ineffective because efforts were unduly scattered. Irrigation facilities decayed for lack of care because they lay beyond a household's responsibilities and abilities. In Maogaitu *sumu* of Otog Front banner, for example, more than 3,000 *mu* of irrigated cropland at 26 sites existed before 1978 under the collectives. In 1990, only 400 *mu* of rain-fed land was left at these sites, without irrigation facilities (interview with officials of Maogaitu *sumu*, 1991). Similar problems emerged in other rural areas in China (Muldavin, 1996), and in countries with similar experiences such as Viet Nam (Pingali and Xuan, 1992). Cooperative teams reappeared in the Ordos in response to the need for recollectivization (*Eer Duo Si Bao*, 20 July 1989).

Recollectivization began with a further reform in the rural areas in 1990–1991. The State Council ''Notice of 1991 on Agricultural and Rural Work'' promoted a two-tier agricultural management system, with households as the production unit and collectives as the coordinating and service agents. Measures include collective management and service systems on scale-dependent matters such as watershed management, application and maintenance of science and technol-

ogy, improvement of livestock varieties, and the supply of seeds and seedlings. Agricultural and animal husbandry extension work has been strengthened. This reform further balanced collective security and efficiency with individual benefit and interest.

Along the road towards a market economy came a levy on land (cropland and pasture) in 1989. This gave Household Responsibility the feature of a contract system. The League defined three classes and 16 types of pastureland according to quality and biomass. Each *mu* was taxed at 0.05–0.1 yuan, depending on the class and quality of the pasture. The pasture tax belonged to the village or *gacha* for collective reinvestment in pastureland. Villages retained small areas of pasture for grazing sheep and goats.

In 1984–1985, five kinds of wasteland – range, gully, slope, valley, and sand – were also distributed to each family. Improvement by grass, shrub, and tree planting was promoted, with a regulation stating that the land was for the use of the households which invested in its improvement. These policies greatly encouraged cropland management, pasture enclosure, and wasteland revegetation. All farmers and shepherds knew that these were the only ways for them to increase their living standards, and they eagerly claimed even the remote and seriously degraded land. Environmental improvement through household-level effort was the result. With labour short and integrated planning absent, however, there were only small patches of improvement that were not as effective as the coordinated improvement of a whole watershed and its contiguous areas. Recognizing this problem in 1989–1990, the Ih-Ju League and some banner governments reunified the wasteland under collective management, requiring each household and each labourer to devote a certain number of work days to its improvement and giving user rights back to each household.

Economic policy in the Ordos has been the core of regional policy and is at the top of the government agenda at all levels: league, banner, township (*sumu*), and village (*gacha*). Since 1978, the League government has begun to enhance basic cropland farming, pastoral development, and pasture protection and construction, and regulated land use so that ''farming goes down to the valley and forestry and grass climb the hills'' (government archive, 1979). Specific agricultural policies include strengthening basic fields and increasing the economic forest (e.g. fruit and timber trees). The ''3153'' project in Jungar banner – 3 *mu* of basic cropland, 1 *mu* of fruit trees, 5 sheep per person, and 3 pigs per household by the end of 1995 – provided

the structure for agricultural development and environmental protection. Measures in animal husbandry include constructing pastureland and improving livestock breeds. Most of these policies and measures have a close relationship with the environment. Some economic programmes sponsored by the national or local governments have also centred directly or indirectly on environmental improvement, such as the family pasture programme in Uxin banner, the establishment of a livestock hazard-resistant base in Otog banner, and pasture construction in the salinized and alkalinized land along the Yellow River plain.

All other government work centres on the economy. One example is the poverty-resistance programme. National and local governments previously spent much money on supporting the poor, but only on food and shelter to help in the short term. Local government now helps those families to develop farming and grazing and to invest in production. In Bayinwusu township in Otog, supporting the poor was given priority in local government work. They set up a contact system with leaders and party members to help the poor; they used national and collective funds to buy livestock, help enclose pasture, and assist the poor to learn cultivation and animal-raising techniques. As a result, by 1990, 96 per cent of the people in the township had ''risen out of poverty'' (*Eer Duo Si Bao*, 28 December 1990).

Policies addressing population, education, and scientific applications have accompanied economic ones. Population policy has stressed birth control, allowing each couple in a city only one child, and in the countryside, allowing Han couples one child and Mongolian couples two. Birth-control policy received close attention from the local government. There are personnel in each banner, township, and village exclusively in charge of this task, and the results are given much political weight. At the village level, for example, my informants told me that population control accounts for half the score in evaluations of leadership performance (while environmental improvement accounts for only 15 per cent). As a result, population growth in the Ordos has dropped sharply. Over the four decades from the 1950s to the 1980s, the population growth rate fell from 4.3 per cent to 2.77 per cent, then 2.24 per cent, and finally 1.4 per cent.

Educational policy has emphasized agricultural and pastoral techniques and has been combined with the programme of scientific applications. In 1990, following the decision of the State Council regarding ''developing agriculture relying on science and technology, and enhancing applications of science and technology in agriculture,''

a law on agricultural development and science and technology application was enacted. Networks of services and leaders have been built for banners, townships, and villages, and special leaders have been appointed for technology application. Leaders have contracted to help farmers and shepherds with cultivation techniques, family pasture, breed improvement, and revegetation. Training in agricultural technology has been especially popular. People have become more aware of the available means for socio-economic improvement and the importance of environmental measures.

Environmental policies are nested within this overall framework of political and economic goals, and are linked especially closely to the agricultural economy. Two national environmental protection programmes have strong impacts upon the Ordos: the North China Revegetation Programme and the Eight Watersheds Improvement Programme in the Yellow River catchment. The former covers the whole Ordos area, while the latter extends only to the Huangpuchuan watershed in the east. Both programmes have attracted major local governmental attention in terms of personnel and funding for administration and environmental management, and both have been combined with the agricultural economy. For example, under the North China Revegetation Programme, local governments have used their funding and personnel resources to meet farming and pastoral needs. They have extended the plantation species from trees only to include shrubs and grass, and expanded the area covered beyond the task area of improvement. In the farming area, the return of steep slopes to grass cover has been combined with the improvement of basic cropfields, and in the pastoral area, family ranchers are the focus in tree planting and pasture improvement.

Local governments have also initiated environmental programmes of revegetation, though their primary aim is economic. After 1978, it was suggested that ''vegetation is the most important infrastructure in the Ordos''; and in the early 1980s ''three plantations'' (grass, trees, and *Caragana* shrub) and ''five small-scale projects'' (water, pasture enclosure, economic forestry, watershed management, and machinery) were proposed. In 1990, the League government initiated the ''Two-Wing One-Body'' strategy/programme for farming areas, with revegetation and water conservation as the wings and agricultural economy as the body. The gist of this is to use environmental measures to propel the growth of the agricultural economy. The ''3153'' project mentioned earlier is among these efforts. The party secretary of the League, Chen Qihuo, has said, ''Two wings are the means, and

economic development is the aim. Without vegetation protection and water conservation, there can be no stable animal husbandry and high-quality farming, and the conditions for human survival will be lost'' (interview, 1992).

This two-wing, one-body strategy is considered the third leap in understanding the importance of environmental management. The first was the ''reclamation banning and pastureland protection'' and ''tree and grass planting and basic cropland building'' policies lasting from the 1950s through to 1964, which were halted during the Cultural Revolution. The second was the ''three plantations and five small-scale projects'' mentioned earlier and proposed by the League in 1982. The two-wing one-body strategy has further raised environmental protection in its status to a governmental and regional priority, and the proposed measures have been quite practical.

Recently, facing the problem of overgrazing, some banners have evaluated and documented pasture grades for each household, deciding to reward or punish a household, in monetary or other measures, for an increase or decrease of pasture grades. Ways of determining livestock and offtake number according to available forage are pointed out and promoted. This approach is only in the experimental stage, and concrete methods are still being formulated.

Local institutional changes, in response to these economic and environmental policies, play an important role in policy execution. The role of local government in policy-making is to formulate implementation and monitoring systems so that the upper-government policy can be realized. Institutional change is one of the major components for local government, aside from making detailed policy or regulations, in response to policy change. For example, in the agricultural project of science and technology application, special leaders were set up in banner and township governments for its execution, to mobilize resources, regulate funds, and monitor its results. The revegetation programme was enhanced by leadership assignments by local governments. The success in population control owes a lot to its important role in leadership performance evaluation, in this case in the existing governmental agencies.

Besides altering all socio-economic and environmental policies in the area, the Household Responsibility system as a form of privatization has also helped people to perceive better the relationship between livestock and pasture and between people and the land. Intuitively, as land – cropland and pasture – is now confined in area for each household, it is easier for people to see what resources they

have to rely upon for the next three to five decades (the proposed length for the land-use contract system). As a result, the system has helped in controlling the growth of both livestock and population. In my interviews, when I asked shepherds about the possibility of increasing herd size, I frequently received the answer: ''There is not enough pasture to raise more.'' Statistics also show that livestock numbers have remained constant or even fallen slightly since 1978 (ranging between 4.5 million and 5 million) while forage and feed production has increased. The livestock death rate has also significantly dropped below 5 per cent (except for 1983; see fig. 7.4 in chapter 7). Population control, though largely implemented by the coercive policy of the state, has also been facilitated by land privatization, as people can see that they have only a certain amount of land and no way to increase it. This facilitates environmental protection efforts.

Economic transformation since 1949

The economic situation has changed greatly since 1949 and especially since 1978. This, although not directly intended as a response to environmental degradation, plays an increasingly important role in environmental improvement, as economic and environmental trajectories come to a better balance. With the close linkage between economic and environmental factors, economic growth in the Ordos has been both an outcome of and a contributor to environmental protection and improvement.

Official statistics for a number of socio-economic indicators show a trajectory of economic growth (although with fluctuations) between 1949 and the early 1960s, stagnation or even declines from the early 1960s to the early 1970s, and then recovery and even further improvement later on, especially since 1978 (fig. 6.4). This trajectory parallels the trend of environmental degradation (i.e., slow, swift, and then level off) over the same period. In the 1950s, socialist transformation played a major positive role in improving the area's economy through political stability, social equality, and better governance. The early 1950s witnessed economic recovery as a result of both national governmental policy and local effort. Data from the local government statistical bureau indicate that total social production, national income, and GNP of the area more than doubled from 1949 to the early 1960s. Per capita values also increased by about 50 per cent. Agricultural change can be illustrated by the moderate increase of yield

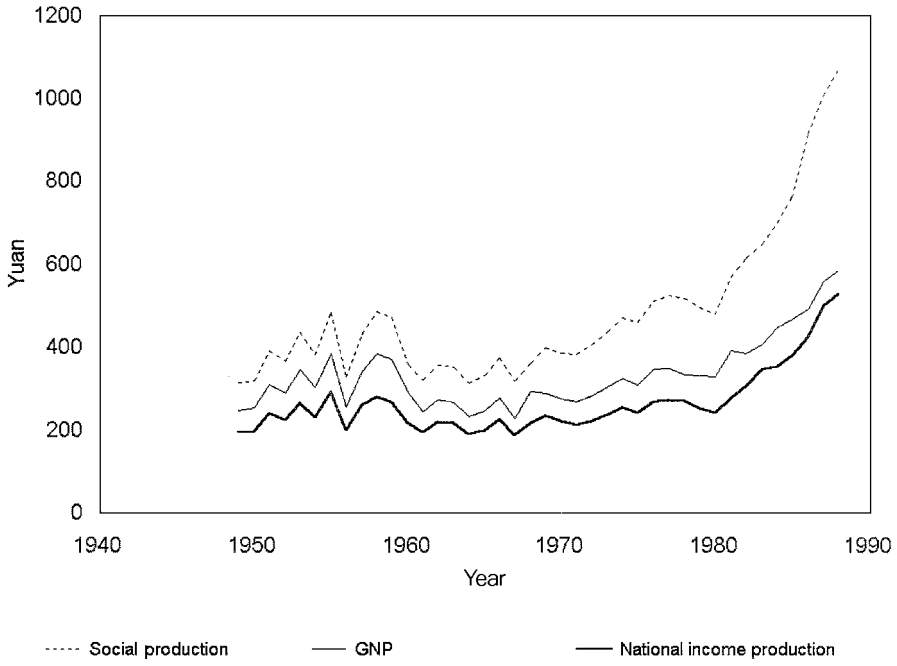


Figure 6.4 **Economic transformation**
Source: Ih-Ju League Statistics Bureau.

from 36.7 *jin*/*mu* in 1949 to the range of 60–70 *jin*/*mu* in the late 1950s. Changing animal husbandry, for a lack of other data, is indicated by the total number of livestock, which more than tripled from 1,582,100 in 1949 to 5,490,300 in 1964. The amount of bank savings, a useful overall indicator of the area's economic development, rapidly increased during the decade, from 20,000 yuan in 1951 to 7,290,000 yuan in 1960. Rural savings rose from 90,000 yuan in 1954 to 4,270,000 yuan in 1960.

Economic stagnation in the 1960s and the early 1970s coincided with accelerated environmental degradation during the political movements of the Great Leap Forward and Cultural Revolution. Total social production, national income, and GNP oscillated between 210 and 350 million yuan, 130 and 200 million yuan, and 170 and 250 million yuan, respectively. With the population increase, the per capita values of these parameters actually declined to the 1949 level (fig. 6.4). Yield per *mu* stagnated in the first half of the 1960s, and then rose slightly owing to the positive impact of "Learning from

Dazhai,'' which will be discussed later. The total number of livestock, however, decreased from its peak in 1963 and not until the 1990s did it regain that level. Bank savings also declined and only in 1970 rebounded to 1960 levels.

Economic growth after the late 1970s also accompanied environmental improvement under changing state policy toward economic development and the adoption of the Household Responsibility production system. Economic parameters rose continuously from the mid-1970s to 1990, reaching ever higher levels. Per capita social production, national income, and GNP have more than doubled compared with the 1960s. Crop yield has increased considerably, from about 70 to over 200 *jin*/*mu* over the same period. Bank savings have soared exponentially, to 120.8 million yuan in total and 53 million yuan in the rural area.

Human well-being has greatly improved since 1978. The living standards of farmers and shepherds have risen enormously; most now have adequate food and shelter, and their income is now, on average, well above the poverty line (300 yuan net income in the Chinese standard – see Wang, 1992). Lacking systematic data, I can use only scattered interview material to show the increase in family income. One farming area, Chuanzhanguo in the Huang-puchuan watershed, experienced drastic change. It lies in Heihadai township of Jungar banner and has a population of 3,760, with a density of 17 people/km^2. Before 1980, the area was very poor; one day's labour earned only 0.4–0.5 yuan at the best, and 0.2 yuan on average. With four *mu* of cropland per person yielding about 90 *jin*/*mu*, nearly half the people depended on grain imported by the national government. Women from other villages did not want to marry into the village. By 1990, however, the grain yield per person had reached 800 *jin*, and per capita net income had increased to 712 yuan.

Shepherds' living standards have improved even more. In Uxin banner, per capita net income rose from about 100 yuan before 1980 to 688 yuan in 1990. The highest figure, 900 yuan in Sherli *sumu*, is close to the national standard (1,100 yuan per capita) of being well-off (*xiao kang*) in pastoral areas. Interviews with shepherds in Bayantaolehai *gacha*, Uxin *sumu*, Uxin banner, traced the history of the village since 1949. In the 1950s, each household owned between three and five sheep/goats, all traditional local breeds with low outputs of cashmere and meat. Livestock products were exchanged for tea, clothes, and tobacco. Bedding in the house was rare; a sheepskin coat was worn during the day and used as cover during the night.

Cultivation was on dry land and produced low yields. Before 1978, under the strict control of the commune, standards of living were low, and per capita meat consumption was only 20 *jin* per year. Even for the most important spring festival, each household could spend only about 20 yuan. Three figures demonstrate the improvement by the 1990s: per capita net income in 1991 was 800 yuan, meat consumption per person is about 200 *jin*/year, and each household spends 400–500 yuan for the spring festival. I have seen fairly solid houses and livestock shelters, and modern appliances such as motorcycles, radios, and television sets (mostly black-and-white, though). This village is at the average economic level. In the better-off places, shepherds can even hire labourers (mostly from the adjacent farming areas of Shaanxi Province in the south) for feed-crop cultivation and grazing. Interviewees informed me that short-term labourers received five or six yuan per day and long-term workers earned eight or nine yuan per day. It is apparent that a shepherd's life has gone well beyond subsistence level.

This positive economic transformation has created the conditions that allow effort to be expended on environmental protection and improvement in the Ordos Plateau.

Case studies: Jungar, Uxin, and Otog banners

The increase of economic status over the whole region is not without a social stratification of households. Some households, consisting mostly of local leaders, educated young people, retired soldiers, and capable farmers and shepherds who have become rich and experienced further economic development, are both examples and propelling forces for regional development. Government support has given priority to these households. In this study, however, the analysis rests on regional and subregional levels, and the social stratification of households, though acknowledged, will not receive further attention.

The Ordos Plateau is an environmentally and socially differentiated region. Each subregion, based on its environmental condition and agricultural activities, has adopted, or has been selected for, different economic and environmental programmes. The cases discussed here have been selected in three subregions, Jungar, Uxin, and Otog banners, representing the eastern loess hills agricultural area, the Mu Us sandy land pastoral area, and the western high denuded plateau pastoral area, respectively. Concrete measurements

underlying subregional development policy according to different conditions will be discussed in each of the three banners. Data regarding each of the cases come from field interviews, unless noted otherwise.

Jungar banner

Jungar banner, covering an area of 7,539 km^2, suffers from serious soil erosion. Water and soil conservation efforts began in the 1950s. A Water Conservation Bureau was set up in 1956. Measures for environmental protection taken by the local government prior to 1965 included basic field building, grass and shrub planting, and reservoir and dam engineering. Small in scale and hampered by a lack of coordination between vegetative and engineering measures, these efforts failed to achieve significant results. Between 1966 and 1972, during the Cultural Revolution, conservation efforts stopped and the Water Conservation Bureau was disbanded. In 1973, with the ''Learning from Dazhai'' movement, soil and water conservation began again in the form of basic field construction (especially slopeland terracing). In short, before 1978, measures of environmental protection notwithstanding, their scale and effects were modest. Projects such as land terracing, damming, and reservoir building, rather than revegetation, were emphasized and the engineering projects frequently decayed for lack of maintenance.

Since 1978, integrated watershed management has emerged and other regional policies also address environmental problems. Three major regional projects in particular have had important impacts on the environment: science and technology applications, watershed management, and riverbed transformation.

Science and technology applications in agriculture

The Science and Technology Application Act came into force in the Ih-Ju League in 1990. The aim of the Act was to apply modern farming and pastoral techniques to promote agricultural development. It used two important levers to effect environmental conservation – improving the economy and advocating education.

Leadership establishment was the first important step. In the banner, and in every township and village, a vice-leader was given charge of this plan. As Director Han in the Agricultural Department stated, ''In the past, we also knew the importance of science and technology in agriculture. But since nobody was in charge of it, the work was not

done. Now the vice-leader in the banner is in charge of the work, and it really gets on the agenda.'' Rural education and other organizations (e.g. the Women's Union and the Youth League Committee) also focus on this plan by providing service and propaganda.

The major priorities in Jungar banner are to build basic fields, to apply new farming techniques and introduce good crop varieties, and to set up technological service networks. Investment in relevant activities has increased considerably. For example, 1 million yuan was invested in basic field building and 200,000 yuan on technological network establishment in 1991. Improved varieties, scientific fertilizing methods, and land surface filming techniques have also been demonstrated and applied, greatly increasing crop yield. Improved varieties can generally raise the yield by 40–100 per cent (interview). A good variety of corn under surface filming on irrigated fields can raise the yield by as much as four times, from 2,250 kg/ha to 11,250 kg/ha. Many technological service centres have been set up at townships, providing seeds of improved varieties (previously difficult to buy), training farmers, and teaching cultivation on the farm sites. In every township, two or three households are selected to demonstrate cultivation techniques, which has considerably facilitated their diffusion.

Basic fields not only are the basis of high production but also help control water loss and soil erosion. Their increase also provides more food and helps the return of steep-slope fields to pasture. The government has also promoted the terracing of slopeland and the damming of gully mouths. For every *mu* of land terraced, the local government has delivered a 50 yuan interest-free loan requiring repayment after two or three years. This leaves only 20 yuan per *mu* to be paid from the individual's own resources. As a result, basic field construction, stagnant after 1980, has been expanding quickly. Economically, it is assessed by local people that after three years the benefits will exceed the costs (interview). Environmentally, in the gully and hilly areas of Jungar, basic fields represent the only viable approach to ecologically sound farming.

The future aim is to complete management, service, training, and application of the technological network and to assist fulfilment of the ''two-wing, one-body'' and ''3153'' projects in Jungar banner. Efforts will be devoted to basic field improvement, fruit-tree planting, rainfed agricultural demonstrations and marketing (in the north), grazing of white-hair goats, and vegetable production. The plan also aims to help the poor by providing guidance on agricultural techniques.

Watershed management

Huang-puchuan watershed management began in 1983 after the Fourth National Water Conservation Meeting. It is sponsored by the State Council's Department of Hydrology and directed by the Yellow River Committee; 38 sub-watersheds have been selected for major investment owing to their contribution to deposition in the Yellow River.

Administratively, the Soil Conservation Department in the banner was initially in charge of the work. It planned for watershed management, employing farmers and shepherds to plant grass and shrubs and to dam and terrace land. In the beginning, no regulation existed to govern the use of this improved land. As a result, the long-term benefits to individual farmers were not secured, and maintenance was problematic.

In 1984, the eroded land was distributed to households, encouraging protection and improvement. Because of a lack of labour and integrated planning, however, such small-scale land management could not improve the environment effectively. Realizing this problem, in 1989 the local government reunited the land under collective management. Each household was required to contribute labour or money for improvements (20 days for each labourer each year), and these households were given the use of the improved land. This system has been effective in combining the zeal of individuals with the integrated management of collectives, but maintenance of the improvements is still a problem. For example, in the 38 key watersheds, only about 50 per cent of the area involved has been effectively maintained. To strengthen maintenance, the Jungar banner government has formulated a regulation to be implemented after the approval of the Representative Committee.

Not only the Soil Conservation Department, but every level of government has been involved in watershed management. Each area has an administrative leader responsible for its improvement, as well as an extension worker for its planning and management. The banner has also established a Soil Conservation Law-Enforcing Group and a Supervision and Examination Station. In those townships where funding is substantial and the government pays close attention, the improvement has been obvious.

Heihadai is one such township. It has 220 km^2 of land, 960 households, and 3,750 people. Since 1983 when Chuan-zhangguo was recognized as a key sub-watershed, environmental protection has been on the main agenda of the local government. The township estab-

lished an environmental improvement headquarters and an 80-person specialized team. Each village has a special leader and caretaker. The management is household-based and accompanied by the collective effort of the specialized team. The team works 50 days a year, and each labourer in a household is required to work 30 days a year on revegetation. In 1991, the newly improved area was 165,800 *mu*, making the total improved area 265,000 *mu*. Per capita income increased from 91 yuan in 1983 to 740 yuan in 1991.

The principles of watershed management are to combine engineering and revegetation measures to reap economic and environmental benefits. Slope and gully management are coordinated, with the revegetation of slopeland and improvement of tributary gullies as precedents, followed by gully-mouth engineering and main gully projects. The control of slope erosion and gully flooding facilitated the maintenance of dammed lands, reservoirs, and channels at the gully mouth. Economic and environmental benefits over the short and medium term as well as the long term are considered. Basic field building and grass planting provide short-term profit, fruit-tree planting produces medium-term revenue, and establishing protective shrub and forest cover proves both economically and environmentally beneficial in the long run. Basic fields and fruit-tree planting are emphasized.

The results of watershed management are apparent. When I visited Heihadai, I was struck by the more than 3,000 ha of pine forest established since 1980. From 1983 to 1989, in the 38 key watersheds, of the total land area of 1,350 km^2, soil erosion was controlled on 465 km^2, 60 per cent more than the area that had been improved between 1949 and 1982. Some 360 ha of basic fields were built, 121 km^2 of grass planted, 330 km^2 of shrub and forest (including fruit trees) set up, and 266 projects established for erosion control, water conservation, stream harnessing, and field building. Agriculture has also benefited. Over the same period between 1983 and 1989, crop yield per unit area increased by 173 per cent and total yield by 129 per cent; the total value of agricultural production increased by 213 per cent. Annual income per capita rose from 140 yuan to 490 yuan. The effects of soil erosion control can be illustrated by one downstream hydrological measurement (with a control area of 3,155 km^2), which showed a 26.7 per cent reduction of runoff and a 17.6 per cent decrease of solid discharge from 1983 to 1989 (unpublished material, Soil Conservation Department, Jungar banner). Effects in other watersheds in the programme area have also been evident (table 6.1).

Table 6.1 **Effects of watershed management**

Watersheds		Heimaotu		Baolaotu		Nanlianggou	
Watershed area (km^2)		6.19		9.85		3.66	
Investment ratio	government : private	49 : 51		68 : 32		56 : 44	
	engineering : vegetation	69 : 31		54 : 46		54 : 46	
year		1980	1989	1980	1989	1980	1989
Basic fields (ha per capita)		0.04	0.12	0.01	0.03	0.01	0.2
Shrubs and trees (ha per capita)		0.16	1.96	0.27	1.79	0.01	1.24
Grass planting (ha per capita)		0.15	0.52	0.02	1.23	0	0.12
Vegetation coverage (%)		7.23	53.98	6.7	64	14.7	54
Annual income (yuan per capita)		114.8	713.3	158	782	150	543
Grain production (kg per capita)		199.8	374.2	240	428	216	494

Source: Data from Soil Conservation Department, Jungar banner.

Riverbed transformation

Jungar banner is a gully-hilly area, and much of its land has steep slopes. Since 1978, returning slopeland to pasture has been required but not fully implemented because of the need for grain production. As a part of the Huang-puchuan watershed management programme, the Chuan-zhangguo sub-watershed riverbed transformation project has provided a viable means of slopeland conversion by enhancing basic cropland.

The riverbed transformation project began with a demonstration in a small area in 1980. Aiming at narrowing the water channel from about 400 m to 50 m, new channels were dug for the stream and dams built to retain silt so as to flatten the rest of the riverbed into highly productive (and irrigable) basic cropland. The process involved a 220 km^2 area, 10 km of riverbed, 12 villages, and 1,500 people. In 1983, the project began and cropland was developed. The late 1980s saw the major results of the project. National investment covered the major machinery and labour costs, and local government was responsible for planning and organization. Labour input came from the farmers. The cropland created was distributed equally among the people in the area. Before the project, cropland along the river was

not flat and suffered frequently from flood and drought. Yields were very low, only 50–100 kg/*mu*. After the transformation, in my visit in the summer of 1992, I saw more than 7,000 *mu* of high-quality cropland planted with corn, broomcorn millet, potatoes, and wheat. The estimated yields were 450 kg, 250 kg, 5,000 kg, and 350 kg per *mu*, respectively, several times higher than on the original cropland (interview, 1992). Having enough cropland for grain, slopeland was turned into human-made pasture and tree and shrub plantations. Environmental protection became an important side-effect of the project.

Looking at the overall success of the project, I found that national investment and planning was only one part of the explanation. The suitability of the measures for dealing with farming and soil erosion problems in the area was another. Basic cropland construction was the only means for rain-fed farming in the area, and only after people had enough food could they deal with environmental degradation. The third part of the explanation lies in the efforts of local leaders. In my interview, I found that the former secretary Lu, the present secretary Tian, and the township leader Wu were all well acquainted with the area and with its economic and environmental situations and solutions, and were very responsible and well respected. Both banner and national governments had honoured all three leaders for their devoted work on watershed improvement.

Uxin banner

Uxin banner covers an area of 11,645 km^2. Situated in the centre of the Mu Us sandy land, it is seriously sandified. Before 1978, grazing depended mainly on natural pasture, and human intervention was modest. Since 1978, the construction of pastures, improvements in livestock breeds, and the establishment of family pastures have had major impacts on the environment.

Pasture construction

Enclosed pasture, called *kulum* in the region, combined with rotational grazing, is the major means of pasture improvement in Uxin banner. Not only has the area of *kulum* increased rapidly, but its use has also expanded from mere forage cutting before 1978 to seasonal grazing, forage cutting, and being a means to combat sandification. By early 1991, there were more than 16,800 *kulum*, totalling 3,753 km^2 and accounting for about 67 per cent of the total grazable pas-

ture area (interview, Pasture Working Station). Of all investment in *kulum* enclosure, it is estimated by the Pasture Working Station, Uxin banner, that shepherds contributed 40 per cent in the form of labour and *kulum* fencing material, the national government 30 per cent, and local government another 30 per cent.

Inside *kulum*, both natural restoration and supplementary planting of shrubs and grass are practised to improve pasture quality. Whereas places near or around livestock shelters and human habitation were once seriously degraded, these places are now the major areas of *kulum* building and pasture improvement. Policies favouring tree, shrub, and grass planting are the same as in Jungar banner. For trees (mainly in the valleys) and shrub planting, for example, the national government invests 5 yuan/*mu* for seedlings. Because of its sparse population and vast continuous area of sand dune pasture, Uxin has not adopted collective management. Instead, airplane sowing is undertaken over large areas, thereby saving labour. Collective services are strong in plantation techniques. For example, the Forestry Department of the banner nurses tree and shrub seedlings and supplies them throughout the banner in the planting season. For the introduced species (such as *Hedysarum mongolicum*), the department offers training in planting techniques. High-yielding human-made grassland is another element in *kulum* where the land has wells for irrigation.

The use of grazing pasture in *kulum* is rotational, following a two-three-season grazing system, with valley meadow as cold-season pasture and sand dune steppe as warm-season pasture, or with valley meadow as spring and autumn pasture, sand dune steppe as winter pasture, and high-altitude steppe as summer pasture.

Kulum also make use of previously sandified land, which, under enclosure and planting, has been improved into grazable pasture. On the remote sandy land not initially distributed to households, the banner's policy has been to encourage private improvement. Households (single or combined) have been able to contract to improve these lands within three to five years; the improved land has then been given to these households as bonus pasture. I have no definitive data about how much total pasture has been improved this way, but my informants told me that most sandy land has now been contracted for.

Family pasture

Family pasture is a new pastoral system, household-based and with improved pasture. It includes five elements: fodder cultivation with

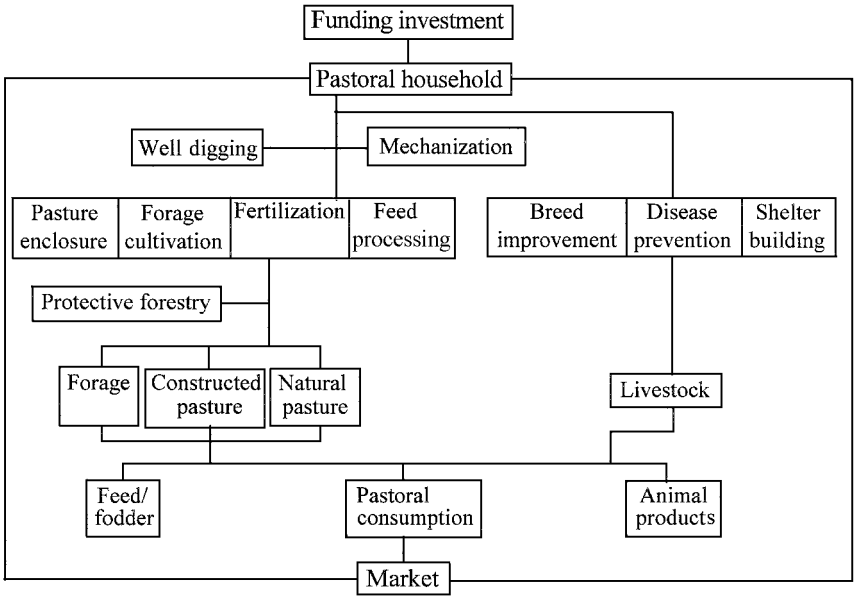


Figure 6.5 **Family pasture structure in the Uxin sandy land**

irrigation, improved pasture, protective vegetation, mechanized equipment (such as diesel engines and tractors), and forage processing. These form the basis of highly productive and hazard-resistant animal husbandry. According to the standard set by Inner Mongolia, a family pasture unit should have 30 *mu* of forage cultivation and over 9 *mu* of planted grass (both irrigated), 5,000–15,000 kg of green forage per year, 3,000 protective trees, over 50 per cent of good-breed sheep, about 20–30 sheep offtake every year, a family income of over 750 yuan per capita, and a household able to master proper agricultural techniques. The overall structure of the family pasture and its connection with various management factors are shown in fig. 6.5.

Family pasture was originally created by shepherds and extended by the Animal Husbandry Department and the Scientific Committee of the banner. It combined the hardworking spirit of shepherds like Zhu Xiandong (who practised digging wells and expanding irrigated forage land), the livestock management of others like Nimazhamusu (who pursued short-term fattening and high offtake rates), and the pasture management of shepherds like Wangdannima (who achieved pasture protection and improvement by combating sandification, forage planting, and machinery development). Toward these ends, the

national, Inner Mongolian, and local governments have invested in setting up family pastures. Besides the Inner Mongolia Autonomous Region and local funding through projects run by the Animal Husbandry Department and Scientific Committee, local government has also directed national government support through hazard-resistance and revegetation programmes. (Unfortunately, I do not have data on the level of overall funding.)

Forage cultivation began in Uxin in the 1960s and increased after 1978. In the Mu Us sandy land, the rich and shallow groundwater favours well digging for irrigation. With the help of more water, human-made productive pasture species, such as *Medicago sativa* and *Medilotus* spp., and green forage, mainly corn, have been cultivated. Generally they have been fenced in *kulum* and protected by trees and shrubs. Banner policy has declared that in pastoral areas, the extent of cultivation will not be restricted as long as it is irrigated. As a result, by the end of 1991, 9,350 wells had been dug, 7,300 of them machinery-equipped, and 130,600 *mu* irrigated. Forage production was 30,050,000 kg (dry), and 50 per cent of fine feed and 100 per cent of forage could be self-supplied. Compared with the situation before 1978, when forage was not sufficient and fine feed depended totally on imports, forage cultivation has greatly reduced the vulnerability of animal husbandry to natural hazards.

By 1991, 1,304 households in Uxin banner had attained the standard of family pasture. *Kulum* having the five elements of family pasture totalled more than 3,700, covering 785 km^2, 22 per cent of the total *kulum* area. The 22 higher-standard family pastures have reached a high level of animal husbandry, every household having 105 *mu* of man-made high-quality pasture, 10 *mu* of forage corn, 264 sheep units, and 180 sheep. Annual income per capita has exceeded 2,000 yuan. In the 400 family pastures in 1990, each household produced 15,000–20,000 kg of forage grass and 2,000–3,000 kg of forage corn, possessed about 15 *mu* of irrigated land, and earned a per capita income of 1,700–2,100 yuan, two to three times higher than other households. The Uxin banner government has decided to develop 300–500 more family pastures each year and seeks to provide all households with wells by the year 2000.

The example of Uxin-Ju sumu

Uxin-Ju *sumu* covers 1,665 km^2 (2,497,500 *mu*). Of its 3,942 inhabitants, 83.6 per cent are Mongolian. In 1991, livestock totalled 77,828, mostly sheep (67,373), and pasture covered 85,4850 *mu*. This *sumu* is

famous for its pasture improvement campaign during the Cultural Revolution. In the 1960s and early 1970s, a slogan in China ran: ''Agriculture learns from Dazhai, and animal husbandry learns from Uxin *sumu*.'' From my interviews, I constructed a general picture of what it was like at that time. The *sumu* leaders Dong and Er reported that:

> With natural grazing dominant at the time, Uxin-Ju *sumu* proposed ''pastureland construction'' for the first time. Eliminating the poisonous grass *Achnatherum inebrians* and enclosing pastureland were the two major activities. The *sumu* government held office wherever this poisonous plant appeared. The direction was correct, but affected by political leftness; the emphasis was on propaganda and the practical effect was neglected. The mass movement for tree planting also did not achieve the expected results.

I interviewed Huhelao, the one-time leader (1953–1983) in Bayantaolehai *gacha*, Uxin-Ju *sumu*. Not very strong or tall, but experienced and determined, he said he remembered everything. Slowly but clearly, he told me the story of the village.

In the land reform of 1951–1952, economic restoration was emphasized. Shepherds were given sheep/goats, but many died of disease. In 1953–1954, cooperative teams first appeared; people exchanged labour in sheep/goat tending and cattle grazing, whereas extra work was devoted to livestock shelter building. Then with the advent of collectivization, sheep/goats were given to the collective and everyone worked together. Sheep/goat disease prevention and breed improvement were advocated. In 1955, the banner offered the *gacha* a good-breed male sheep, but nobody accepted it, saying that the lambs would be hairless and short-tailed and produce bland meat. Later they realized the benefit of improved breeds.

In 1960–1965 the village undertook land reclamation, mainly owing to the difficulty of purchasing staple foods. Villagers had to travel far and use cattle to carry the grain back. Working with three other brigades (now villages), and inviting Han farmers from outside to help, the village, under the order of the banner, decided to reclaim the dry sandy land. The shepherds objected, however, and fought with the farmers. In 1965, the League leader Baoyanbatu visited the village and berated them, asking ''Do your sheep and goats eat bread?'' and ordering them to plant grass instead of grain. His policy was planting trees and grass and improving sheep and goats, a suitable policy for which he was later dismissed during the Cultural Revolution when grain was given priority.

Beginning in 1964, the village enclosed pastureland and removed poisonous grass, as part of the pastoral Dazhai movement. After 1966 (and until 1976), under the Cultural Revolution, the Dazhai movement was more vocal but its real effects on pastureland were largely neglected. The village actually enclosed only one pasture of about 1,000 *mu*. It was a nationally cited pastoral model, and leaders devoted themselves to mass-movement propaganda and monitoring anti-revolutionary activities. Meanwhile, shepherds devoted most of their time and dairy products to receiving visiting delegations from all over China. Their income decreased. The small numbers of privately owned livestock were confiscated by the brigade since they were considered ''capitalist tails.''

Only after 1978 did effective pasture protection occur. The story of the village since then has followed the general trend of regional development and is considered ''nothing special.'' Several data about the *sumu* indicate the extent of change. By 1991, pasture had been 100 per cent enclosed and 50 per cent of sandy land enclosed for improvement. (Since there are over 500 *mu* of sandy land per person, labour shortage is a constraint on sandy land revegetation.) In animal husbandry, the village began to control quantity and raise quality so as to increase livestock offtake. As the *sumu* leaders Dong and Er concluded:

> Before 1978, the political movement did not care about the results on the economy, and people felt they were not working for themselves and were not paid for their efforts. The total attempted area for revegetation had been several times the whole area of the *sumu*, without much success. The problem was a low survival rate. Now with the Household Responsibility system, people planted more trees and cared about maintenance; therefore more have survived (80 per cent). We have been working on revegetation and pasture protection for many years. The overall direction is correct, but with different political systems the results have been strikingly different.

Otog banner

Otog is also a pastoral banner. It has an area of 32,210,000 *mu*, with 26,610,000 *mu* of pasture and 20,740,000 *mu* of usable pasture. The pasture is mostly of the dry high-plateau type, and irrigation is impossible. The banner suffers from frequent droughts that affect the pastoral economy significantly. Since 1978, the development of the regional and national economy has given the banner two opportunities: the wool price increase that has stimulated goat and sheep

grazing, and government support that helps in building a hazard-resistant base for the pastoral economy.

With the opening of the economy and the growth of the wool industry, wool and cashmere prices rose after 1980 and peaked in 1986–1987. As the demand for wool and cashmere outstripped the available resources, prices soared and traders could make hundreds or even thousands of yuan with one transaction. This phenomenon, dubbed the ''cashmere war'' by the locals, provided the first opportunity for the Otog shepherds to acquire money and improve their living standards. During my field visit, I found the shepherds in the Otog on the higher end of the scale of income and wealth in the Ordos. Before 1978, they used mainly horses and camels for transportation, and few families had good, sturdy livestock shelters. In 1992 when I visited, most families used motorcycles for transportation, and some even owned jeeps, which had previously been rare even in eastern China's rich countryside. Most families had solid livestock shelters and windmills. Everyday life was greatly improved, favouring environmental protection.

In pasture management, the programme for ''building a hazard-resistant base for the pastoral economy'' greatly improved both pasture and animal husbandry. This programme, which began in 1987 under the sponsorship of the autonomous region government, aimed to provide food and shelter for livestock and reduce the vulnerability of animal husbandry to hazards, especially drought. The focus was on water (drinking water for people and livestock), fodder, shelter, and fine feed, and the measures included pasture *kulum* enclosure, grass and shrub planting, well digging, forage processing, and breed improvement. Among the major shrubs species were *Caragana* spp. and *Salix psammophila*.

Governments have played an important role in programme experiments, early demonstration, and funding (table 6.2). For programme demonstration, the government provided 40,000 yuan (half the amount needed) in interest-free loans to selected households (those who were thought likely to be able to repay) in Xinzhao, Arbasi, and Chabu *sumu*, requiring that they return half the loan in five to nine years' time.

The shepherds were active in pasture improvement. By the middle of 1991, shepherds had spent 6,620,000 yuan in the hazard-resistance base construction programme, over three times the governmental investment and over 20 times the collective (*sumu* and *gacha*) investment. They enclosed 2,530,000 *mu* of pasture at 5,867 sites, of which

Table 6.2 **Investment in *kulum* building in Otog banner**

Year	Total investment (million yuan)	Government investment (million yuan)	Shepherds' investment (million yuan)
1980	223.2	86.7	136.5
1981	240.3	143	97.3
1982	163.6	80	83.6
1983	324.4	200	124.4
1984	399.3	150	229.3
1985	114.9	50	64.9
1986	157.6	120	37.6
1987	3,340.2	950	2,390.2
1988	3,645	710	2,935

Source: Data from Animal Husbandry Department, Otog banner.

1,373 sites (700,000 *mu*) had the ''five pastoral elements'' (water, fodder, trees, machines, and fine forage), dug 3,127 wells, and planted 569,800 *mu* of pasture and 1,288,000 *mu* of *Caragana* spp. shrub. By 1992, 70 per cent of the fodder and 80 per cent of the fine forage had been processed, and 85 per cent of the livestock had shelters. Cold-season (five months) forage (150 *jin*/sheep standard) was 50 per cent self-supplied, and fine feed (30 *jin*/sheep standard) also increased. Meanwhile, the death rate of livestock was controlled at 2.5 per cent, compared with 4.9 per cent in 1986. The per capita income of shepherds increased from 408 yuan in 1986 to 692 yuan in 1990 (*Eer Duo Si Bao*, 5 July 1991).

Experiments on the control of overgrazing also began. In 1989, pasturelands were graded and documented for each household. The banner determined that improvement in pasture grades would be rewarded and deterioration punished. To control overgrazing, the Animal Husbandry Department of the banner evaluated the carrying capacity of pasture for each family, and proposed a regulation to apply penalties for excessive sheep/goat numbers.

To a considerable degree, pasture construction is still a top-down task imposed on shepherds. Local government, with the aim of maintaining the pasture/livestock balance and protecting pasture, regulates the species of shrubs, the area of plantation, and the number of sheep/goats shepherds can keep. The difference from pre-1978 policy is that the regulation now resides in the banner instead of in the upper-level governments, and is based on research results from the Animal Husbandry Department. Shepherds have found the policy acceptable and have been able to fulfil its requirements.

Evaluation of regional development policies

As the three foregoing examples show, the Ordos has taken environmental improvement as the basis of economic development. Regional policies have addressed both environmental degradation and its underlying driving forces. Environmental protection programmes have addressed sandification, soil erosion, and vegetation degradation through measures of revegetation, watershed management, and pasture enclosure. The key measure has been vegetation regeneration, accompanied by engineering methods such as slopeland terracing, riverbed transformation, and pasture fencing.

The impacts of policy on the environment have been largely indirect, i.e., through affecting other societal factors, either to encourage human driving forces or to bring about responses to environmental problems. It is clear that merely environmental measures are far from sufficient, since socio-economic driving forces, if unchecked, continue to induce degradation. Environmental policies *per se* are often not powerful enough to redirect human behaviour, and state policy and socio-economic forces have far stronger effects. The influence of the Household Responsibility policy on overall resource use in the Ordos is an obvious example. In agricultural policies, emphasis on forestry (shrubs, trees, and fruits) in the eastern loess hills and on forage cultivation in the pastoral lowland has led to land uses better suited to the local environment. On the one hand, these economic policies include environmental measures; on the other hand, it is the economic growth brought by these policies that furnishes the necessary conditions and capacity for environmental improvement. The policy for population control also deserves mention here, since it has helped to regulate people-land relationships by restraining population numbers. In conclusion, though at-large socio-economic policies have not directly addressed environmental problems, their side-effects on environmental improvement should not be underestimated.

Policy directions have been generally suitable for the Ordos Plateau since 1978. Less sufficient, in many cases, have been measures for implementing these policies, such as watershed management and overgrazing control. Policy execution, carried out by the local government and local resource-use institutions, has modified the strength and directions of state policy, and therefore has sometimes been more important, even decisive, in shaping the outcomes. Increasingly, national and regional government policy only gives general directions, and it is up to the local government to formulate detailed exe-

cution plans. It is in the execution of policy and monitoring of results that local government plays a key role, strengthening or weakening the intended directions.

Technical measures for environmental protection and improvement

Before 1980, human responses to environmental changes were mostly adaptive. Prior to the 1950s the population was sparse and land area per capita was large. When one cropfield was depleted, farmers simply abandoned it and turned to another; when one pasture was degraded, shepherds moved their households and livestock elsewhere. They avoided degraded areas and looked for higher-quality lands. After the 1950s, population increases and growing human interference with nature left the land seriously eroded and sandified. Adaptation strategies were no longer feasible. Strategies of adjustment were then promoted in the ''Learning from Dazhai'' movement. Farmers built terraces and checked dams in cropfields to reduce erosion and increase yields, and shepherds began controlling pastures to preserve them. These activities illustrate the positive effect of political movements during the Cultural Revolution. These efforts, however, existed only in small areas and on a small scale. Systematic environmental improvement did not occur. In Jungar banner, for example, dammed lands and reservoirs at the outlets of gullies were not coordinated with gully-slope vegetative measures. As a result, the land was ravaged by flooding and reservoirs filled with sediment. In Uxin-Ju township, only a small area of pasture was enclosed, while others continued to be overgrazed and sandified.

Since 1980, with increasing human awareness of, and societal responses to, environmental degradation, purposeful adjustments have produced significant improvements except in certain areas, such as the western part of Jungar, where capital scarcity and poor environmental conditions have obstructed improvement efforts. Specific measures for environmental control and improvement include a number of different initiatives (Academia Sinica, 1982).

Human-made pastures

During the three periods of reclamation, some grazing lands were ineffectively converted for cultivation, and the farming area in the east expanded on to steep slopes. Soil erosion and sandification were

rampant. In the 1980s, a new land-use policy reclassified 15 townships as a new grazing region (see fig. 2.2, chapter 2) and reallocated slopeland exceeding 20 degrees and with thin soil layers to pasture. Croplands were restricted to gentle slopeland, terraced land, and river valleys. With this policy, much of the cropland on steep slopes was effectively converted into human-made pasture.

In the Mu Us sandy land and the Hobq Desert, man-made pasture is found on irrigable ploughed land. Valleys in the Mu Us sandy land prove to be the most productive; there, for instance, *Medicago sativa* can yield over 10,000 kg/ha of dry biomass for about 10 years.

Pasture enclosure

Pasture enclosure has proven to be an effective means for restoring pasture that is not irreversibly degraded (table 6.3). Not only has pasture vegetation been improved, but soil fertility has also greatly increased.

In the 1950s, the Ih-Ju League government promoted pasture enclosure for valley meadows, but the scarcity of funding for fencing material and mismanagement of collective pasture made it ineffective. Since the 1980s, with economic growth and allocation of pasture-use rights, enclosure has increased rapidly. In 1985, enclosed pasture accounted for 10.3 per cent of the total usable area, and by 1989 the proportion had increased to 18.7 per cent.

Grass and shrub sowing

Sowing is a quick way to revegetate seriously degraded pasture behind protective fencing. Of the grasses, *Melilotus suaveolons*, *Melitotus albus*, and *Astragalus adsurgens* are sown on valley meadows and inter-dune lowland, where water conditions are favourable. These grasses are highly suited to these locales and can raise the biomass by threefold to sevenfold. Shrubs, mainly forage types including *Hedysarum mongolicum*, *Artemisia phuerocephala, Hedysarum scopatium*, *Caragana* spp., and *Artemisia ordosica*, are used to improve sandy land, loess, rocky hills, and western high-plateau pastures. *Salix psammophita* is sowed in inter-dune places. All these species are of high quality and suitability and are highly productive. *Caragana* spp. and *Salix psammophila* are most emphasized for their economic benefits, and *Hedysarum mongolica* is important in airplane sowing.

Caragana spp., an especially favoured shrub, is well suited for dry

Table 6.3 **Effects of pasture enclosure**

Place	Situation	Main species	Number of species	Coverage (%)	Height (cm)	Biomass (kg/ha)
Zhuhe, Otog banner	enclosed for 7 years	*Calamagrostis pseudo Helerpestes ruth.*	14	95	15–110	3,021
	overused and degraded	*Calamagrostis pseudo. Phragmites austr.*	8	20	4–18	327
Honghaizi, Ejin Horo banner	enclosed for 4 years	*Astragolus melito. Artemisia sco. Caragana korshin.*	26	50	3–60	422
	overused and degraded	*Agriophyllum squa Cynanchum koma. Caragana korshin.*	10	25	3–50	309
Talahao, Dongsheng city	enclosed for 2 years	*Thymus mongolicus Stipa bungean Aneurolepidium chin.*	20	60	5–45	648
	overused and degraded	*Aneurolepidium chin. Thymus mongolicus Saussurea anara*	17	35	2–17	108

Source: Data from Yang, Di, and Huang (1991).

high plateaus, loess hills, fixed or semi-fixed sand dunes, and semi-moving sand dunes. It can serve multiple uses, both economic and ecological. In terms of fertilizer, one *mu* of *Caragana* can provide 29 kg of nitrogen, 5.5 kg of phosphorus, and 14.3 kg of potassium, equal to 400 kg of sheep dung. Its twigs and leaves have four to five times more nutrients than grass, and it also reduces runoff by 73 per cent and soil erosion by 66 per cent on experimental fields. Shepherds rank highly its ecological resistance, palatability, and quality, and say that ''during the half-month flowering season of *Caragana*, the livestock have a festival'' (*Eer Duo Si Bao*, 22 July 1992).

Airplane sowing began in the Ih-Ju League in 1979. It is a labour-saving and efficient means of pasture improvement, suitable for sandy land where sand dunes are not high and for large inter-dune lowlands. Airplane sowing begins in middle or late June before the rainy season. Experiments show that a suitable combination of seeds for one hectare is 7.5 kg of *Hedysarum mongolicum*, 7.5 kg of *Artemisia phuerocephala*, and 4.5 kg *Melilotus albus*; with good water conditions, *Astragalus adsurgens* seed is also applied. The two grasses, *Melilotus albus* and *Astragalus adsurgens*, are used to raise the quality of pasture. In the total air-sown area, the vegetation cover has increased about 40 per cent, and moving sand has become fixed within five years (Wang 1983).

Sand dune improvement

Sand dune improvement was first undertaken in the 1950s, and local people now have a rich and lengthy experience of it. They apply vegetation measures in the front (windward), back (leeward), bottom and top of the sand dunes, and summarize these approaches as ''blocking in the front and dragging from the back'' and ''putting on the shoes first and then the hat.'' On the lowest third of windward slopes, *Artemisia ordosica* and *Salix psammophila* are planted to hold the sand; if the areas are rich in groundwater, *Populus canadensis* and *P. simonii* are also planted. Wind barriers are built on the upper slopes. The growth of these plants can reduce surface (0–30 cm high) wind speed by 60 per cent and sand transportation by 85 per cent (at a wind speed of 3.7–6.4 m/s). As the slopes are gradually flattened, planting continues toward the top of the sand dune. Within four years, the sand dune can be flattened and covered with vegetation. On the low area in front of the leeward slopes, several rows of *Salix*

psammophila are planted to block the moving sand (Huang and Song, 1981). These approaches have been very effective.

In the inter-dune low areas, where water conditions are favourable, a three-layer pasture is built. The first layer is *Salix matsudana* and/or *Populus* spp., whose leaves are good forage; the second is a shrub layer of *Salix psammophila*, *S. cheilophila*, and *Amporpha fruticosa*; and in the third layer are *Melilotus* spp. and *Astragalus adsurgens*. This pasture is very productive: its dry biomass can reach 3,000 kg/ha (Huang and Song, 1981).

On low-lying sandy land, *Salix* and *Populus* have been planted since 1949. Uxin-Ju *sumu*, a leader in tree planting, witnessed clear results. In 1949, it had only 94 trees, planted in the Qing dynasty with the construction of Buddhist temples; by 1975, each person in the *sumu* had 200 trees (*Eer Duo Si Bao*, 4 September 1990). This number has increased further since 1978.

Measures in cropfield protection

There are two major measures for cropfield protection: leaving original vegetation for wind resistance and planting shrub vegetation in rows perpendicular to the wind direction. *Salix psammophila* and *Caragana korshinskii* have been used frequently. In recent years, with the thriving of woven willow products, more *Salix psammophila* has been planted. These protective shrubs not only help to control wind erosion, but also protect crops from sand encroachment. As a result, the yields can increase by over 20 per cent.

Rotational cultivation of crops, leguminous grass, and green manure are also practised, though to a lesser extent. This can increase soil fertility. On every hectare of cropfield, green manuring of *Melilotus* spp. is equivalent to 375 kg of $(NH_4)_2SO_4$ fertilizer or 30,000 kg of dung manure, and can increase the yield by as much as 20–80 per cent.

Conclusion

This chapter has investigated societal responses to environmental degradation. Given the predominant role of government policy in the Ordos Plateau, the emphasis is on policy responses to environmental degradation, which occurred mainly after 1978. The analysis covers political, socio-economic, and environmental policies at national, re-

gional, and local government levels. The policy intervention has resulted in a changed environmental trajectory with a reduced rate of degradation and increased improvement.

It is important to understand the role of government policies – how they influence all other socio-economic factors that in turn affect the environment. For example, policies on population control and economic development have resulted in reduced population growth rate and increased economic capability, which in turn curbed human driving forces of environmental degradation and brought positive outcomes in terms of environmental protection. Policy also directly affects the environment through environment-related regulations and programmes. In the Ordos Plateau, it is demonstrated, however, that the indirect impacts of political and socio-economic policies have played a predominant role in environmental change (i.e., they have been more important than environmental policies). The environmental impacts of governmental policies must thus be understood through their indirect effects on the environment, which calls for an integrated analysis of environmental change through political and socio-economic mechanisms as well as environmental ones.

7

Past and future

Taking the Ordos Plateau of China as a case study area and a time-span from 1949 to the early 1990s, this study uses a regional approach to global change to investigate the human dimensions of environmental changes. The first part of chapter 2 summarized regional environmental changes since 1949, while the last part of chapter 2 and chapters 3–6 analysed human dimensions of the changes: their societal impacts, human driving forces, and societal responses. The close link between the environment and society is apparent. To conclude this study, this chapter first briefly summarizes the major findings associated with each aspect of the research, then addresses the key questions of human-environment relationships posed in chapter 1. To draw more general conclusions on the past trajectories combining both environmental and human factors, I examine and apply the concept of ''criticality.'' The chapter turns finally to a discussion of possible future environmental impacts of the changing societal factors and suggestions of several precautions for the environment.

Environmental change and its human dimensions

Over the past 45 years, the environment of the Ordos Plateau has changed tremendously, as has the socio-economic and political situa-

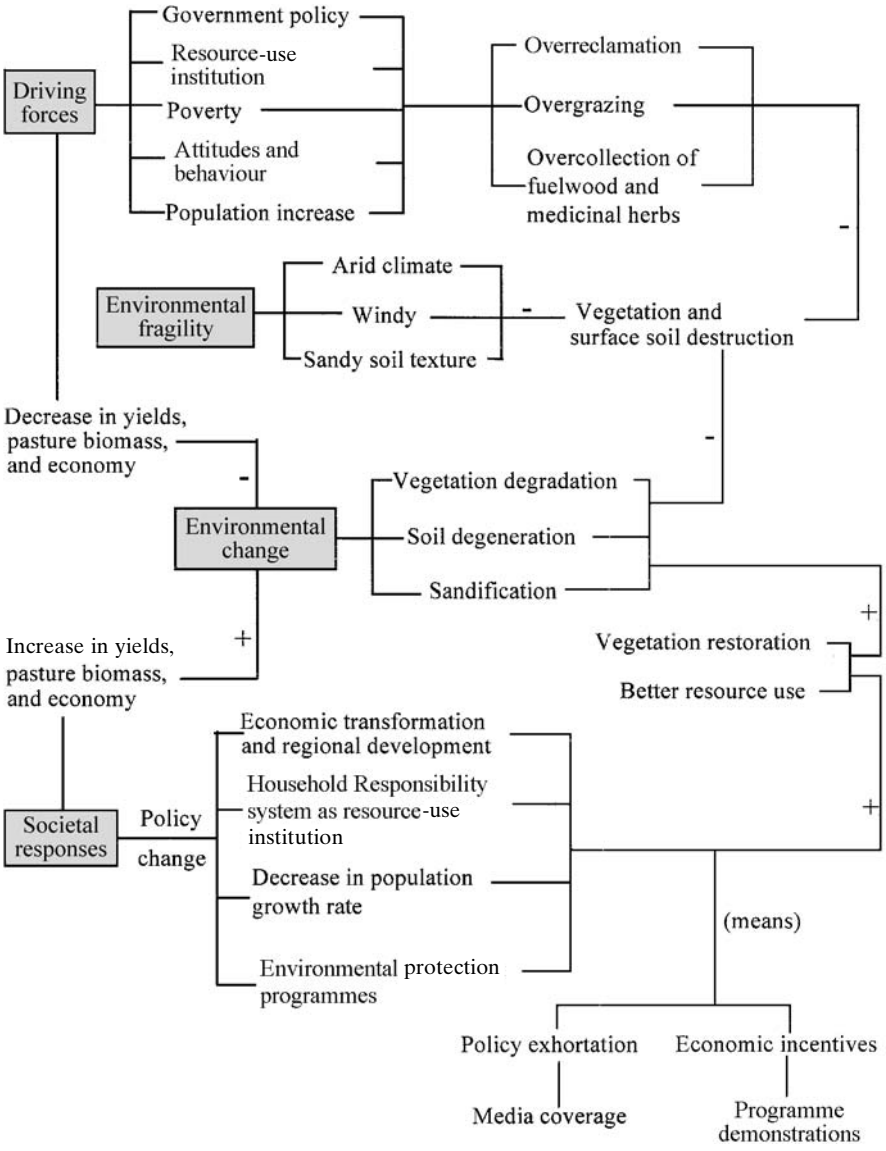


Figure 7.1 **Environmental change and its human dimensions**

tion. In both phenomena and mechanisms, environmental and social changes are closely related. Fig. 7.1 summarizes the principal factors of change and their interrelations, in which arrows represent directions of influence, with plus (+) signs indicating positive impacts and

minus (−) signs negative impacts. Note that both driving forces and societal responses are also affected by exogenous influences; they also affect each other. These links are not shown in fig. 7.1.

Environmental change and its societal impact

Throughout human history, the environment of the Ordos Plateau has changed greatly, with ever-increasing human impact. Since 1949, the general trend in environmental change has been increased degradation, including vegetation degeneration, soil erosion, and sandification. These types of degradation all start from vegetation destruction, which leads directly to decreased biomass and vegetation cover and indirectly to the loss of soil nutrients and surface soil. Where the land is sandy, sandification usually follows. The degradation is initiated by human activities, but its effect is exacerbated by the dry, windy, and sandy features of the environment.

During the study period, the rate of environmental change has varied greatly. Environmental degradation proceeded slowly in the 1950s and swiftly from the 1960s to the 1970s. Since the 1980s, the rate of degradation has slowed, and in some areas the trend has been reversed, with a net environmental improvement. Take sandification, for example, which dominated the Ordos Plateau before the 1970s; moving sand increased from 16,446.5 km^2 in 1957 to 27,660 km^2 in 1977. Since 1980, the trend of sandification has seen a net improvement, though with both improvement and continuing degradation occurring in different places. By 1986, moving sand had decreased to 22,374 km^2 for the whole region. This varying rate of change is in accord with the socio-economic change in the society, as discussed in chapters 3–6.

As a rural farming-pastoral society, the Ordos Plateau relies heavily on the ecosystem for its economic survival and overall livelihood. With a low level of resistance, the Ordos Plateau is severely affected by environmental degradation. The impact on agricultural productivity and everyday life ranges widely, from property loss and facility damage owing to hazardous events (such as sandstorms) to economic stagnation due to chronic decline of the quality of the environment. For instance, sandstorms are recorded to have destroyed crops, roads, houses, animal shelters, and even livestock and human lives. Efforts to increase agricultural productivity were partly thwarted by environmental degradation. Owing to this degradation, available pasture shrank and biomass decreased by 17 per cent and

26 per cent, respectively, from the 1960s to the 1970s, thereby decreasing the land's carrying capacity and impeding the livestock economy. The stagnation of income and agricultural production is the result of multiple factors, environmental degradation being one of them.

Human driving forces

Environmental degradation is caused by the integrated effect of multiple factors in society. Global-change studies identify two kinds of forces: proximate activities that lead directly to environmental degradation, and human driving forces that lead to proximate activities. In the Ordos Plateau, the main proximate activities include land reclamation, overgrazing, and biomass collection (for fuelwood and medicinal herbs). These activities set off the destruction of the vegetation and surface soil – the protective layers of the landscape – and induce a chain of degradation, including vegetation degradation, soil degeneration, and sandification.

Human driving forces are the societal culprits for environmental degradation. This study has recognized the following aspects of the society that have, at least during certain periods of time and with certain combinations of other factors, adversely affected the environment: governmental policy, resource-use institutions, economic capacity, attitudes/beliefs and traditional land-use styles, and population change. In the Chinese socialist society, government policy determines the overall direction of most other socio-economic factors as well as the environmental outcome. From the late 1950s to the early 1970s, government policy disregarded individual initiative in resource management, neglected economic development and environmental protection, and ignored the relationship between population and environmental capacity. As a result, population grew rapidly but the economy stagnated, and swift environmental degradation was the outcome. Attitudes and beliefs work to facilitate this process by acting as obstacles to necessary responses. Meanwhile, traditional extensive land-use practices affect the environment negatively since they cannot ensure a balanced human-environment relationship under increased population and improved technology. According to the degree of primacy as a driving force, government policy ranks first, followed by resource-use institutions, economy (economics), attitudes and behaviour, and finally, population change (see chapter 4).

Specific attention is needed to address the interactions among

these factors. For example, policy is of foremost importance not just by itself but because it affects most other socio-economic factors; traditional cultural hierarchy does not in any way affect the environment negatively by itself, but it facilitates or perhaps even enforces the command and control of central government and associated negative impacts on the environment. Traditional land-use practices would not have been so destructive if technology and population had been maintained at the pre-1949 level. Human driving forces link together in intricate ways, which between them determine environmental impacts; accordingly, the individual influence of each factor is difficult, perhaps impossible, to ascertain.

Socio-economic factors serve as driving forces only when they affect the environment negatively; the same factors may also have positive impacts on the environment under a different situation and therefore serve as responses to environmental degradation. The factors cited above served mainly as driving forces of environmental degradation between 1949 and the 1970s, especially between 1958 and 1976. Since 1978, with the change of political orientation toward economic development and environmental concern, and with the establishment of the Household Responsibility system as a resource-use institution, the same societal factors have produced positive effects on the environment.

Societal responses

As environmental degradation is closely related to human factors, the environmental problem is first of all a political and socio-economic one. Accordingly, the way to slow down human-induced environmental degradation calls for, initially, political and social changes. This has happened in the Ordos Plateau since 1978.

With the end of the Cultural Revolution, China's political orientation changed, thus bringing broad socio-economic changes. Economic development became the key focus of the government agenda, and environmental phenomena such as land degradation and sandification, which were closely associated with economic activities, were seen as problems. The establishment of the Household Responsibility system allocated user rights of land to households and allowed individuals to manage their land with increasing freedom. This brought economic incentives to resource management and greatly stimulated individual enthusiasm. The rapid growth of the economy helped to alleviate poverty, thus expanding land-use choices and reducing the

forces that produce degradation. Owing to the policy on population control, facilitated by the improving economy, population growth was also slowed. Economic and environmental programmes brought environmental improvement directly, and alleviated the stigma for change in people's attitudes and beliefs, thereby promoting environmental responses indirectly. Traditional land-use practices were also changed, with the new land-use regulations (such as slopeland conversion to grassland and pasture protection) and programmes (such as construction of human-made pasture). As a result of these changes, environmental degradation was slowed, and the net result has been environmental improvement since the 1980s.

State policy has served as the main source of response, primarily because of the socialist political system in China. Under the centrally planned political system, government policy determines the overall orientation of the society; changes in all spheres, social, economic or environmental, start from changes of government policy (although local participation often speeds up the process). Most other forms of responses – socio-economic and environmental – are descendants of state policy. Positive policy changes have happened since the early 1980s, and there have been many ways of enforcing their implementation, including conservation and training programmes, media coverage, economic incentives, and ideology exhortation. The means of policy execution can be as important as policy itself, since the latter cannot be implemented effectively without the availability of the former. It is through these social, economic, political, and psychological mechanisms that government policy has deeply impacted on the environment.

Economic development is the main means for environmental improvement in the Ordos. As a developing country, China has set economic development as its first priority since the 1980s, and views environmental problems through an economic lens and manages them mainly in the economic sphere. For example, pastureland protection is practised through economic development, and watershed management through economic incentives. This has proven to be effective for environmental protection.

It is worth mentioning that human perceptions and behaviour are important elements of responses to environmental problems, though they are not necessarily the initial or driving source of response. It appears that behaviour is governed more by policy and economic interest than cultural values and traditions, as assumed in some cultural studies (e.g. Douglas and Wildavsky, 1982). This indicates that, in

interaction with the overwhelming forces of social and political changes, culture acts in a facilitating or intermediate role in its influence on perception and behaviour. When environmental problems are perceived and responded to in a coherent fashion, and stimulate voluntary perception and behavioural adjustments, the positive impacts of responses are more sustainable.

Socio-economic changes serve as indirect responses to environmental degradation, as they curb driving forces and bring about positive impacts on the environment. Direct responses follow both socio-economic programmes and environmental protection programmes. Measures include pasture enclosure, construction of human-made pasture, grass and shrub sowing on degraded pasture, airplane sowing, sand dune protection, terracing and shelter building for cropland, and so on. The effectiveness of these measures depends upon specific environmental conditions and post-measure maintenance.

Several important questions

Chapter 1 sets forth important questions in the study of global change that call for support or challenge from regional empirical studies. Here I attempt to answer these questions, drawing on the empirical results of this study of the Ordos Plateau.

Environmental change – natural or human causes?

Are natural or human factors the main source of environmental change? Many environmental researchers have asked this question. Some global-change studies have emphasized the human causes of changes that have happened over the past 300 years (Turner et al., 1990a), and accorded insufficient attention to the role that natural factors have played in the ultimate effect of human activities. Researchers taking a larger time-scale (e.g. thousands of years), however, have argued for natural variations (Dong, Li, and Gao, 1983). In the Ordos Plateau, opinions stressing both natural and human causes exist in explaining environmental changes. It is important to examine this question more carefully instead of dismissing it as a mere opinion, since it has practical implications for environmental protection.

Although the time-scale of this study is about 45 years, too short a time to confirm natural trends, especially given the fluctuating natural environment, the fact remains that natural features discussed in chapter 2 (i.e., the dry, windy, and sandy environment) conspired in

the ultimate effect of human activities, and therefore contributed to environmental degradation. It is apparent that without physical sensitivity the same magnitude of human disturbance would not have produced such serious environmental degradation. Once human activity triggered changes in an already sensitive environment, the speed of degradation and the difficulty in implementing remedial improvements were shaped by both the magnitude of the disturbance and the sensitivity of the ecosystems.

Even if natural factors played only a small role in causing the degradation, after it happened, natural factors were extremely important for environmental recovery and improvement. In the Ordos Plateau, environmental restoration started from vegetation reconstruction, an environmental element very closely related to other environmental factors. Highly fragile, the environment of the Ordos requires extra care in its improvements, be it through the means of replanting or natural recovery. The natural dry, windy, and sandy features have prevented some human efforts from being successful; successful improvement only occurs when natural factors receive careful consideration.

In conclusion, both natural and human factors are indispensable for understanding the processes of environmental degradation. Human factors may have played a more important role in triggering environmental degradation, but natural factors participate in determining the final result of human disturbance, particularly the degree of degradation. In addition, for environmental remediation to be successful, both factors must be taken into consideration.

Does culture matter?

Culture, if taken as an all-encompassing concept of values and behaviour, is the root of many problems in a society, including environmental degradation. In this study, the analysis of culture encompasses only the valuation of land and traditional land-use practices. In looking at the negative impact of traditional land-use practices, I am aware that the culture as a whole has provided a positive force for survival and perpetuated the society for thousands of years.

Following 1949, social changes happened drastically in the Ordos Plateau and greatly altered cultural traditions. The impact of culture is thus modified by, and muddled with, the effects of other social, economic, and political factors. Though it is difficult to separate the particular effects of culture, its role cannot be neglected. The nega-

tive impacts can be understood in two ways: as relationships between traditional culture and other societal factors, especially the effects of cultural beliefs on the political and economic system, and the role of traditional land-use practices in environmental change.

For the first, in the absence of the traditional cultural hierarchy, the centrally planned political and economic system would not have been so powerful. As a consequence, the negative impacts on the environment during the Great Leap Forward and the Cultural Revolution may not have been so detrimental. Though hard to prove, this impact of traditional culture is not difficult to understand.

Traditional land-use practices have contributed greatly to environmental degradation. In the past, under a sparse population and a low level of technology, the land enjoyed sufficient time for recovery. The extensive farming and grazing system was thus suitable and did not induce much degradation. The fact that past sandification happened only slowly supports this interpretation. But traditional land-use practices, without modification, have been detrimental to the environment, since with the changed socio-economic situation (i.e., the increased population, production pressure, and improved technology) these practices require more land than is available and allow less time than is needed for environmental recovery. I am aware that this counters some prevailing views favouring indigenous techniques (see Rocheleau, Benjamin, and Diang'a, 1995), but the regional history of the Ordos does not suggest otherwise. This shows, in this case, that regional environmental change does not always accord with general global conclusions and that regional approaches and contexts are important.

As for people-land relationships, since land is both a ''pull'' and a ''push'' factor for the Han and Mongolian peoples, the impact on the environment is twofold. On the one hand, people place a high value on their land; thus environmental protection is encouraged. But on the other hand, the culturally low social status and historically low standard of living associated with land foster a misuse of land, especially for the Han people, who have a more established cultural hierarchy.

The case of the Ordos Plateau provides compelling evidence that culture matters; such elements of culture as traditional land-use practices have played a negative role in environmental change. Other elements, such as people-land relationships and valuation of land, provide important cultural and historical contexts in which human behaviour toward the environment can be better understood.

The role of population

Is it population numbers or the consumption level of the population that is the main force for environmental degradation? This question frequently arises in the global-change community. At a global level, it is widely accepted that population increases are one of the main reasons for environmental change. However, some researchers have pointed to the inconsistency of this explanation at a regional level (e.g. Meyer and Turner, 1992) and called for further scrutinization of the issue.

In the Ordos Plateau, population increases have served as a driving force for environmental degradation, but have not been its primary cause. Other societal factors, such as government policy and resource-use institutions, have deeply affected population change and therefore served as primary reasons for population increases. In addition, throughout the study period, the role of population increases has changed. Multivariate regression of environmental and socio-economic factors shows that, before 1977, population increase created significant negative impacts (negative coefficient) on the environment, but after 1980, this impact disappeared (coefficient of the population variable is 0). This indicates the importance of the interaction between population increases and other socio-economic factors to determine the ultimate impact of population on the environment. After 1980, since policy and other socio-economic factors have brought about positive responses to the environmental problems, the negative effect of population growth was greatly mitigated. This also indicates, again, that the impact of a single factor is often difficult to ascertain, and that the interaction among factors is of foremost importance in understanding the mechanisms of change.

The standard of living of the population is a factor that cannot be easily incorporated into the equation of environment-society relationships, but its impact on the environment is often pervasive. Per capita income may serve as a relative measure for standard of living, but other factors such as social infrastructure, education, and social welfare cannot easily be expressed quantitatively, nor is their association with the environment always clear. Comparing the living standards of the Ordos Plateau with those of other parts of the world, especially the wealthy parts, it is apparent that consumption is not a primary source of environmental problems. But this does not mean that we need not be concerned about the low standard of living. Just the opposite. If the reason that we are concerned about environ-

mental problems is for the well-being of the local people, and not just impacts on global climate that can potentially affect the wealthy, then the low standard of living (i.e., poverty), in addition to its contribution to environmental degradation, should be of great concern. Quality in infrastructure, opportunity for education, and level of social welfare are of great concern for local existence, even though it is often difficult to establish direct causal connections with environmental change. To raise the quality of well-being, one crucial means in the Ordos Plateau is economic development, a potential cause of environmental degradation. This makes the task of environmental protection far more daunting than it may appear.

To conclude, population growth is an important but not a primary driving force of environmental degradation in the Ordos Plateau. Its negative impact is better understood through its interaction with other socio-economic factors, such as government policy, resource-use institutions, and economic factors. Quality of life, though not easily incorporated into the study of human dimensions of environmental change, is important both for its relationship with the environment and for its own significance for society. Therefore, it calls for more attention and treatment.

Economic factors

Is affluence or poverty the main cause of environmental problems? This is, again, a question posed by the global-change community. Both are found to be driving forces of environmental change in the literature of environmental study (Ehrlich and Ehrlich, 1990; Hosier, 1988). In the Ordos Plateau, it is poverty, and to some extent the urge to be affluent, that drives environmental degradation; and it is also the desire to eradicate poverty through economic development that allows environmental problems to be recognized and responded to at both regional and national levels.

It is important to understand the relationship between poverty and environmental degradation, and between environmental concern and economic measures. As a driving force, poverty restricts resource-use options. Traditional extensive land-use practices, which require little material and technological input, are encouraged by the condition of poverty and thus induce further degradation. Combining with a growing population, poverty further increases the demands for resources and restrains the per capita resource pool. Poverty also limits the economic capacity for environmental improvement. Its

coupling with a fragile environment triggers the vicious interactive cycle between poverty and environmental degradation, thereby making environmental problems even harder to manage. For these reasons, poverty is an important cause of environmental degradation, and economic development is an essential precondition for environmental improvements.

Economic factors are both the lens to constructing environmental problems and the means for environmental protection. It is very important to understand that only environmental problems which are closely related to the regional economy and the life-support system are publicized and combated. Similarly, only regional environmental problems were considered; large-scale environmental impacts (such as the impact of coal mining on global climate change) were not of concern. As a developing country, China recognizes its foremost task as economic development and treats the environment as an element in the economic system. In the Ordos Plateau, since the environment is an indispensable part of the agricultural production system, degradation has been recognized and responded to since the 1980s. When environmental problems are responded to as part of economic measures, such as economic incentives and development programmes, the results are in fact much more effective.

Economic development and environmental protection have gone hand in hand in China since the 1980s. This does not replicate the situation in developed countries in their early stages, when environmental damage was the cost of development. Only after economic capacity increased and the ability to address environment protection grew in these countries did environmental clean-up occur. China has learned these lessons from developed countries, and so far has succeeded, to a certain degree, in combining the two. The fact that under rapid economic growth the environment has not worsened but has gradually improved supports this view (see also Ross, 1987). This further suggests that economic development and environmental protection need not be in conflict in China. Rather, the former has enhanced the latter and made it possible.

The role of policy

This study has revealed that government policy plays the foremost role in environmental change in the Ordos Plateau, both as a driving force of environmental degradation and as a response that brings

about environmental improvement. To understand the role of policy, one has to understand the socialist political system and the centrally planned economic system. Since policy determines most other socioeconomic factors, both human driving forces and societal responses are largely derivatives of governmental policy. From 1949 to the present, the impact of governmental policy on the environment has been both negative and positive, depending upon the orientation of the political system at different periods: how tightly control is exercised, which affects the character of resource-use institutions, as well as how the environment and its relationship with the economy are perceived and treated. When all aspects of the economic system, in both production and distribution, are controlled, *and* when the role of the environment in economic development is not fully appreciated, state policy produces driving forces that tend to generate environmental degradation and place the environment at risk.

A related question is the role of the socialist system, a factor that cannot be separated from the role of government policy. The socialist system before 1978 generally failed in protecting the environment, in addition to causing other disasters (such as political and economic). But this does not suggest that the socialist system is intrinsically detrimental to the environment. The same general regime, but combined with private resource management and appreciation of the environment, has since 1980 slowed down environmental degradation and improved environmental quality. The problem with the socialist system before 1978, as indicated earlier, lay in the degree of overcontrol combined with a lack of caring for the environment. When the control was loosened after 1978, economic development and environmental improvement followed. Initially, the land was privatized in the early 1980s with very little collectivization. This soon presented a problem for environmental protection, since the effect was very limited. In short, privatization by itself may not work either. It was then realized by local and national governments that success in environmental protection, as well as in economic development, lay in the combination of privatization (of land resources) and a certain level of command and control (see also Glaeser, 1987). This has been the direction pursued in the Ordos Plateau since the early 1990s. It seems that neither privatization nor collectivization alone can save the environment; a combination of the two appears to be the most promising. The role of the former is to preserve individual interest and initiative; the role of the latter is to promote efficiency and equality.

The past trajectory of change

In fig. 7.1, it is clear that human driving forces, societal responses, and environmental changes are interrelated, and their interaction at certain times decides both the net environmental effects of human factors and the societal impacts of environmental change. At different times in the study period, the combination of these same factors, owing to changes in each and in their interaction, has created different results and therefore different trajectories of change. In order to integrate the environmental and human aspects, I adopt the concept of ''criticality'' as defined by Kasperson and colleagues (1995) as a measure of environmental change, and use it to evaluate the overall trajectory of environment-society interaction in the Ordos Plateau for the period since 1949.

Environmental criticality

Criticality is an assessment of the total maintainability of the environmental-socio-economic system. The concept is developed from studies on sustainability, a concept often enlisted to evaluate environmental degradation and its human dimensions. Geocentric and anthropocentric concepts represent polar and incomplete approaches to defining sustainability (Turner et al., 1990b). The geocentric approach uses the pristine state of an ecosystem as a baseline and defines any significant human-induced perturbation as ''degradation'' or ''criticality'' if it essentially transforms the natural state. The anthropocentric approach does the opposite: it uses only socio-economic parameters to define criticality. As long as society is not significantly affected or can adjust, a situation is not considered critical. Also different are their ways of defining system boundaries. The geocentric view recognizes closed systems and refers to sustainability as within the limits of the closure, whereas the anthropocentric view assumes open systems and accounts for the flow of energy and materials across space to substitute for these limits.

Both approaches are incomplete, since both neglect the interaction of the two functioning systems – physical and human. As Turner and Benjamin (1994) have pointed out, the concept of vulnerability is a relationship between human societies and their natural systems. The same is true of sustainability. Since the Stockholm Conference on the Human Environment in 1972, thinking about the complex relationships between the environment and development has evolved considerably, and sustainability has come to be seen as requiring both

environmental protection and economic development (Soroos 1994). As *Our Common Future* (WCED, 1987) puts it, ''sustainable development is not a fixed state of harmony, but rather a process of change in which the exploitation of resources, the direction of development, and institutional change are made consistent with future as well as present needs.'' A time dimension has thus also been added to the concept. Environmental change is a natural phenomenon, whose processes cannot be understood without uncovering physical mechanisms. It is also, however, a social phenomenon, whose origins and impacts cannot be explained without exploring societal processes. Thus, to evaluate the trajectories of environmental change, both natural and human factors need to be considered.

In the study of global environmental change, it is ''criticality,'' as opposed to sustainability, that calls for an urgent examination, since it is the adverse impacts of environmental change that need to be prevented. Recognizing the need for a concept of ''criticality,'' Kasperson and colleagues initiated the research project on Critical Environmental Zones (ProCEZ) in 1990, selecting cases for study from around the world. This project defines environmental criticality as ''a state of both environmental degradation and associated socio-economic deterioration'' (Kasperson et al., 1995). It not only recognizes environmental changes and their societal impacts, but also acknowledges the essential role of human management and response. The definition combines the geocentric and anthropocentric approaches in emphasizing the interaction of physical and human systems and in acknowledging use-environment relationships both within and among regions. Recognizing the dynamic relationships between environment and society, the definition also accepts time dimensions in impacts and responses. Furthermore, ProCEZ develops a spectrum of concepts for scaling, or classifying, the nature-society relationships of a region, in the order of environmental criticality, environmental endangerment, environmental impoverishment, and environmental sustainability. Definitions for the first two conditions are:

> Environmental *criticality* refers to situations in which the extent and/or rate of environmental degradation preclude the continuation of current human use-systems or levels of human well-being, given feasible adaptations and societal capabilities to respond ... Environmental *endangerment* refers to situations in which the trajectory of environmental degradation threatens in the near term (this and the next generation) to preclude the continuation of current human-use systems or levels of human well-being, given feasible adaptations and societal capabilities to respond (Kasperson et al. 1995, 25).

On the continuum are also environmental *impoverishment*, referring to situations in which the trajectory of environmental change threatens the medium- to long-term future of human-use systems and human well-being, and environmental *sustainability*, referring to situations in which the environment can support the continuation of human-use systems and sustain human well-being over long periods.

The criteria for evaluating environment-society relations on this scale include factors from both systems: environmental sensitivity and degradation, wealth, well-being, economic and technological sustainability, and societal responses. Vulnerability is also important, as the assessment addresses not only what is threatened by the environmental degradation in the society but also whom. This study adopts the concepts in this criticality-sustainability spectrum, and their definition and methodology, in offering conclusions concerning the changing environment-society relationships in the regional context of the Ordos Plateau.

Conclusion on past trajectories of change in the Ordos Plateau

According to the concept of criticality, it is important to consider both environmental and social factors in evaluating a trajectory of environmental change. Constructing a composite measure of sustainability has been a difficult task (Pearce and Atkinson, 1993); moreover, in this study, a lack of continuous data on environmental change makes measuring a composite indicator of sustainability impossible. I will, however, demonstrate separate indicators and discuss their relationships. Of the environmental factors discussed in chapter 2, namely vegetation and soil degradation and sandification, although mechanisms and symptoms are clear, most data are sketchy and inconsistent. With the data at hand, I use two indicators, sandification (i.e., area of serious sandification and total area of sandified land) and soil erosion, to illustrate the trends of environmental trajectories since 1949 (fig. 7.2). Data are only available for certain years, and the trends between the available data points assume straight lines. Fig. 7.2 shows that both sandification and soil erosion increased slowly in the 1950s, rapidly in the 1960s and 1970s, and declined during the 1980s and 1990s. As was discussed in chapter 2, the trend of soil erosion has a time lag because the soil column is built up only slowly. Therefore, the areas of soil erosion continued to increase after 1980 even though environmental protection was effective. The rate of increase was much lower, however, and the sandification area even

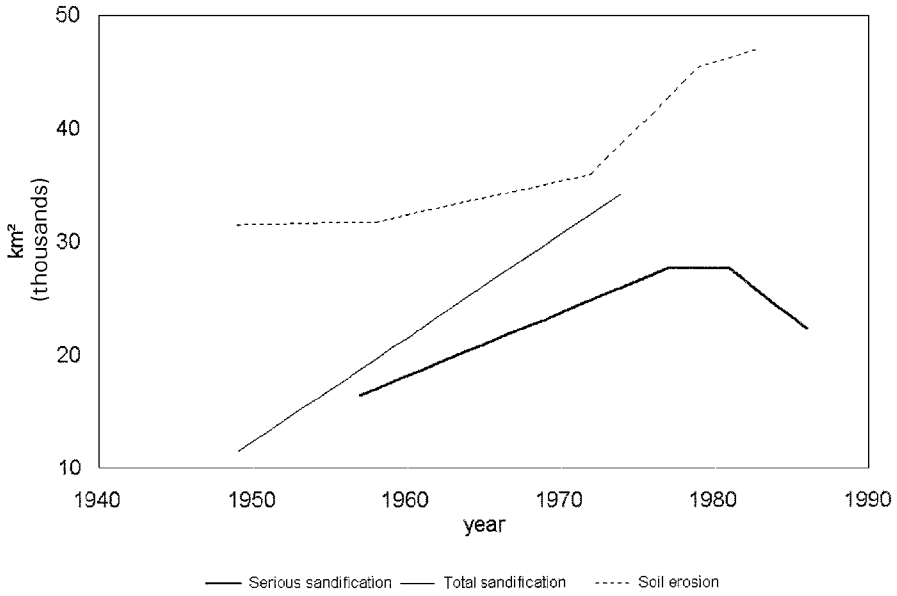


Figure 7.2 **Environmental change**
Source: Yang, Di, and Huang (1991) and interviews with the Water Conservation Centre, Ih-Ju League.

shrank after 1980. The general trend coincides with the change of the socio-economic indicators listed above.

Of the social factors involved, income, well-being, wealth, and health can be taken as indicators. In the Ordos Plateau, as I have indicated earlier, quality of life is difficult to measure and the appropriate parameters are often lacking. Under these circumstances, to construct trends over time I identified several social parameters to be used in this assessment. For income and the economic system, GNP per capita serves as an indicator (fig. 7.3). In China, GNP, social production, and national income are used to indicate the level of economic development, and their general trends are the same in the Ordos Plateau (see fig. 6.4 in chapter 6). Between 1949 and the late 1950s, GNP ranged between 230 and 350 yuan per capita, and the fluctuation was high. Between the 1960s and 1970s, the figure remained low, indeed the lowest level was in the 1960s (lower than the average level in the 1950s), indicating a depressed stage. Since the early 1980s, per capita GNP grew rapidly to 588 yuan in 1989, the highest rate of growth ever reached.

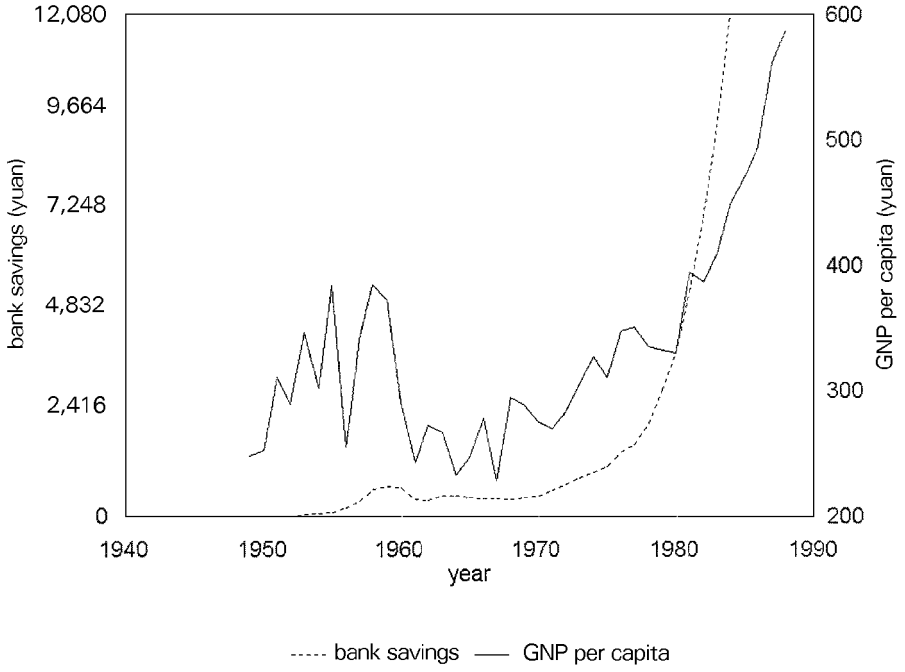


Figure 7.3 **Economic change since 1949**
Source: Ih-Ju League Statistics Bureau.

Bank savings, though incomplete (fig. 7.3), mimic the trend of economic change and show a rapid increase since the late 1970s. This figure, deceiving as it may be since not all rural Chinese deposit their money in banks, serves as a rough indicator for change in levels of wealth and affords some measure of relative change.

Two other social indicators are yield per unit area and the livestock death rate (fig. 7.4). Both reflect the increased productivity of the agricultural system and to some degree the quality of the resource base (i.e., farmland and pastures). The general trend of yields is one of stagnation between 1949 and 1973 and of rapid increase since the late 1970s. Meanwhile, the livestock death rate, although fluctuating with climate variations, has generally decreased over the whole period, indicating an increased capability in animal husbandry and a more robust feed base.

The trends of environmental and social indicators roughly coincide, in ways that suggest how environmental degradation and economic stagnation reinforce and contribute to each other, and that curbing

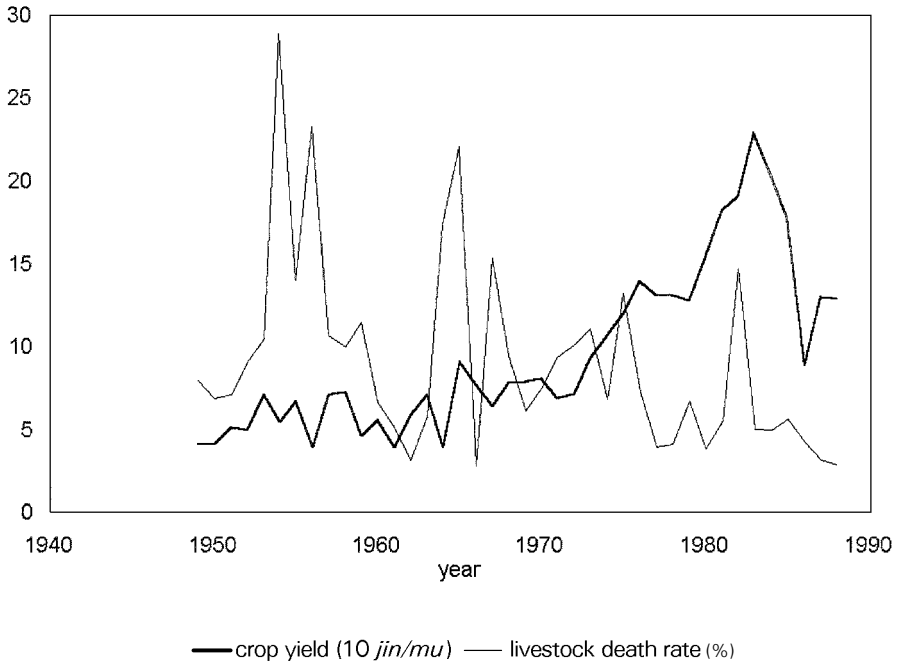


Figure 7.4 **Yields and livestock death rate**
Source: Ih-Ju League (1990).

degradation and environmental improvement may go hand in hand with economic growth. These trends match the political change and policy developments which serve as the essential triggers for many other changes, as discussed in chapter 6. I will summarize the aggregate regional trajectory of change drawing on all the above indicators.

The trajectory of change reflects distinct three periods in the Ordos Plateau since 1949. The first, 1949 to the end of the 1950s, reflects a gradual increase in GNP, bank savings, livestock numbers, and crop yields, but it also betrays a gradual increase in environmental degradation. With the establishment of the socialist political system, 1949 was a landmark for Chinese society; it also served as a starting point for increasing environmental deterioration. The establishment of new social and economic forces and institutions, such as land reform and an economic-recovery policy, brought rapid social and economic changes. Economic development and population growth were apparent. Human interaction with the environment increased, but its im-

pact on the environment was not fully realized. Pastureland protection programmes promoted measures banning pasture clearance and advocating replanting, but the efforts were only sporadic and the results largely localized. Environmental degradation accelerated gradually. Toward the end of this period, with the radical Great Leap Forward movement and formation of communes, pasture clearance reappeared, and the environment faced increasing endangerment.

The second period, from the 1960s to 1978, saw GNP, bank savings, and livestock numbers largely stagnated. Meanwhile, sandification and soil erosion were rampant. This was the most disastrous period in China and in the Ordos Plateau. In the early 1960s the harmful impacts of the Great Leap Forward were recognized, and farming and pastoral development regained priority and pastureland protection also made a comeback. With the onset of the Cultural Revolution in 1966 came a period of social and economic depression and unbridled environmental degradation. Class struggle became the focus of all government agenda, whereas economic activities were completely controlled by the commune. While human power over nature was advocated as a political goal, the environment as a base of economic production was neglected and government environmental protection agencies were disbanded. Farming expanded into dry pastureland, and vegetation degradation and soil erosion increased swiftly. Environmental deterioration, in turn, impeded socioeconomic development. Local people grew increasingly aware of the impacts of environmental degradation, but they had no confidence in government efforts in environmental control and improvement. Only small-scale, haphazard measures were taken, such as slopeland terracing, that had only local impact. Overall, the Ordos Plateau was on a trajectory to regional environmental criticality.

The third period is 1978 to the present, with 1978 as the key turning point. GNP and bank savings increased rapidly, livestock numbers were stabilized, the livestock death rate decreased, and per unit crop yield increased. Soil erosion slowed and the trend of sandification reverted. With the end of the Cultural Revolution, the Household Responsibility system gave individuals rights to use and manage production, including land and production materials. This system was initiated based on the recognition that the socialist practices of the past had suffocated individual initiative and hampered social and economic development. With this change in resource-use institutions and management systems, with policy reoriented toward economic

development, the economy grew rapidly and the driving forces of environmental degradation slowed. For example, poverty shrank, and population growth rate dropped owing to the population control policy. Societal capacity to respond to environmental problems mounted. As the environment was highly valued as a basis for farming and pastoral systems in regional development policy, environmental degradation was consciously responded to in two ways: indirectly through economic development, and directly through environmental remediation programmes. Overall, the trend toward environmental criticality flattened, and the environmental trajectory remained in the endangered range. If the current trend persists, the environment-society relations could reach a state of impoverishment, heading in the direction of environmental sustainability.

It is important to distinguish between environmental sustainability with high and low levels of socio-economic development. Since an environmental trajectory characterizes the dynamic state of human-environmental interaction, both the trend of environmental change and society's coping capability are important parameters. The foregoing analysis assesses both the first and the third stages of the trajectory as environmental endangerment, but these stages reflect different levels of economic development and different future directions. The first stage had a low economic capacity and was moving towards a critical state, whereas the third is the opposite. This indicates that sustainability itself has different levels, and only environmental sustainability with a high level of and potential for socio-economic development can succeed in the long run. In the sense that the social and political change initiated in 1949 eventually led the Ordos Plateau to this new and promising trend of environmental trajectory after 1978, 1949 should not be considered a catastrophic turn for the environment. With trial and error through the stages of endangerment and emerging criticality, the Ordos Plateau has marched toward a new level of economic development and environmental potential in the 1990s.

What does the future hold for the Ordos environment? This question can be probed by looking at the trends of all the natural and social factors involved. Among the social factors, policy change, institutions, and socio-economic development are the most important, as was indicated in the analysis of human driving forces and societal responses. The development of a market economy and coal mining are the main future concerns.

Changing trends

Future environmental trajectories can be determined by the trends of both natural and social factors. According to Shi (1991), the Ordos Plateau may not experience a significant trend of natural climate change beyond the normal fluctuation of the semi-arid and arid environment in the near future, although a 12–15 per cent deviation from the present (1955–1980) average in precipitation and temperature may be expected. Thus human activities will continue to play an important role, and the changing structure of the society will deeply affect the future trajectories of environmental change.

Current state and regional policy, economic change, socio-economic development, and their future changes will combine to determine future trajectories of environmental change. Although most factors are likely to continue their current trends, at least in the short term, as discussed in chapter 6, two factors are experiencing significant changes: the establishment of a market economy and increases in coal mining. The impacts of these two factors could be critical in determining the future state of the Ordos environment.

Market economy

At the time of writing, China is increasingly becoming a society of a market economy, which brings higher potential for economic growth but is not without its own problems. With the loosening of control for many economic activities, such as pricing and product distribution, most agricultural products are becoming market commodities without governmental regulation. The Ordos Plateau faces increasing pressure to produce for the market raw materials of wool and other animal products, in addition to the new market products, coal and energy. Since the Ordos Plateau is at the margin of the available technology, resources, information, and capital, a market economy devoid of protective regulation is not likely to favour the area. Indeed, the Ordos is likely to be in a disadvantaged position. For example, the area's lack of modern road, electricity, and communication systems severely limits opportunities to attract outside investment, and therefore is likely to hamper local industry. Raw animal products are the area's main commodity that may benefit local people, but their market prices have not been favourable. Although the coal and energy industry is growing rapidly in the area, it is owned by the state and its local benefit is limited. Thus local people

rightly worry that the area's social and economic development may be impeded by a market economy.

It is not at all certain if the market economy will, in fact, create a situation in which the Ordos Plateau is exploited like developing countries in the world capitalist system, or if the Chinese political system will recognize this potential problem and seek to remedy the situation. An overzealous pursuit of the market economy in China may, however, adversely affect Ordos society if the requisite combination of sufficient and appropriate government controls is not forthcoming. Inequity and social instability could easily be the outcome. As a country containing one-fifth of the world's population, China's foremost political task has been to produce enough food to feed its people; socially produced inequity caused by the dominating force of a free market will certainly make this task more difficult if wealth becomes more unevenly distributed. This will hurt the majority of the people – those living in the countryside or remote areas who lack sufficient resources, technology, and access to information. In my interviews, local people and their leaders have clearly expressed the same concern. If the Ordos Plateau becomes socially marginalized along the road to a market economy, its economic development and its environment could well suffer.

Inequity has been an inherent problem associated with a market economy in most capitalist countries. There is little reason to believe that China will not acquire the same problem if effective countermeasures are not taken. In fact, inequality is already evident as wealth has become more polarized in the big cities. As the past experience of the Ordos Plateau suggests, taking the ''middle road'' (i.e., combining a market economy with the socialist practice of governmental regulation and collective control) may avoid this pitfall of the market economy, so that both economic development and equality may be sustained and the environment will also benefit. As a new phenomenon, the effects of the market economy on the environment remain to be seen and understood, both in the Ordos Plateau and in China more generally.

The potential effect of coal mining on the environment

In the past, industry was limited in the Ordos Plateau, thus its impact on the environment was minimal. But the upward trend of industrial growth has mounted sufficiently that significant impacts may occur. For example, in 1952 the area had only 15 industrial plants and

2,750,000 yuan of total industrial production. By 1985 these figures had risen to 318 and 273,140,000 yuan (1980 prices), respectively. Most of these industries were based on local resources such as coal, natural alkali, sulphur, salt, and agricultural products.

Coal mining has been a major industry in the Ordos Plateau since the late 1980s. The Ordos Plateau is rich in mineral resources and contains one of the major coalfields in China. The three main coal-mining areas – Jungar in the east, Dongsheng in the centre, and Zhuozishan in the west – contain 99.64 billion tonnes (one billion being one thousand million) of proven high-quality coal deposits, of which 18.4 billion tonnes, located mostly in Jungar, are shallow deposits suitable for open-pit mining. But coal mining began only after the late 1950s, and with only a small capacity. Coal production in 1989 was still limited, and coal-driven power plant provided only 8.5 million kilowatt hours of electricity, insufficient even for local needs. The rich resources did not represent any substantial economic capability. Since the late 1980s, with the new national economic policy that has shifted the emphasis inland, the Ordos area has been defined as an energy base for its rich coal resources, and investment was diverted to the coal-mining and related power and chemical industries. Jungar, Dongsheng, and Dalad banners are in the development area, and the envisioned development is in progress. One of the projects, Dalad power plant, a large coal-burning power station, had by 1995 attained a capacity of 120 MW with a total investment of 1.69 billion yuan. The designed capacity is 250 MW by the end of 1999, and 500 MW ultimately.

Since the state operates the coal-mining and energy industries, direct economic benefit to the Ordos Plateau is unlikely. However, these industries are expected to benefit the area by stimulating related enterprises such as the food-processing industry, as well as by alleviating economic pressure and attracting a rural population. For example, Wangqingta village in Dongkongduo township, Jungar banner, planned to set up a food business to serve mine workers. Coal mining has certainly provided the area with new opportunities for economic development and market involvement, but it also threatens the environment.

Coal mining, especially open-pit mining, may contribute to soil erosion and sandification. The land surface will be disturbed by activities such as construction of houses and roads; abandonment of open mining after production may also cause serious problems if remedial action is not taken. Taking the Heidaigou open mine in

Jungar coalfield as an example, the area is covered by sandy loess with old sand beneath. Baoyu Li (personal communication, 1991) estimates that the disturbed land surface will produce 11,200–32,500 t/km^2 of erosion per year, 2–4.5 times that of the original land. In the first stage of the project, it is estimated that construction will severely disturb 20 km^2 of land and wipe out its vegetation, and will also disturb the surrounding 220 km^2 of land. The open mining site will be 45.3 km^2 at the bottom and 52.11 km^2 at the surface, with a designed capacity of 12 million tonnes of coal production per year. The average deprivation ratio is 5.22 m^3 for every tonne of coal produced, and the whole mine, with a total deposit of 1.37 billion tonnes suitable for open-pit mining, will generate 7.17 billion m^3 of deprived soil mass (Wang, 1991). This is a tremendous source of potential soil erosion and sandification. Dongsheng and Shenfu (in Shaanxi Province south of the Ordos Plateau) coalfields have 24 mining wells and four open-pit coal mines in the first stage of development, as a result of which 40.28 km^2 is likely to be severely disturbed (Yang, Di, and Huang, 1991). Under the windy and sandy environment, without effective land refill, soil disposition, and revegetation, coal mining will probably cause severe degradation and sandification, and increase sandy drainage into the Yellow River.

Faster population growth, air pollution, and wastewater contamination are other potential impacts of coal mining. The worker population in coal mines in Jungar will initially increase by 50,000, 3.4 times the present figure. Air pollution from sandy particles will also worsen, and wastewater generated from coal washing and coal-burning power plant will also increase. Drainage to the Yellow River could cause hazardous effects on drinking water and aquatic life in the lower reaches. An increase of carbon dioxide as a result of coal burning could contribute to global climate change. In short, coal mining could have diverse and far-reaching impacts on the local, regional, and global environment.

The potential effects of coal mining have aroused great concerns among local governments. As required by the Chinese Environmental Protection Agency, an environmental impact assessment (EIA) has been completed for all coal-mining projects, and technical measures for environmental protection such as land filling and revegetation have been proposed. Local governments have also proposed environmental fees for coal mining. Since these large-scale coal mines are run by the national government, coordination of national and local government is very important in environmental control. The

monitoring system needs to be enhanced, so that the existing environmental regulations on coal mining can be enforced.

Conclusion

Global environmental change has registered increasing effects on the security and well-being of societies. Thus the human dimensions of the change are important public concerns and research topics. Because the human causes and consequences of environmental changes are not evenly distributed around the globe, a regional approach of analysis is essential.

This study, proceeding as a regional study of such environmental changes, selected the Ordos Plateau to analyse environmental changes (both degradation and improvements) under the centralized socialist socio-political system of China. The analysis of the human driving forces of environmental changes has taken into account this specific socio-political context; the key factors identified include governmental policy, resource-use institutions, economy (economics), cultural values and human behaviour, and population growth, in a descending degree of primacy. An analysis of societal responses has addressed how human perceptions of environmental changes have evolved and how different levels of government and local people have responded to the degradation. Given the predominant role of government policy in Chinese society, government policies have received particular attention, and both their indirect environmental impacts through political and socio-economic change and direct effects on the environment have been examined.

This study indicates that government policies have played the major role in environmental change as both a driving force and a societal response. They have affected the environment directly through environmental policies and programmes. However, their indirect impacts have been even more important, as they have largely shaped the role of other socio-economic factors, which then act either as driving forces when their environmental effects are negative or as societal responses if their environmental effects are positive. Resource-use institutions, as direct descendants of government policy in Chinese society, have actualized government policy by prescribing rules for the management and distribution of resources. This study further suggests that politico-economic factors are a key means through which the negative or positive environmental effects of the above two factors are filtered and realized. Furthermore, poverty has

been an important driving force, whereas economic development has, in aggregate, helped to protect the environment. As for cultural attitudes, human behaviour, and population changes, they are important mediating factors; they have been deeply affected by the above three factors, as have their roles in environmental transformation.

To conclude, this study has employed the concept of environmental criticality to consider both environmental and societal factors in the evaluation of regional environmental trajectories. Having examined the human dimensions of environmental change in the Ordos Plateau, this volume seeks to help the area identify a route toward sustainability under the changing environment. By adding to the empirical research on human dimensions of global environmental change, it also seeks to contribute to regional comparisons with other similar studies as well as to an emerging analytical framework.

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