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TOPIC PAPER

ENVIRONMENTAL PROBLEMS AND THE ORGANIZATION OF DEVELOPMENT IN THE ARID LANDS OF SOUTH-WEST ASIA

BY

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ABSTRACT

The international development effort so far has been based primarily on investment and technology - or, more exactly, on the injection of investment and the transfer of technology. The people affected, whether as target populations or by contingent processes, have on the basis of the assumption of shared rationality been expected to adapt themselves both as individuals and as groups to the resulting new conditions and to develop new structural forms that would facilitate the optimum operation of the new technology. Within this paradigm of development, few specific projects and probably no large situations can be claimed as unqualified successes. Local populations have not responded as expected. A common reason has been that their motivation is embedded in a social structure that was an integral part of the traditional production system and is not adaptive to the new technology. The reaction of planners and others responsible for the development process has typically been to attempt to enforce legally the application of the new technology; but in many cases, legal enforcement is frustrated. Where output has increased, living standards of significant proportions of the affected population have tended to decline in relative terms as the result of inadequate distribution of wealth and attendant increases in social and cultural inequity. Environmental problems have been common concomitants of these processes, conspicuously so in the special conditions of arid lands: waterlogging and salinity have accompanied the large-scale development of irrigation; range deterioration has reversed the effects of pastoral development, and soil erosion has followed the mechanization of agriculture. In recent years, a general consciousness of the urgency of these environmental problems has developed. At the same time, it has been gradually realized that there is a correlation between the environmental and the social problems associated with the development process.

In this paradigm of development, the quality of social life and the quality of the environment are two major components of total food production systems that have not received major attention, and the conclusion that this inattention was responsible for the disappointment of the development record so far is inescapable. This conclusion has been recognized and discussed with increasing urgency in the 1970s but so far no generally accepted principles have been formulated for assessing either environmental or social quality. The continuing discussion directs attention towards the apparent correlation between environmental and social quality and suggests the hypothesis that the reconstruction of the one might be achieved by the development of the other. Partial support for such a hypothesis comes from the observation that individual and group responsibility for resources derives from local perceptions and that local perceptions vary from one cultural situation to another as a function of social processes.

Such a hypothesis which, in recent years, especially since the tragedies that followed the Sahelian drought, has become more and more evident as the philosophical underpinning of discussions on development, is changing our paradigm. The most conspicuous aspect of the change is the attention now given to the human, social or cultural, as distinct from the purely economic or technological factors. The argument here seeks to formulate in practical terms the new paradigm that is emerging. The difference between the old and the new paradigms is less a difference in aims than in the implicit definition of a system eligible for development. Such a system should be defined by identifying its components as

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(a) natural resources, (b) the technology of production and the investment that it requires, (c) production, distribution, consumption and perception - that is, the labour and culture of the associated human populations. In the new paradigm it is (c) - the human component - that defines the boundaries of the system eligible for development.

The new paradigm is sociocentric instead of technocentric. The natural resources in a production system are culturally selected and defined. Development is likely to involve change in orientation towards those resources and therefore also modification of their selection and definition. By technology is meant here the techniques (including the use of equipment) that mediate between labour and resources in the production process. Investment is the input of money and labour for engineering and equipment that is necessary to get the system going, and is thus distinguished from operation. Although there are attempts to generate development endogenously, development is invariably exogenous. Planners plan for communities to which they themselves do not belong. Development involves the introduction of foreign technology and investment. But the human resource (which in most cases should be the local population, if they are not to suffer displacement) is central to the operation of the system before, during and after development. The human resource both provides the labour of production and distribution and generates the perception that manages and directs the system and also determines some of the consumption.

Development requires careful planning for the integration of these three sets of variables. The planning may be external but must give primacy to the human component without which the other components are likely to be ineffectual. Planning must, therefore, involve the participation of the target population. Participation as a social process is inevitably structured in the sense that it is embedded in a social structure. In order to achieve participation it is necessary to facilitate the development of suitable structures. The organization of participation is likely to be more successful if it includes incentives. Finally, this organization must evolve through the stages of planning and implementation into an administrative form of organization that will comprehend the new (developed) production system and generate values or forms of perception that will direct and maintain it.

This argument is illustrated in accounts of selected material from the two most significant land-use development processes in south-west Asia - irrigation and pastoralism. Major cases are developed from the experience of irrigation in Pakistan and pastoralism in Iran. Different experience with similar problems from situations in Afghanistan and India are also discussed briefly in order to develop a comparative perspective.

Contents

		Page
I.	Introduction	1
	A. Basic concepts	3
	B. Aridity and the development of food production in south-west Asia	11
II.	Environmental problems in development	18
	A. Irrigation	18
	B. Pastoralism	35
III:	Conclusion	51
Annex	The campaign to combat desertification in south-west Asia and the south-west Asia transnational monitoring project	53
Bibliography		56

I. INTRODUCTION

The history of land use in the arid lands of south-west Asia provides good documentation of the evolution of current environmental conditions and of the problems that confront planners and that will complicate development in the coming decades. Based on this documentation, the present paper interprets two general processes of development which are implicated in economically serious environmental problems in the region. The aim of the interpretation is to contribute to the rethinking of the development effort and to formulate a position that will be more productive of ecologically efficient development in the future.

Dissatisfaction with the results of the development effort as it has been pursued generally since the 1940s has become increasingly vocal in the present decade. Awareness of the role of development in the Sahelian tragedy, and in desertification generally, has been a major factor in this increase. The United Nations Conference on Desertification,[1/] which demonstrated that desertification is a threat to the over-all productivity of the world's renewable natural resources, provided a synthesis of existing knowledge and of technologies for the solution of desertification problems, and mobilised an international effort to apply them. Desertification was represented in the Conference as one particularly serious type of environmental damage that has been inadvertently furthered by the development process, but that can "be halted and ravaged land reclaimed in terms of what is known now. All that remains is the political will and determination to do it"[2/]. Each of the countries of south-west Asia participated fully in the Conference and has contributed to the Transnational Project to Monitor Desertification Processes and Related Natural Resources in Arid and Semi-Arid Areas of south-west Asia, which is a major component of the follow up (see annex).

In analyses of problem situations deriving from development projects, a number of correlations have been made between environmental and social. or human degradation. Whatever the causal relationships between environmental and social variables, although the economic costs of environmental problems can be estimated fairly reliably in terms of lost production, the social, cultural and phychological costs are difficult to quantify usefully. These non-economic costs generate rearrangements in the distribution of populations and

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1/ Secretariat of the United Nations Conference on Desertification, "Report of the Conference," A/Conf. 74/36. (Nairobi, UNEP, 1977); and Secretariat of the United Nations Conference on Desertification, Desertification: its Causes and Consequences, (Oxford: Pergamon Press, 1977).

2/ Secretariat of the United Nations Conference on Desertification, Desertification: its causes and consequences, op. cit. p. 61.

in social groupings, which will affect future living standards and production levels in ways we cannot predict. The long-term relationship between trends in living standards and environmental perception, and between perception and responsibility for resources, although difficult to demonstrate conclusively, seems a priori undeniable. This is particularly the case in south-west Asia where the inter-relation of ecological and social problems can be seen in the perspective of ten or so millennia of human residence and food production.

From the sociological point of view, the land-use situations that demand development and generate environmental problems may be divided into two types. The most common is a traditional mode of production that has remained essentially unchanged by modernisation except insofar as it is related to a larger economic system with which its terms of trade have changed - which is the case with most pastoral systems. There is a significant difference between this type and the situation where a new technology was introduced under a colonial administration, as is the case in most large-scale irrigation systems. The difference lies in the relationship between the social structure of the population and the requirements of the technology.

In the former type, there is likely to be a high degree of congruence between the social structure of the population and the requirements of the technology, because they have co-evolved over a number of generations. Introduction of a new technology, or of technological modification, or even an increased level of investment into the system, is likely to upset the systemic balance between cultural and ecological variables - whether or not the system is in equilibrium. The results of such a perturbation are difficult to predict. In the Sahel, in combination with other factors including prolonged drought, the result was a major disaster.

In the latter type, populations were constituted on newly created resource systems and left to work out for themselves from the assorted cultural baggage they had brought with them not only an adaptive social structure, but a suitable agricultural technology. The introduction of perennial irrigation on a large scale in the Punjab in the nineteenth century by means of industrial age engineering serves well as an example. The structure of social relations with which the population embarked on the application of the new technology did not facilitate the necessary types of co-operation and leadership.

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In these two types, discontinuity between the existing structure and the exotic intrusion occurs at different points in the system and may, therefore, require different solutions.

If a development project not only demands social forms not facilitated by the social structure of a rural population, but actually causes perturbation in that structure, there is a risk that the social unit will disintegrate and be lost. As a result, conflict and migration are likely to increase; morale will decline; and there are broader repercussions. Existing urban problems are exacerbated and food production suffers because reconstitution of the population requires heavy financial incentives and increases considerably the costs of production.

If the value of the human resource is accepted, it is necessary also to understand the nature of that resource, especially the dynamics of individual group motivation. A particularly important factor in motivation is participation. Further, encouragement of the population to participate in the solution of their interrelated social and ecological problems will reduce the cultural discrimination suffered generally by relatively sparse populations in arid lands. This discrimination, which is a function of the economic gap between city and desert affects their morale and their sense of responsibility for their resources because it reduces (in their perception) their range of possible options. Acceptance of the value of the human resource in arid lands is a possible public policy strategy and, as such, should be seen as the political key to the problems of environment and development. Before illustrating its potential efficacy by reference to specific representative problems in the arid lands of south-west Asia, it will be useful to discuss briefly in general terms what this acceptance entails. The following paragraphs, therefore, discuss some basic concepts and explain the choice of material as a basis for the interpretation that follows.

A. BASIC CONCEPTS

Development implies planning for increased economic activity which, whether or not it is directly associated with food production, tends to increase pressure on natural resources, if only because it increases demand. Any development, therefore, is likely to lead to environmental problems and should be based on careful co-operation between economists and ecologists. However, because of their different orientations, economists and ecologists have developed different approaches to development. Economists base their arguments on the need to increase the distributional aspects of economic activity (though this does not of course

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necessarily mean that they aim for egalitarian distribution of wealth); ecologists emphasize production, but they are concerned that increase on one level should not prejudice production at lower levels - that is, primary productivity is given priority over secondary productivity and secondary over tertiary. A synthesis of these two orientations in the development planning process would be an important step towards a theory of environmentally efficient development.

Both the economist and the ecologist focus relatively narrowly on specific variables on the basis of which they extrapolate general processes. All disciplines have basic yardsticks which make them sensitive to particular aspects of behaviour. Economists are sensitive to the degree to which people maximize economic options; ecologists are sensitive to the degree to which they maintain the productivity of particular resources. These yardsticks restrict their ability to take full account of purely social or cultural variables, such as the effects of different social structures on the individual's response to economic incentives or the condition of a local resource. Extrapolation of the general from the particular is the essence of scientific activity, but it has been increasingly recognized in recent years that the narrowness of focus that extrapolates general processes from disciplinarily limited studies has led to failures of prediction. The present argument seeks to correct this bias, and presents the motivation and felt needs of individuals and the dynamics of social and cultural processes that derive from them as the least understood variables in the total systems that are the focus of development planning. Insofar as they generate the political process that determines public policy, these variables should be at the centre of our attention. This argument suggests that we should seek to formulate a sociocentric approach towards the solution of environmental problems in development - an approach which starts from the analysis of perceptions and interests of the social groups involved rather than from the assumptions of outsiders. Commitment to a sociocentric approach may also be the best way of ensuring the participation of local populations in the development process.

The physical processes that lead to the basic environmental problems in arid lands (water-logging, salinity, the qualitative and quantitative decline of vegetation cover, wind and water erosion, and the accumulation and movement of sand), the immediate causes of these processes (such as over-grazing, over-irrigation) and the technical solutions to them are all generally understood. The over-all position taken at the United Nations Conference was that we have the knowledge and the technology; we must organize its application. This position can be misleading. It suggests that the knowledge and technology are separate entities that can be injected into populations that are diagnosed as needing them. However, where technology transfer has failed, it is partly because the meaning of the knowledge and the application of the technology are culturally specific and cannot be transferred en bloc from one cultural context

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to another. A sociocentric approach to the social and cultural processes that have led to desertification will allow scientific analysis in terms of the perception of the involved population and generate solutions (partly by means of technology transfer) with their participation. We have come a long way from the accusations of ignorance and irrationality whereby the investigator faced with the failure of a project in effect threw up his hands and cast both the responsibility for failure and the burden of explanation on the people who were the object of his study. Nevertheless, very little work has yet been done on environmental perception and the analysis of social and cultural processes that have led to desertification.

When considering the relationship between human populations and their environment, social scientists generally tend to assume that it is adaptive and seek to analyse it according to certain general principles of adaptation but the quality of the relationship varies to the extent that adaptation (which is a term imported from the natural sciences and arbitrarily given trans-disciplinery efficacy) ceases to be useful. Increase in economic activity involves increase in the use of money as a general medium of exchange, and therefore breaks down any remaining boundaries of autarchy between populations and involves them more and more in wider and wider economic universes as they develop tastes for and become dependent upon new products and the resources of a larger geographical area. The process is generally accompanied by significant and sustained growth in population. It leads inevitably to a change in relationship between the population and the natural resources on which it depends. If an autarchic population depletes its resources, it faces ecological ruin and subsequent disintegration unless it can migrate to or develop new resources. Once it makes the transition to a level of socio-economic integration where the economic opportunities in a larger social universe are more important than the immediate natural resources, rationality no longer necessarily dictates conservationist techniques of exploitation. This change in the ecological relations of human populations has been described in evolutionary terms as the ecological transition.[3/]

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3/ John W. Bennett, The Ecological Transition: Cultural Anthropology Human Adaptation (London, Pergamon Press, 1976).

Before this transition, the community organizes its resources in the idiom of kin relations. Ethnographic cases where group solidarity takes precedence over individual acquisitiveness and ambition are common. In recent years it has been argued that in this condition where ownership of resources is not individualised, there is a natural tendency to over-exploit because each individual assumes that what he does not consume himself will be consumed by others who will thereby gain an economic advantage over him. This idea has been promoted in the phrase "the tragedy of the commons" as having significant explanatory power for the analysis of environmental problems. Like adaptation, however, its application is limited since there are traditional pastoral situations (such as among the Kirghiz nomads in northeast Afghanistan)[4/], where the social system has effectively conserved resources and avoided overgrazing and there are situations with private ownership (such as the history of agriculture in the American West) where degradation has been significant.

As a population progresses through the ecological transition from subsistence production to a cash economy, cultural values change and conflict may occur between the interests of production groups on either side. Such conflict is in itself not only socially disruptive but leads to abandonment or neglect of resources which can also cause degradation.

On the modern side of the transition, however, the level and complexity of organization change. The market is the integrating factor in a much larger socio-economic universe; kinship and community are no longer sufficient organizing principles; the tragedy of the commons is a real danger (though private ownership does not necessarily mitigate it); and administrative forms of social organization are developed for specific productive purposes from small agricultural enterprises to large multinational corporations.[5/] This qualitative change in forms of organization is a factor of great significance in the evolution of man-environment relations.

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4/ M. Nazif Shahrani, "Ethnic relations and access to resources in northeast Badakhshan", J.W. Anderson and F.F. Strand (eds.), Ethnic Processes and Intergroup Relations in Contemporary Afghanistan. Occasional Paper No. 15 (New York, Afghanistan Council of the Asia Society, 1978), pp. 15-25.

5/ A.F.C. Wallace, Administrative Forms of Social Organization (Reading, Massachusetts, Addison-Wesley, 1971).

Although organization will receive more attention later, it is introduced here not only in order to explain better the concept of the ecological transition, but to put into perspective the concept of equilibrium. Equilibrium, like adaptation, is commonly extended from purely ecological studies to comprehend human populations, but it can be misleading if applied to populations that have passed through the transition, for it focuses on the immediate relationship between a human population and the natural resources it exploits; whereas on the one hand this relationship is arbitrarily abstracted from a system that incorporates a much larger universe, and on the other hand, the human population is itself not a unit, but divided into competing interest groups.[6/]

Ecosystems and human use systems are rarely, if ever, co-terminous, and never so on the modern side of the transition.[7/] Human use systems (for example, a system of transhuman pastoralism or of modern cash cropping and marketing) commonly integrate two or more ecosystems. At present and future levels of economic integration, competing economic interests and natural resources will always be resolved by political processes. Development is itself a political process. An ecological cause takes precedence over the political process only when it is espoused by a politically successful group. This is a truism, but the obverse requires serious attention: ecological damage, also a political process, occurs not because its perpetrators are irrational, but because (on the modern side of the transition) they are pursuing their political interests rationally in a universe wider than the immediate ecosystem. If this hypothesis is valid, it would imply that given the necessary technical expertise, the answer to environmental problems in development, and in modernisation generally, lies in the political process. Even though we may be witnessing the continuing growth in global consciousness of the significance of environmental problems (the institution of the United Nations Environment Programme is an indicator of an earlier stage of this process), it is essential to harness it politically at all intellectual levels of the world community.

The political process depends on participation, organization, and the formulation of public policy. The question of participation has received considerable attention in recent years in the United Nations and

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6/ William Tucker, "Environmentalism and the leisure class: protecting birds, fishes, and above all social privilege", Harpers, 255 (1531): 49 (December, 1977).

7/ UNESCO, "Task force on the contribution of the social sciences to the MAB Programme, final report", MAB Report Series, No. 17 (Paris, 1974).

international forums.[8/] Organization is a somewhat recondite subject that is studied from different angles by a handful of exclusive social science disciplines. Public policy is perhaps the least developed of the three as a field of scientific discussion.

The discussions that have taken place so far on participation need to be developed further in order to show why it is essential and how it can be realised. It has already been suggested that commitment to a sociocentric approach will help to ensure participation but participation in decision-making and planning requires explicit organizational structuring. The development of suitable structures has certain implications. First, it suggests a holistic approach to production systems: that they should be analysed as integrated systems involving natural and human resources as well as other components such as capital. Secondly, culturalvariation from one social group to another presupposes that a sociocentric approach must also be culturally relative. Each social group by participating fully in decision-making and planning relevant to its own production system, encouraged by the sociocentric approach of the planners, will assert its own cultural values which will differ to a greater or lesser extent from those asserted by other groups. The cultural independence and tolerance that will be thus promoted will have the beneficial effect of reducing cultural discrimination which is currently the normal condition between politically dominant and marginal groups, especially discrimination of urban against rural populations.

It is interesting to note here that there has been a tendency for successful societies in arid lands to be politically independent and not dominated by political centres in less arid areas. The rise of nation states has, in some regions, led to a re-drawing of boundaries by which arid areas have lost their political independence, or their independence has been reduced. Where this has happened, for example in the Sahara and the Sahel, marginalization has occurred in the sense that the arid areas have become economically peripheral and politically dependent on centres in less arid areas and local strategies of resource use have suffered as a result of the economic influence of external interests. Even where boundaries have not changed significantly, such as in Iran and Afghanistan, the modernization of communications has changed the relationship

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8/ Cf. for example, United Nations Economic and Social Council, Commission for Social Development, "Popular participation and its practical implications for development", Progress report of the Secretary-General (Geneva, 17 January-4 February 1977).

between the more arid, sparsely populated areas and the major political centres in such a way that these areas have suffered losses, not only in de facto autonomy, but in the self-confidence and morale on which long-term strategies of resource use must be based. A significant exception to this process in the modern period is seen in the political evolution of the United States where populations in arid areas, such as Utah, have been able to form states with equal representation in the United States Senate with the most populous states of the union.

The problem of organizing participation in approached here as a problem of developing new forms of social organization or structures that will serve specific purposes, and will fit within the general framework of the existing social structure, based on kinship and community. This general framework is referred to here as the general form of organization and the new forms are called "special". Special or administrative forms of organization generally, such as those represented in the organizational charts of large firms, since they are designed for specific production objectives, depend for their success on the insulation of each individual in his position on the chart from the influences of the external social structure in which his everyday life is embeded. In order to maintain this insulation, and also to obviate the hindering effects of personal relationships that develop between people who work together, it is common for individuals to be moved frequently to different positions on the chart where they will carry out similar but different functions "interfacing" with different people, and for the chart to be continually modified to maintain and improve efficiency. This concept of insulation explains the most serious difficulties that have been experienced in attempts to develop the use of new agricultural technologies in the context of traditional social forms. The formation of water-user associations to solve environmental problems caused by inefficient irrigation in Pakistan, which is discussed in detail below, shows how this concept might be applied.[9/]

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9/ Douglas J. Merrey, "Reorganizing local level water management in Pakistan, a case study prepared for symposium on Desertification and Anthropology" (Jodhpur, Central Arid Zone Research Institute, 1978).

There is a sense in which a community has not one social structure, but several. Each member of a community has a repertoire of different roles which changes according to his stutus. As situations change, he moves from one role to another. According to the task that is being performed, the people involved each play a particular role from their repertoire. As a group, they develop a structural pose (comparable to a special form of organization) that is one particular realization of the underlying structure, (or general form of organization) of the community. A community of transhumant pastoralists would take on one structural pose at a wedding, characterized by the fact that the wedding symbolises a new alliance in a series of which each one modifies the constellation of interest groups that generate the political process; the same community would take on a different structural pose at a meeting for making decisions or resolving differences about the timing of a migration, where a different type of expertise would come into play. If the same community turned from transhumant grazing to perennial irrigation, it would develop a series of new structural poses, but without the benefit of relevant expertise. The introduction of water-user associations in Pakistan should be seen as an attempt both to provide the expertise and to develop a special form of organization. The organizational problem is to design the water-user association in such a way that the community should be enabled to operate the technology more efficiently but fit into it as a new structural pose. Administrative forms of organization must be designed as culturally acceptable structural poses.

Some of the problems of the formulation and introduction of special administrative forms of organization into production systems that are embedded in general traditional social structures might be alleviated if more attention were paid to the relationshup between individual and group interests, and the need for incentives. An important first step in this direction is the recognition that individual interests may conflict with those of the continuity of the group (which is the locus of interaction between cultural norms and everyday behaviour), that altruism cannot realistically be expected, and that it is reasonable to anticipate a similar degree of villainy in all societies and plan for it by designing administrative forms of organization that will contain it. Attention to the need for incentives, especially in the form of real participation in significant decisions, provision for which must be built into any structural innovation, will help avoid the two extreme forms of organization characterised by (a) enforcement from above, and (b) the too rigid structuring of participation, which are responsible for most failures in planned social change.

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B. ARIDITY AND THE DEVELOPMENT OF FOOD PRODUCTION IN SOUTH-WEST ASIA

Roughly one third of the land surface of the earth is generally classified as arid, and is estimated to contain 14 per cent of the world's population. Although the productivity of arid lands is generally low, since they form such a large proportion of the world their total production is significant. A large proportion of these arid lands comprises almost the total territory of south-west Asia. The arid lands of south-west Asia in Iran, Afghanistan, Pakistan and northwest India are particularly important because they are more densely settled than other arid regions, and their present population has inherited environmental problems caused by the longest history of human settlement and land use. Solution of the environmental problems of development, therefore, insouth-west Asia is not only economically significant for some 150 million people but will contain important lessons for other arid regions. Arid lands generally, and particularly in south-west Asia, apart from the large sums spent on engineering the control and delivery of river flow, have received relatively little investment so far and little of that has been successful, but they have great potential for development if only the environmental problems can be solved.

Historically the most significant forms of land use and food production in the area have been irrigated agriculture which requires substantial investment and is an intensive form of land use, and pastoralism, which requires relatively negligible investment and is extensive, together with dry farming in semi-arid parts of the region. These two forms of land use have constituted components of closely interrelated social systems of food production for thousands of years, though recently the development effort with its pronounced sectoral emphases has tended to separate them. Historical evidence shows significant declines in production from time to time during the last 5,000 years, but the causes have not been reconstructed convincingly. The Harappan civilization of the Indus Valley, for example, which must have been dependent on irrigation, fades from the historical record in the middle of the second millennium. The decline of irrigated agriculture in the Helmand delta (now on the border of Iran and Afghanistan) coincided with political decline in the tenth century A.D. Most systems of this type in developing countries have been in decline during the period of European expansion and in some cases much longer.

A historical perspective can be helpful in the analysis of ecological problems that involve human populations because it illustrates the range of possible adaptations to a particular set of natural conditions. Further detail of this historical development of irrigation and pastoralism will be given in appropriate places, but it will be useful here to discuss briefly the history of these forms of land use in more general terms.

Environmental problems in development generally derive not from basic technologies such as types of irrigation or grazing but from the scale of the productive activity in relation to the resource. Before the first attempt to industrialize irrigation in the Punjab 120 years ago, irrigation (which probably developed in its most primitive form not long after the domestication of plants and animals some 10,000 years ago elsewhere in south-west Asia) had already served as the basis of vast agricultural projects, and had had environmental effects which had reduced productivity seriously. The best known example is from Mesopotamia, where there was probably the largest ancient (pre-industrial) system.[10/11/] Like smaller systems on the Helmand, the Indus and the Oxus, and in other parts of the world, it was generally restricted to flood plains and was seasonal, depending on the annual flooding of the river. Perennial irrigation, which requires storage and gradual release of the water through the period of minimum flow, was only introduced on any significant scale during the industrial age. It has allowed the cultivation of virgin lands and the intensification of cropping. But it also intensifies the adverse effects of irrigation: soil salinity and water-logging develop faster and some of the effects are more difficult to reverse. Perennial irrigation as a means of increasing agricultural productivity is an invaluable technological advance, but it must be applied carefully - a problem of organization - lest indiscriminate application lead in the long run to reduction in productivity through adverse environmental change.

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10/ T. Jacobsen and R.M. Adams, "Salt and silt in ancient Mesopotamian agriculture", Science 128 (3334): 1251-1258, 1958.

11/ David and Joan Oates, "Early irrigation agriculture in Mesopotamia" in C. de G. Sieveking, I.H. Longworth and G.E. Wilson (eds.), Problems in Economic and Social Archaeology (London, Duckworth, 1976), pp. 109-136.

The oldest form of river flow irrigation in the Punjab (sailaba) simply uses overflow within the active flood plains. This simple technology was important in the eighth century A.D. when the Arabs distinguished irrigated from non-irrigated land for tax purposes, and it is still important today. It has ecological advantages since it flushes the land, prevents accumulation of salts and maintains fertility by depositing silt. The next stage was inundation canals. These greatly extended the area of cultivation but were less viable ecologically, and were similarly vulnerable to floods.

The change from inundation to perennial irrigation was a quantum change which throws into relief the contrast between the ancient and modern period. The modern period is characterized by much higher investment and involvement in a much larger economic universe. Where the ancient system depended on government investment, the modern system depends on investment which is beyond the means of the domestic resources of many economies. The enormous increase in investment needed for this quantum jump would not have been feasible except for a similar increase in the potential market.

In the middle of the nineteenth century the first modern perennial irrigation engineering project was begun in one of the interfluves of the Punjab. Despite setbacks, the programme gradually grew to incorporate all of the Punjab and was extended into Sind. Environmental problems developed in due course but, for a long time, there was no need to attend to them since it was simpler to extend the programme on to new lands. Although the Indus Valley irrigation system, now divided between India and Pakistan, became by any standards the largest integrated irrigation system in the world, has been growing for 120 years, is still being extended in both countries (though now as two separate systems), and still has room for growth, the environmental problems that have appeared in its wake were causing serious anxiety by the middle of this century. When development began in the late 1940s and 1950s - in the most generally accepted sense of increasing productivity and modernizing traditional systems without direct or tangible benefits to the investor - it focused on increasing output in the Punjab by alleviating the environmental problems that had arisen as a result of the application of industrial technology to irrigation.

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Although at first sight the history of pastoralism in south Asia may appear totally different from that of irrigation, there are interesting comparisons to be made. Perennial irrigated agriculture is the most intensive form of land use and its development demands high investment and offers high returns. The necessary investment, which is generally beyond the means of the individual cultivator, or even the cultivating community, is carried out at the will of an urban-based financing institution. Really large-scale irrigation engineering systems, both before and after the Industrial Revolution, have been government programmes. Hence the all-pervasive debate made classic by "Oriental Despotism",[12/] concerning the intimacy of the relationship between forms of irrigation engineering and forms of government, which introduces the problem of organization. Large-scale irrigation engineering, therefore, because it requires substantial capital investment invariably brings the cultivator into close, though not therefore necessarily happy, relations with a broader economic universe and with the bureaucracy, and might therefore, for these reasons, be taken as the classic development situation. Pastoralism, on the other hand, in its traditional forms requires minimal capital, and perhaps the major problem in pastoral development, therefore, has been the integration of traditional forms of pastoralism into national economies. There has been an important cultural aspect to this problem which has characteristically received less attention than the technological and economic aspects. This aspect can be seen in the growing credibility gap between planners and pastoralists which leads to cultural discrimination and accusations of irrationality. The situation is complicated by the fact that since traditionally pastoralists do not depend on other sectors of the population for investment, and many pastoral populations especially in south-west Asia are in origin overflows from settled agricultural populations, they could see themselves in competition with them. When the cities could not control the nomads, the nomads raided the cities and cut communication. The aftermath of this historical relationship is still evident in the general antipathy between governments and traditional pastoralists.

/Reconstruction

12/ K.A. Wittfogel, Oriental Despotism: A Comparative Study of Total Power (New Haven, Yale University Press, 1957).

Reconstruction of the ecological history of pastoralism in order to understand better its ecological effects is an extremely complex task since in south-west Asia pastoralism is likely to have fluctuated as much in indirect response to the investment in agriculture as in direct response to the quality of the vegetation. However, in recent decades the condition of pastoralism has been similar to that of irrigation in that grazing lands appear to be in a state of ecological decline. A major part, therefore, of the effort to develop or modernize pastoralism (apart from arguments about the viability of traditional forms, including nomadism, in the modern world), as with irrigation, has been devoted to counteracting what are represented as the adverse ecological effects of the history of that technology. The challenge of pastoral development was recognized somewhat earlier than with irrigation to be a problem of organization, but the assumption was that pastoralism should be reorganized along lines similar to its recent evolution in the West.

In the case of pastoralism, population growth and the ecological transition have often led to patent imbalance between animals and vegetation, which in many cases is linked with change in the terms of trade between pastoralists and the rest of society. The resulting ecological change and damage is less sensational than that caused by the enormous investment in irrigation but whereas only a few million hectares are at risk from irrigation, hundreds of millions of hectares are at risk from pastoralism.

The questions that must be answered in regard to pastoralism concern the history of the vegetation in relation to particular pastoral technologies. Unlike irrigation which is a new technology requiring new organization, with pastoralism it is necessary to start from the existing systems. In order to make the most of the existing systems, it is necessary to investigate in detail the adaptive relationships between vegetation, animals and the productive strategies of the pastoral population. This investigation has scarcely begun; what has been done so far, however, suggests that modification of the present situation, based solely on western experience, could be as damaging to long-term human interests as a policy of no interference since it breaks down existing systems, and dissipates both the human resource and its heritage of local environmental knowledge.

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The most significant difference between the irrigation problem and the pastoral problem is that the former is a technology essentially industrial and exotic so that the need for a new organizational structure to implement it is obvious. The latter is traditional. How the productivity of traditional forms of pastoralism should be increased and its environmental problems alleviated is a question that has not been carefully investigated. Instead, it has been assumed that exotic forms of management of range vegetation or animals should replace it, despite the fact that they were developed in conditions that were different in terms both of natural resources and of cultural perception and the market context. Nevertheless, both the irrigation and the pastoralism situations pose problems of organization.

Dry farming has also led to serious environmental problems in south-west Asia but dry farming is less important as a problem for development. Environmental problems arising as a result of the extension of dry farming on to unsuitable surfaces has generally been contingent upon development programmes with a different focus, or simply on modernization. However, it has been doubly damaging, since it has led not only directly to soil erosion, but indirectly to overgrazing on poor ranges, in that it deprives pastoralists of their better pastures.

In terms of national economies and possibly also of over-all economic significance, the most pressing environmental problems for the development of food production in south-west Asia are those of water-logging and salinity in the Indus Valley in Pakistan and of rangeland ecology on the plateau of Iran and Afghanistan. Progress in solving these problems in these countries would constitute an important step towards the solution of many similar problems in other countries, both in the ESCAP region and elsewhere. Work has been carried out on a large scale on purely technical solutions for both of these problems since the 1950s, but progress, though not insignificant, lagged decidedly behind expectations. Although it has been proven in some cases that foreign experts are able to correct the ecological problems and run similar systems without causing similar problems, the local populations continue to produce the same problems. The purely technical solutions must, therefore, for all their value be judged inadequate.

/For

For these reasons, irrigated agriculture in the Punjab and traditional pastoralism in Iran have been chosen for special attention in this paper. It is important to note the scale of these studies. The advantages or disadvantages of an exclusively technical solution are best illustrated on the scale of a single project. Where ecosystems are the focus, the holistic study needs to be on the scale of the ecosystem. In the case of a human socio-economic focus, where the context of behaviour is the national economy, a much larger scale is required. The process of decision-making is the core of the problem, and it will not be understood unless the context of decision-making is allowed to determine the boundaries of the investigator's universe of study and of the planner's attention. If we are to break out of the succession of piecemeal "middle range" solutions of local problems which, whether they work or not, prove non-transferable, it is necessary to change the scale and at the same time the orientation to the problem. Our rationale for a change in orientation is the necessity to focus on the human population as an integral resource in the production system. The scale of the investigation must, therefore, be determined by the social universe of that population. The fault in the responses so far is that they have not been radical enough. If we are to make progress, it is necessary to leave the relatively safe and well-trodden methodological ground of small-scale technology-centered case studies and try something new for which the theory has not yet been satisfactorily worked out.

/II.

II. ENVIRONMENTAL PROBLEMS IN DEVELOPMENT[13/]

A. IRRIGATION

1. The experience of the Punjab (Pakistan)

The resource

The average annual flow of the Indus River system which is twice that of the Nile and ten times that of the Colorado, amounts to 171.5 billion m^3 and commands some 15.4 million hectares. Water quality is good, with 100 to 300 parts per million of dissolved solids. There is great seasonal variation in flow. Between November and February, the flow averages only one-tenth of what is normal for the summer monsoon months. Rain adds an average 7.4 billion m^3 to this resource each year, and it is estimated that 54.12 billion m^3, of which 24.6 billion are presently available, can be taken annually from ground water, but because of its inferior quality this requires mixing with river water before use. Soil quality varies from moderately fine and deep alluvial deposits in the flood plains to moderately coarse on some of the higher ground between the rivers. As is to be expected in arid lands, there is a general lack of organic material.

The partition of India and Pakistan in 1947 caused a de facto division of the waters of the Indus drainage system. This division was formalized in the Indus Waters Treaty, 1969, by which Pakistan received exclusive use of the Indus, Jhelum and Chenab Rivers.

Technology

The irrigation system that has been developed over the last century and a quarter now diverts within Pakistan approximately 123 billion m^3 of the annual river flow and spreads it over 13.4 million hectares of cultivable land, of which 8.9 million hectares can be irrigated throughout the year. This controlled distribution is accomplished by means of 17 barrages and canal diversion works, 42 major canals, 6,000 km of minor canals, 600 km of link canals, and 78,000 watercourses. The total capacity is nearly 7,000 m^3 per second, or 250,000 cu ft per second (cusecs) as it is commonly measured. This

/flow

13/ Information adduced in the following pages is derived from a field trip to south-west Asia undertaken in 1978 and from the sources cited in the bibliography.

flow is supplemented from 156,000 tubewells which raise 24.6 billion m^3. The over-all pattern of flow is from one of the major rivers to major and minor canals through outlets (moghas) to water courses (khals) to farmers' fields. What cannot be absorbed within the system can either be returned to the rivers or disposed of in some other, often more costly, manner. A large network of surface drains is directed towards the solution of this problem.

The major emphasis in this technology is on spatial and temporal control of the flow. Control is directed towards maximum area of distribution and optimum level and speed of flow. The speed must be slow enough to minimize erosion of the bed and banks of the canals. However, while the horizontal movement of the water is controlled relatively efficiently, vertical movement is more difficult to manage. The system is vulnerable to seepage and evaporation. By spreading surface water over a much larger area or "command" than it would naturally cover between two points in a stream channel, and by causing it to spend more time in the commanded area than it would spend in the stream channel, irrigation greatly increases the amount of recharge to the water table. Once the water has passed both below the root zone of the crops and below the level (approximately 3 m in the sandy loams that predominate) from which capillary action can raise it to the root zone, it becomes valueless unless it can be pumped out again. If the water table rises to the level where it interferes with plant growth or allows capillary rise combined with evaporation to increase salt accumulation in the upper soil horizons or on the surface, it reduces productivity.

This form of irrigation is at once the largest scale, most investment intensive, and most economically significant technology of food production. Both as an economic and as an ecological system, it is totally different from what preceded it. It might be expected, therefore, that development would require complete reorganization of the human population that works it. In fact, however, there appears from the beginning to have been a conscious policy not to interfere with local cultural procedures. Formal irrigation administration reaches down to the level of the canals and their outlets only. There are three levels of irrigation official: the patwari assesses crop revenue; the pansal nawees reports on the flow of water; and there are mogha overseers. (There are also tube-well operators.) From the canal outlet (mogha) onwards the farmer was left to his own devices. He had to align, dig and maintain his own water course and develop a rotating water delivery system in co-operation with his neighbours, without the benefit of any outside assistance or advice. There is generally one mogha per village but there is no necessary congruence of water course sharers with spatial or social groupings of the population.

/Production

Production

The en ironmental change caused by perennial irrigation in arid lands is spectacular, and the enormous investment it requires is justified by the increase in productivity. The significance of agricultural production, of which the irrigation of the Punjab contributes the major component for the economy of Pakistan, is demonstrated in table 1. But this production leads to environmental problems which reduce productivity. As a result, increase in gross sown area cannot keep pace with population increase. In fact, even by the time of Partition, the Punjab had ceased to provide any substantial grain exports. Even though Pakistan inherited almost all of the surplus-producing irrigated areas, the population growth and ecological damage quickly - by the mid-1950s - made its a net importer of wheat. Reclamation of irrigated lands is now generally recognized to be the most important task confronting Pakistan's economic planners.

Table 1. Pakistan: gross national product and per capita at constant factor cost, 1970-1976.

Year	Gross national product (GNP) (rupees million)	Contribution of agricultural sector to GNP (percentage)	Growth of GNP (percentage)	Per capita income (rupees)	Growth rate of income (percentage)
1970-1971	32,296	37.7	-0.1	525	-3.1
1971-1972	32,745	38.5	1.4	517	-1.5
1972-1973	35,153	36.5	7.4	539	4.3
1973-1974	37,126	36.0	5.6	552	2.4
1974-1975 (revised)	38,300	34.2	3.2	553	0.2
1975-1976 (provisional)	40,201	33.8	5.0	564	2.0

Source: Government of Pakistan, Pakistan Economic Survey 1975-1976 (Islamabad, Finance Division, Economic Advisor's Wing, 1976), pp. 8, 9 and 12.

The problem

The major problem arises from the loss of cultivable land through water-logging and salinity caused by seepage, poor maintenance of watercourses and inefficient application to crops: about half of the total irrigated land is estimated to be affected to varying degrees. Until recently this process was

/counteracted

counteracted only by bringing more land under cultivation. A subsidiary but related problem, caused by water loss through these same processes and through evaporation, is lack of water.

Before the development of the system, water table depths over most of the area now irrigated were about 24 to 28 m; of the 123 billion m^3 diverted annually, only about 71.5 billion m^3 are available at the heads of watercourses. It has been estimated that from 5 per cent to as much as 65 per cent per mile is lost in the watercourses. Altogether, less than 30 per cent of the water diverted from the rivers is stored in root zones for crop use. Historical data show that the water table has risen an average of 15 to 35 cm per year since. modern irrigation was introduced. Further, in an area where the underground water has a salinity of 1,000 parts per million, which is acceptable for virtually all crops, evaporation at a rate of 2 ft per year, which is a typical value where the water table is only a few feet deep, will raise the salt content of the top three feet of soil to about 1 per cent in 20 years. This level is too high for even the hardiest crops. Not only, therefore, are environmental problems causing loss of cultivable land, the irrigation system is working at only 30 per cent efficiency and this inefficiency is responsible for the loss. These processes are probably exacerbated by inefficiencies in actual cultivation. In the 1960s it was estimated that between 50,000 and 100,000 additional acres were being affected each year and, in the worst districts, 40 per cent to 50 per cent of the cultivated land was already severely damaged.

Unfortunately, there is no exact method of quantifying water-logging and salinity damage. They vary from season to season, and year to year, depending in part on the strength of the monsoon and the spatial and temporal distribution of rainfall and ground water re-charge. Evaporation also varies according to temperature and ground cover. Crop damage varies according to water and salt sensitivity of the particular plant. Surface salinity has been compared to skin rash appearing in blotches which vary continually in intensity and extent.

Background

Before the middle of the nineteenth century, irrigation was confined to parts of the flood plains and was mostly seasonal. Elsewhere, pastoralism was the major form of land use supplemented here and there by dry farming. River flow irrigation can be traced back as far as the eighth century A.D. The oldest form of irrigation is the sailaba, or flood irrigation which is still practised on a substantial scale in the active flood plains. This form has made an important contribution to the agricultural economy and has the inherent advantage of keeping the soils fertile and relatively free of salt.

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The next stage in the development of irrigation was the use of inundation canals which drew water during the summer when the rivers rose above the levels of their inlets, and irrigated lands which otherwise would not have received water by natural flooding. The inundation canals are, however, uncontrolled and do not allow exploitation of low river flows. This form of irrigation was limited to relatively narrow strips of land on the rivers. The supply channels were inefficient, depending on uncertain river flows and tending to silt up rapidly. There were also dangerous breaches in the flood season. In spite of these shortcomings, the inundation canals constitute an advance in the technology of irrigation. The system was subsequently improved during the Mughal period, especially in the seventeenth century, to the extent that limited perennial irrigation was possible in parks and gardens.

These traditional systems were designed to spread the water over as large an area as possible during the period of maximum flow. Limited engineering works maintained a constant level of water suitable to the level of the land to be irrigated, "heading up" the flow of water, and distributing it through a system of canals. The modern system, construction of which began in 1851 and which has developed steadily ever since, is designed for continuous control.

The motivation of the colonial Government in embarking on this vast and innovative engineering scheme is in itself instructive. It was not untypical of motivations for the further development of it since, and for the development of similar projects elsewhere (for example, in Iraq, Afghanistan, Egypt and Soviet Central Asia). The desire to appear to have improved on the engineering of previous regimes provided the general motivation, while the immediate need to ensure against the threat of famine and to settle the recently disbanded Sikh levies were the specific motives. The guiding principle was incautious optimism rather than careful research and planning, despite the complete lack of relevant experience. In addition, the colonial administrators wanted to expand the area under irrigation and bring new lands into cultivation so that they could be settled and taxed. Ancillary motives included resettlement and relief of crowded conditions in long-settled areas, the creation of a granary which could supply its grain surplus to the famine prone areas of north central India and, later, especially in Sind, creation of new areas of cotton production. The optimism inherent in these motivations hindered clear perception of the environmental problems that soon developed.

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On the Western Jumna Canal of the Ganges Basin (where the development of irrigation had begun in what is now India with the provision of permanent headworks in 1936), water-logging and salinity problems had already appeared by 1859. Between 1870 and 1880, the irrigation channels were re-aligned and natural drainages cleared, with gratifying results; but this did not lead to a general policy to deal with what was becoming a general problem. When the Lower Chenab Canal, which opened in 1892, had produced serious water-logging by 1908, some maintained the cause lay not in irrigation but in the fact that the canal, road and railway embankment were interfering with surface run-off, or even that the Punjab was in a rainy cycle. Others maintained that a high water table was actually an advantage because it facilitated the operation of hundreds of Persian wheels in shallow wells and produced some regeneration of water supplies by seepage during the dry season. A Water-logging Enquiry Committee was finally established in 1925 but there was still more interest in extending the system on to new lands than in reclamation. Of course the cost of bringing water on to new lands was increasing, and the new lands had much coarser soils and lower initial fertility, and their seepage and evaporation rates were higher, and even the Indus Basin would eventually run out of new land to replace the old in a gravity-fed surface water irrigation system.

Partly as a consequence of these motives, and the perception of the situation that they engendered, the cropping pattern was dominated by wheat which was the staple grain, and cotton, the obvious cash crop, thus permitting the water to be spread thinly. Even these crops, however, which have low water requirements, received much less than the optimum, and although sugarcane, which requires more water, was allowed to a limited extent, rice cultivation which would tolerate higher accumulations of salt as well as using more water, was generally discouraged, at least until the water table had risen close to the surface.

Corrective measures

Efforts have been made to reduce evaporation and seepage but only to the extent that the cost appeared economically justifiable in the context of the perception of the problem. Apart from the policy of spreading the water thinly, which had always carried an economic rationale, canals were re-aligned. Some canals were lined in badly leaking places, and surface drains were constructed. These practices have been continued up to the present, but the most promising technical attack on the problem was proposed as early as 1927. It was not

approved until 1944 and not put into full operation until 1952. This was the Rasul scheme which employed 1,257 tubewells ranged along badly seeping canals in two of the interfluves, in a dual effort to lower local water tables and also provide additional supplies of irrigation water. Although this scheme was not particularly successful, because most of the wells were too close to the canals and actually accelerated seepage, it did lead to a better understanding of the problem. It was followed by a second similar scheme in 1953/54, and a third in 1957/58. Finally, when the Water and Power Development Authority (WAPDA) was established in 1958, it was specifically entrusted with "prevention of water-logging and salinity and reclamation of water-logged and saline lands".

WAPDA's Salinity Control and Reclamation Projects, known as SCARPs, have steadily increased the number of tubewells ever since. The factor which differentiatas these projects from their predecessors lies in the concentration of these tubewells in fields of from 1,500 to 3,000 tubewells, each of three to four cusecs capacity, and each serving approximately 250 hectares. The capacity and spacing of the wells is designed to allow full control of the drainage in each project area.

Combined with supplies from an even greater number of privately owned one-cusec wells, and the enhanced surface water supplies made possible by the newly constructed Mangla and Tarbela dams on the Jhelum and Indus Rivers, the amount of water available for irrigation in Pakistan is now estimated at over 100 million acre feet or 1,233,488 million m^3. Two-thirds of this supply is from the surface water storage distribution system, and almost one fourth from the government-owned tubewells. The total supply represents a substantial improvement over the 68 million acre feet or 838,772 million m^3 available in 1965 and thus enhances significantly the capability for efficient irrigation of crops and for leaching of salts from the top soil.

This increased amount of water spread on the surface would serve only to increase the water-logging and salinity damage to soils and crops except that the massive concentration of high capacity tubewells offers the hope of controlling the level of the water table. But a further problem lies in the quality of the ground water. Wherever the ground water is of usable quality (roughly 2,000 parts per million of total dissolved solids or less, depending upon the chemical composition of the salts), its use for crops should produce a net gain, and through consumption and evapo-transpiration result in a gradual lowering of the water table. In other areas, saline ground water must be mixed with surface water of

/good

good quality before being applied to crops; to accomplish this mixing, canal capacities in certain areas need to be enlarged. In some areas, the ground water has proved too saline even for blending and will have to be exported either by the rivers (which will cause problems downstream), or via new waste-ways constructed for this purpose.

Although the technical problems of the SCARPs have been overcome, and they have caused significant improvement in the situation, they are nevertheless still inadequate. For example, in SCARP No. 1, which began in 1962, the water table has declined to an average of two to three metres below land surface, and about 45 per cent of the affected area was reclaimed in the first nine years. Subsequently, however, progress was rather slow - which has been attributed to the sodicity of the soils. Generally, as a result of land drainage, reclamation of considerable areas, increase of water supplies from tubewells, together with additional agricultural inputs, such as fertilizers and better quality goods, yields have improved. In one experimental project area (known as Mona, see below), the gross value of agricultural produce - both crops and livestock - has increased by a factor of 2.5, but deterioration in ground water quality is causing adverse changes in chemical characteristics of the soils and decline in the yield of sensitive crops.

Thus Pakistan's ground water and reclamation programme represents an extremely complex and costly effort to offset the consequences of surface water irrigation. For the periods of Pakistan's third anf fourth five-year plans (1965-1975), the total cost of government-owned tubewells, canal remodelling, and drainage works - not including surface water storage - was set at Rp 5.3 billion ($US 1.1 billion at official exchange rates), slightly more than the cost of the Tarbela Dam which itself represents roughly half of the total cost of the Indus Basin Project. It is expected that the gains achieved in Pakistan's agricultural sector, which has been growing at a healthy rate of 3 per cent to 4 per cent per annum since 1960 (though most of the gain is due to non-food crops), will eventually more than compensate for these investments. But, it is understood that these gains will depend not only upon increased surface water and ground-water supplies, but upon further input of fertilizers, improved seed varieties, insecticides, and pesticides, and upon improved techniques of irrigation and cultivation. Generally, it has been recognized that although reclamation programmes must be continued, the best hope for future progress lies rather in prevention.

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The Mona reclamation experimental project

One of the background documents prepared for the United Nations Conference on Desertification was a UNESCO-sponsored case study based on experience in the Mona reclamation experimental project from about 240 kms north-west of Lahore. The Mona project and the case study[14/] have provided some of the most specific information on the problem and full use is made of them in this analysis.

It is not clear when irrigation was started in the project area but there is evidence of prosperity there at least as early as the seventeenth century. New canals were brought into the area in 1860, and the present form of controlled irrigation began in 1901. Part of the area received perennial irrigation from the lower Jhelum canal and is divided into regular squares to simplify planning. Another section of the area, which is commanded by a canal known as the Shahpur branch, which has only recently been incorporated into the lower Jhelum canal system, is not divided into squares. As a result, traditional and introduced systems of land tenure are mixed in an over-all planned system.

The gross area served by individual watercourses varies in size from 150 to 600 hectares, with an average of 280 hectares. The water supply for these areas varies from one to three cusecs according to size. The watercourses branch off into field cahnnels as they run through the farmland to deliver water to individual holdings. Usually all the watercourses are unlined. The water is distributed turn-by-turn to each farmer starting from the head of the watercourse; the time of delivery is fixed in proportion to each farmer's area. The farmer diverts the water to his field by making a cut in the water course at the beginning of his land holding. When his stipulated time is over he closes the cut and allows the water to flow downstream for the next farmer.

The flow in the irrigation channel is dependent upon the flow in the rivers. There are times when acute shortage occurs and all irrigation channels cannot be supplied according to their full capacity. In such circumstances, canals are run with partial supplies and in rotation. The distribution system is designed so that each outlet draws proportional shares and water is carried to the tail end of the channel. Shortages are thus

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14/ S.B. Hasan, "Case study in irrigated areas with problems of salinization and water-logging", Planning and Co-ordination Cell, Irrigation Drainage and Flood Control Research Council, 106-C/2 Gulberg-III, Lahoure (A/Conf.74/13), 1976.

proportionately distributed throughout the system. The increased control afforded by the new Mangla and Tarbela dams has reduced the shortages.

For the individual farmer, water distribution is the most immediate logistical problem. He receives his share of water according to a fixed cycle of distribution which may vary from a week to ten days. The length of time of his share in the cycle is in direct proportion to his farm area. Traditionally the farmers of each watercourse worked out their own system of distribution (known as kacha warabundi). These traditional systems have the advantage of flexibility in that it is easy for individuals to enter into arrangements to swap shares in order to meet specific crop requirements outside the cycle. However, although their ability to make such arrangements is not restricted by the system, it may be restricted by their personal relations. Worse still, their personal relations deriving from the range of roles and statuses in the general social structure may lead to a degree of injustice in the operation of the system that renders it intolerable for the poorer and less influential parties to a particular watercourse.

Before considering what happens in such situations, it will be useful here to consider briefly the basic elements of the social structure which provides the essential context of the operation of the system. Village communities are important social units in this area and have provided the basis for interaction with the administration. But within each village, the population is divided into kinship units known as biraderi. The biraderi is best glossed as a group of families related primarily through males who stand in a fraternal or filial relationship to each other. Since there is a strong preference for marriage with first cousins, marriages tend to reinforce the exclusiveness of existing kinship groupings rather than integrating unrelated groupings into a larger unit. The basic structure of the society, therefore, militates against co-operation on the level of a total number of parties to a particular watercourse. This tendency towards exclusiveness in small biraderi groupings of related families is exacerbated by distinctions of caste, and of land tenancy status. In the Mona project area, as many as 50 per cent of the land holders have units below the subsistence level. About one-fifth of the cultivators are both owners and tenants, operating about 17 per cent of the total farm area. As many as 37 per cent of the cultivators are landless tenants, operating 40 per cent of the total farm area. A certain degree of land reform protecting the rights of tenants was introduced in 1972. A further organizational problem lies in the fragmentation of holdings. Finally,

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the leaders of each biraderi compete for izzat, which may be glossed as honour or "face". Izzat can be acquired only at someone else's expense. Punjabi village society is, therefore, structurally predisposed to competition and conflict between relatively small groups of families which are generally not large enough to constitute a watercourse community. The general structure of the society conflicts with the requirements of the technology.

How has such a situation come about? In this case, the answer is relatively clear, and provides an excellent illustration of the general problem. The present population is of three different origins. The original population of the area before the development of the irrigation system appears to have been the main determining factor in the present structure. These people were semi-nomadic herders with subsidiary interests in dry farming and, perhaps, a little irrigation. From what is currently known of traditional modes of pastoralism in the area, it is immediately evident that the biraderi structure correlates usefully with the requirements for co-operation, movement, and exploitation in such a traditional pastoral system. The settlers, who were brought in to supplement the population as the development of irrigation increased both the carrying capacity and the labour requirements, probably came from a similar background. The third component of the present population is the refugees that have come into the area from India since Partition. These come from more diverse backgrounds, but appear to have modified the structure of the society significantly. This interpretation not only explains the present problems in co-operative arrangements for operating the system, but it draws attention to the fact that socio-cultural systems do not necessarily adapt to changing ecological or technological conditions as quickly or predictably as they are often assumed to. The problem is to explain why they do adapt in some cases, and not in others.

As might be expected, therefore, although there is general recognition among farmers of the fact that more efficient co-operation would solve many problems, the most common response is individualistic: the farmer seeks ad hoc solutions to the problems as he perceives them. For example, to counteract loss of productivity due to water-logging, he shifts from wheat to rice cultivation even though wheat continues to be his dietary staple. He can do this because rice yields more calories per hectare, is salt tolerant, and unaffected by water-logging, and can be exported and the farmer is able to buy wheat with the proceeds. Between 1949/50 and 1959/60, the area sown to rice in Pakistan increased by over 30 per cent, from 0.93 to 1.21 million

/hectares

hectares and the yield per hectare increased from 1,410 to 1,510 kilogrammes. Over the same period, the area sown to wheat increased only from 4.2 million hectares to 4.9 million hectares while the wheat yield per hectare actually fell from 1,540 to 1,330 kilogrammes. Where salinity is the problem, the usual response has been to try to delay the process by sowing only one crop per year, or to spread the available irrigation water even more thinly over the saline land. Such a response ultimately increases the problem since the salts cannot be leached below the level from which capillary action operates, and the combination of capillary rise and evaporation returns the salts to the surface where they continue to accumulate until the land must be abandoned. These responses derive from the farmers' perception of the situation, and their perceptions are a function of their social structure, which appears to be essentially unchanged from an earlier (predevelopment) land use system.

There are two ways to approach this problem. One is to ascertain why the structure did not change with the change in land use (the various components of the population did, after all, embrace the new technology); the other is to develop an administrative form of organization that would harness the general structure in a structural pose for the operation of the system. So far, the first approach has scarcely been tried; something similar to the second approach has had some interesting but so far inadequate results. For example, an administrative form of water distribution system (known as pacca warabandi) has been offerred to replace the kacha warabundi where the latter was not working equitably due to problems in social relations deriving from the general structure. In many cases, it has been accepted but it has an inherent disadvantage compared to the kacha system in that it is fixed and cannot be adapted to the changing requirements of individual crops. Water User Associations have been devised and introduced on an experimental basis as a more inclusive form of administrative organization. They have had limited success in some villages and appear to be a step in the right direction, although at the moment their chances of success seem to correlate closely with certain variables in the general structure of the society. One problem lies in their legal standing, and an adequate and suitable legal basis for them still has to be worked out. They do, however, provide a useful administrative framework for communication between irrigation officials, engineers, and farmers. Land levelling, watercourse renovation, and reduction of the size of irrigation basins are examples of simple

/technological

technological aids that can probably be pursued more successfully where a Water User Association facilitates communication and provides the farmer with a sense of participation and incentive. A sense of participation and incentive appear to be the conceptual keys to the solution of the problem. If the legal aspect of Water User Associations can be worked out in such a way that the individual farmer perceives the incentive of participation in the larger irrigation system, it may be possible to develop them into a comprehensive solution to cover all the ad hoc technological measures mentioned above.

If the Water User Association concept is to be successful, it must be given a formal legal basis that will constitute it as a special form of organization providing insulation against the influence of the general structure but building on local concepts, providing incentive and a sense of participating, and protecting the weaker against the stronger participants. A brief review of the organizational tasks that must be covered by this administrative structure will complete our discussion of the problem.

The organization of an irrigation system depends logically on the integration of a number of sub-systems. The first of these is the organization of the investment of money, equipment and labour that is required to build and maintain the system. The second is the distribution among the population of shares in the system or rights of access to the resource. And the third is the spatial and temporal distribution of flow among the land parcels of parties to the system. In an integrated system as large as that of the Indus River Basin, investment can only be organized by government. This investment problem cannot logically be totally divorced (as it generally has been) from the organization of the distribution of flow and of rights, which below a certain level at least (for example, the level of the watercourse) for efficiency requires a flexibility that must be provided by local organization. Lastly, the logistical problems of water control and delivery cannot be divorced from the requirements of the local systems of cultivation. In order, therefore, that the existing technological knowledge for development of the resource without damage to the environment should be successfully used, it is essential to integrate all these components of the total system administratively in such a way that the structure gives individual contributors to the system the incentive and capability to participate in making it work. The Water User Association is the most likely answer to this problem. Successful development of it will require far more attention to the perceptions and interests of individual farmers than has been given so far.

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2. Comparative situations

The Indus river system was the first to be developed. Since then the same technology has been used to develop other comparable river systems in south-west Asia and the Middle East: the Nile in Egypt, the Tigris and Euphrates in Iraq, the Oxus and the smaller rivers of Soviet Central Asia, and most recently, the Helmand of Afghanistan. In each of these cases, there has been direct transfer of engineering skills and hydraulic theory, but apparently no transfer of lessons learned concerning environmental problems or organization even though these problems have recurred in each situation. This phenomenon can only be explained in terms of perceptions and the structure in which they are embedded.

Iraq

There is a close similarity between the experience of Pakistan and that of Iraq.[15/] Irrigation has been practised in the lower Mesopotamian plain since the sixth millennium B.C. During the last few centuries tribal leaders who were able to command large work forces dominated the agricultural system. Typically, they selected arable land for wheat and barley cultivation and dug irrigation ditches to the Tigris and Euphrates. Despite a two-year cropping cycle which left the land fallow for two summers after each winter cultivation, productivity was quickly impaired by rising salinity and the people moved regularly to new areas. By 1950, approximately 60 per cent of Iraq's agricultural land was estimated to be seriously affected by salinity; 20-30 per cent had been abandoned and the rate of loss was estimated at 1 per cent per year.

There is not space to treat here the history of irrigation in Iraq in so much detail as that of Pakistan, but one project is particularly interesting in the context of the present argument. In the greater Mussayeb Project, which was initiated by the Government in 1953, approximately 90 km south of Baghdad, a modern irrigation and drainage network was installed and the land was classified and distributed in lots to tribesmen, many of whom had had no previous agricultural experience. An important aim of the project was social: to break the old tribal system and generate a population of independent farmers. However by 1964, only ten years later, rise in soil salinity and siltation in the canals had led to migration of some of the

/settlers

15/ See Robert A. Fernea, Shaykh and Effendi: Changing Patterns of Authority among the El Shabana of Southern Iraq (Massachusetts, Harvard University Press, 1970); and J.S. Dougrameji and M.A. Clor, "Case study on desertification: Greater Mussayeb Project, Iraq" (A/Conf. 74/10)(Nairobi, United Nations Conference on Desertification, 1977).

settlers and almost to a disintegration of the system. Apart from some technical problems - for instance, the radial gates to the head regulator had been fitted in the wrong position to that the heavy silt-laden water of the river's bottom layers had been drawn into the canal system - social problems were largely responsible for the failure. No attention had been paid to the development of a social unit that would be structurally adaptive to meeting the requirements of the new technology. A rehabilitation project was begun 1965 and considerable success has been achieved since then in developing the technical aspects of the system and providing services to the population. However, it is not clear from the report that the greatly increased population (32,000 in 1976 compared to 15,000 in 1965 and an estimated 1,000 in 1953) has become an efficient agricultural enterprise. There is evidence in the report that proximity to Baghdad which enables technicians and administrators to make quick visits may be largely responsible for the present success and that nothing has been learned that would make the earlier social problems more tractable in irrigation projects in more isolated areas.

Afghanistan

The case of Afghanistan is perhaps the most sensational. Although the watershed of the Helmand river comprises 40 per cent of the country, it is a relatively small system. River flow depends on winter and early spring rains and summer melt, and poses a difficult control problem since it is more variable even than the flow of the Indus system. Before the Kajakai Dam was completed in 1953 providing a reservoir of 1,495,000 acre feet (1,844 million m^3) capacity, the lowest recorded maximum natural flow was 1,620 second feet in July 1953 and the highest was 50,100 second feet in April 1949. Major modern engineering was begun in the late 1940s by an American firm, and since the 1950s has been sponsored by USAID. The environmental problems have developed faster and more disastrously than anywhere else and for exactly the same reasons. The aims of the project were to bring virgin lands under cultivation, settle nomads, store and control the river flow, and solve national problems created by border disputes with Pakistan and Iran. So long as the development of irrigation was confined to the flood plains and interfluves, no serious problems developed. But in the 1960s the project was extended on to virgin lands. The fact that these lands were characterized by shallow soils over impermeable conglomerates was not taken into consideration. These lands are now worthless for the cultivation of wheat or cotton, and are probably

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most useful for what they can teach us in the long term about the technology of reclamation. In the continuing development of all these major river systems, there is still insufficient general attention given to the lessons already learned on a local level.

India

Perhaps the most interesting comparison with Pakistan is to be made with India, especially since it is not only a continuation of the same grographical zone but includes a significant part of the same river basin which is heir to the same history of irrigation development and occupied by a culturally-related population. However, despite the general historical, geographical and cultural similarities, the Indian experience has diverged somewhat from that of Pakistan. There are a number of reasons for this divergence, particularly the differences between the Indian and Pakistani shares of the system at Partition and as agreed in the Indus Waters Treaty (1960), the difference in potential for development of the two shares, both in terms of water capacity and accessible arable lands, and the difference in numbers of technicians with relevant skills on the two sides. It is also important to note that optimum exploitation of the Indus river system is much more important to the national economy of Pakistan than is the case with irrigation generally for India, let alone with irrigation in its north-western arid zone. Nevertheless, India made a major effort to maximize its use of its share of the Indus rivers (the Beas, Ravi, and Sutlej) by extending its irrigation system as far as possible through Haryana and into Rajasthan in order that use of this important resource should eventually have the maximum possible social impact at the national level by being spread as far as possible, rather than the greatest economic impact at the local level by using the water to maximize the productivity of the nearest arable land. This policy decision was supported by the commitment to line all canals so as to minimize two of the major problems discussed above: water loss seepage and the related long-term rise in the water table causing water-logging.

The Report of the National Commission on Agriculture (1976)[16/] acknowledges that already the water supply in many canals is inadequate for crop needs and that "on many irrigation systems the present mode of utilization of water is wasteful. On /pre-existing/ unlined canals in the alluvial tracts, only about two fifths of water released at the canal head is utilized by crops; the rest is lost in transit and in the field."[17/]

/However,

16/ Government of India, "Report of the National Commission on Agriculture" (New Delhi, Ministry of Agriculture and Irrigation, 1976)(mimeo.).

17/ Ibid., volume 5, p. 10.

However, elsewhere it is stated that in Punjab, Haryana and Rajasthan, the state irrigation departments are "responsible for managing supplies right up to the field including distribution of water among the co-sharers on each outlet"[18/] which suggests that bureaucratic management systems play a more significant role in obviating inefficiency and the resulting environmental damage on the Indian than on the Pakistani side. Still, water-logging and salinity are significant problems. In Punjab and Haryana alone, 800,000 hectares are estimated to be affected. The report considers the most important cause of land degradation to be "wanton misuse and interference,"[19/] and emphasizes the importance of solving the associated social problems. It underlines the significance of the problem by continuing: "it is not by coincidence alone that by and large the poor occupy these lands."[20/] The general tenor of the report, however, suggests a faith in enforcement as the only ultimate answer to these problems.

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18/ Ibid., volume 5, p. 76.
19/ Ibid., volume 5, p. 178.
20/ Ibid., volume 5, pp. 178-179.

B. PASTORALISM

The resource

The potential for pastoral development in south-west Asia is enormous if only the problems of socio-cultural integration and environmental degradation can be solved. Some 120 million hectares (out of 165 million hectares) in Iran, 54.7 million hectares (out of 65.2 million hectares) in Afghanistan, and an only slightly smaller proportion in Pakistan are affected. This vast area cannot be used efficiently for any other food production system, and if its pastoral use can be efficiently developed, not only will regional food production be greatly enhanced, but an extremely important contribution will be made to the socio-economic and cultural integration of each country. Traditionally, these areas have been used for pastoralism to varying extents but such traditional forms of pastoralism are accused of depleting the vegetation and causing permanent reduction in productivity which, in extreme cases, has led to sand accumulation and dust storms that affect the environmental quality of urban life. The existing pastoral population in these areas is similarly an important resource. If it were lost through migration, pastoral development would probably become impractical. Both the natural and the human resource have suffered in recent decades from a negative attitude on the part of government that has led to the alienation of significant areas for dry farming, even though pastoralism would be economically more productive.

Technology

The technology of traditional pastoralism has, until recently, generally been assumed by development planners to be uncomplicated, and has received little attention. Anthropologists, who because of their choice of subject matter, might have filled this gap in fact, with few exceptions, have illuminated only the purely social and cultural aspects of the pastoral systems they have studied, and have produced little information directly relevant to the solution of development problems. This work does, however, demonstrate that it is misleading to consider traditional pastoralism as a single form of land use. It comprehends a wide range of variation of practice that needs to be understood in terms of the variation in natural conditions, animal species and their ecology, market availability and cultural values. In order to make efficient use of natural grazing, which varies temporally and spatially according to season, topography and latitude, most forms of traditional pastoralism involve seasonal movement. The species of domesticated animal (the usual range of choice is sheep, goats, cattle or camels) that pastoralists

/choose

choose to herd depends on natural conditions on the one hand, and markets and cultural values on the other. The decision to produce particular products depends on the same variables. The strategies of traditional pastoralists, their productivity, their choice of products, and their impact on the environment must be evaluated by planners in the light of their dependence on these variables, which also determine perception and openness to introduced change. How these strategies operate within the context of these variables is the core of traditional pastoral technology, which has been very little studied.

1. The experience of Iran

Production

Iran has a total human population of about 34 million and an average *per capita* GNP (1975) equivalent to $US 1,650. In terms of volume, domestic product (GDP) in recent years has been growing at between 10 per cent and 15 per cent per annum. When changes in international oil prices are taken into account, national product (GNP) has been growing at a rate in excess of 35 per cent, but there is great variation of growth in successive years. Some 40-50 per cent of GDP originates in the petroleum sector and only about 10-15 per cent in agriculture. But 55 per cent of Iran's human population live in rural areas; and their *per capita* expenditure is only about 25-50 per cent of the average in urban areas. As might be expected the emigration rate from rural areas is high.

In contrast to the economy as a whole, agricultural output has grown at only 3-4 per cent per annum in recent years, and the output of the livestock sector at only 1-2 per cent. As a consequence of the slow growth of livestock output in relation to that of national income and consumption expenditure, there has been a very rapid rise in the importation of livestock products. For example recorded imports of meat and livestock for slaughter increased, in volume terms, by a factor of two between 1970 and 1974, amounting to 65,000 tons (about 12 per cent of total meat consumption) of meat-equivalent in the latter year.

Statistics on the size and composition of the Iranian livestock population, and on its economy and modes of production are incomplete. The best recent estimates (relating to 1974) for the size of the national herd give the following range of estimates:

/Type

Type	Head in millions[a]	Female animals (millions)[b]
Sheep	31.3	19.6
Goats	14.5	9.0
Cattle	6.6	3.1
Camels	0.3	n.a.

Notes: a/ Excluding the year's products.
b/ Females of reproductive age.

Of this total national ruminant livestock population of 53 million (87 per cent of which are sheep and goats), it is estimated that 50-60 per cent are involved in major seasonal (nomadic or transhumant) migratory movements between grazing areas. A recent estimate puts the number of tent dwelling nomadic pastoralists in Iran at 700,000. Some 25 per cent of all sheep and goats and 18 per cent of cattle are thought to belong to nomads and 13 per cent of the remainder belong to people without land. Among farmers, small land owners (less than 10 ha) control 42 and 54 per cent respectively of the national total of small ruminants and cattle. This confirms the general impression gained that extensive animal husbandry for meat is in the hands of small land owners, landless and transhumant or nomadic pastoralists. The average holding among settled pastoralists is 24 head (sheep and cattle). Herds of more than 50 head make up only 32 per cent of non-nomadic small ruminants. Among non-nomads, ownership of cattle is fairly evenly distributed (90 per cent of all cattle being owned in holdings of less than 11 in number, and 55 per cent in herds of less than 5). The ownership of sheep and goats by non-nomads is rather more concentrated, 32 per cent being owned in holdings of more than 50 in number. The degree of concentration of ownership of the flocks of nomads is not known but is likely to be more concentrated because nomads are generally more specialized.

Available figures, which may be used as a guide to the main production parameters of the national herd as a whole are:

/Calving

	Sheep	Goats	Cattle
Calving/lambing rate[a] (percentage)	80	92	65[b]
Mortality - lambs (percentage)	15		
Up to 1 yard including lambs/calves	20-25		
Adult	5		
Average including lambs/calves[c]	13	11	10[b]
Offtake rate[c] (percentage)	25	30	18[b]
Meat tonnage produced (carcass) in thousand tons	180	60	80
Average carcass weight in kg	18	12.7	87
Milk (1,000 tons)	500	250	800
Wool (1,000 tons)	48	-	-

Notes: a/ Live young born as percentage of breeding females.
b/ Includes specialized dairy herds.
c/ Expressed as percentage of total population including those born in current year.

The value of extensive animal husbandry production is of the order of Rls 80 billion, of which 55.4 per cent is from sheep, 28.8 per cent from cattle and 15.8 per cent from goats. The average gross product per female animal is around:

Rls 7,500 ($US 106) for local cattle;
Rls 2,300 ($US 32.50) for sheep;
Rls 1,400 ($US 20) for goats.

Prices of meat and milk products have risen sharply in recent years, probably doubling in the last four or five years (a period during which retail prices generally rose by 50 per cent). Meat prices - at or near the "farm-gate" - are in the following range:

Live sheep:	$US 1.1-1.4 (Rls 80-100) per kg live weight.
Ghee (clarified butter):	$US 7 - 10 (Rls 500-700) per kg.
Cheese:	$US 2.4-3.5 (Rls 170-240) per kg.

If we assume that it takes 28 litres of milk to make one kilogramme of ghee, and from this quantity an additional 1 kilogramme of cheese-like products are made, this gives a value to raw milk (without labour) of about $US 0.34-0.48 (Rls 24-33) per kg.

/Seventy-five

Seventy-five per cent of the total territory of Iran is classified as rangeland or desert. The proportion of total livestock feed contributed by these areas has recently been estimated at 63.5 per cent, the remainder coming from cereals and fodder crops (11.8 per cent), agricultural by-products (23.3 per cent), and industrial by-products (1.4 per cent).

The problem

From the purely ecological point of view, the traditional forms of pastoralism are prone to overgrazing which, in many cases, has led to long-term deterioration of the vegetation cover and consequent erosion of the soil. From the socio-economic point of view, although there are obvious inadequacies in most traditional forms of pastoralism, such as the standard of living, there is no alternative way of making productive use of these vast areas. Further, there is in fact very little exact detailed information on the relationship between traditional pastoral strategies and vegetation trends over a significant period.

Background

Pastoralism is in many ways the opposite of irrigated agriculture. In particular, since it is an extensive form of land use, and not susceptible to industrialization, it does not demand large-scale investment. Its great importance lies in the fact that it can exploit almost all land, including vast arid areas otherwise unavailable for food production, and its products are of great nutritional significance. Its problems lie in its integration with national economies and societies, and in its effects on the environment. Modern technology has tended to exacerbate these problems. The discussion here is concerned not with specific projects of pastoral development but with the potential for development, especially in Iran (where because of the greater economic potential it has received most attention), and the causes of lack of success so far in which once again there is close and significant correlation between social and environmental problems.

Pastoralism in south-west Asia presents somewhat different problems from other areas. For both historical and ecological reasons, pastoralism here has always been economically interrelated with agriculture. This economic relationship has not, however, led to easy social interaction between pastoral and agricultural groups. Despite their economic interdependence, and the fact that there has been considerable interchange of population between them, relations between pastoralists and farmers have generally not been easy.

/This

This condition was largely due to the difference in perceptions engendered by the differences in land use. Traditional forms of pastoralism have generated varying degrees of nomadism based on small social units with a high degree of structural flexibility. The nomad is concerned with detailed understanding of large expanses of natural vegetation. He is not interested in investing in the modification or improvement of the natural resources he exploits except, perhaps, to provide watering points.[21/] Agriculture, on the other hand, ties individuals to specific resources - land and water - and requires them to co-operate in a more stable way in larger social units, and invest in the improvement of specific resources. The conflicting perceptions engendered by these differences have caused farmers to fear nomads in the past, and now affect economic planning since, insofar as the planners are local, they are from agricultural stock. The "credibility gap" between planners and pastoralists is greater than between planners and irrigation farmers. For these reasons, pastoral development in south-west Asia, though apparently simpler from the point of view of technology and investment, presents enormous difficulties of planning and organization. But if these difficulties could be resolved, the results would be of very great significance for the economic and social development of the whole area.

Corrective measures

Once again, corrective measures so far have been directed towards the treatment of symptoms as perceived by specialists trained in a different cultural and economic environment. This perception has led to the introduction of a number of programmes of management and rehabilitation based on experience in other parts of the world, especially the American West, specifically protection and reseeding of poor quality rangeland, demonstration projects, administrative measures to decrease stocking rates, extension services, animal health services, and the introduction of more productive breeds. Many of these projects have had limited success, but the impact on the over-all situation has been negligible.

The Turan Programme

The case study presented to the United Nations Conference on Desertification by the Government of Iran,[22/] which was taken from the Turan Programme

/for

21/ Brian Spooner, The Cultural Ecology of Pastoral Nomads (Reading, Massachusetts, Addison-Wesley, 1973).

22/ Department of the Environment, "Case Study on Desertification: Iran: Turan". Prepared for the United Nations Conference on Desertification (Tehran, 1977).

for Ecological Research and Management in the Desert Areas of Iran, provides illustrative details from a particular pastoral situation. The project area comprises some 2 million hectares on the northeastern edge of the Central Deserts. The dominant form of land use is pastoralism of various types, sedentary and transhumant. At present, some 150,000 sheep and goats winter in the area from November to May, of which 25,000 belong to the local settled population and remain in the area through the summer. There is a close relationship of interdependence between the settled and the transhumant populations.

Preliminary surveys suggested that the natural resources of the area are deteriorating and the quality of life is falling further behind that of neighbouring, less arid areas. The vegetation cover has been judged to be degraded and possibly still deteriorating in quality and quantity as the result of excessive exploitation by both settled and transhumant populations. The terms of trade between the pastoral, agricultural and industrial sectors in the national economy had changed during the last decade to the extent that the transhumants now find it difficult to hire shepherds, with the result that the traditional technology is being less efficiently practised, but the over-all pressure on the range has not lessened.

Turan exports substantial quantities of livestock and livestock products, cotton and tobacco. It imports paraffin, consumer durables, clothes, sugar, tea, small amounts of other foods, fertilizers and feed barley. Although 80 per cent of the animals that use the area belong to non-residents, some 30-40 per cent of the proceeds of the sales from these animals return to residents in the form of shepherds' wages; and a further small proportion may return as payment for feed barley grown or bought in the area.

Compared to areas of traditional pastoralism in other parts of the world, Turan appears to have quite a healthy economy. Standards of housing, health and hygiene are relatively high. Wage rates for hired shepherds run at $US 1,200-2,400 (Rls 80,000-170,000) per annum, plus food, and shepherds also make some additional income from the farming activities of their families. However, shepherding as an occupation has a low cultural value because it implies an ardous and uncomfortable life without modern facilities. Very tentative estimates of net income from one village in Turan, on the basis of an average livestock and land holding, suggest a possible family income in that village from livestock and cultivation averaging about $US 325 (Rls 23,000) per year. Such farm income could be supplemented by employment or craft earnings (e.g., in carpet weaving).

/Although

Although this figure is considerably below the per capita GNP indicated above, it must be remembered that GNP figures include much expenditure on government services, investment, etc., not applicable to family income and expenditure. A more meaningful comparison can be made by looking at figures for annual private expenditure per head. In 1973, this amounted to about $US 490 (Rls 34,000) per person for Iran as a whole, the total being an aggregate of $US 800 (Rls 60,000) in the urban sector and of $US 210 (Rls 15,000) per head in the rural sector. On the basis of these figures, and those given in the previous paragraph, and assuming that family size is about 5 persons in Turan, then it appears that incomes in Turan are at least equal to, and may be considerably in excess of those for rural incomes in Iran as a whole, and may approach the level of the working class in urban areas, whose total consumption is only about 50-70 per cent of the average figure for all urban classes. It is necessary also to bear in mind that in statistical comparisons of this kind the real value of housing, water supplies and domestic fuel tends to be underestimated in published figures and that such figures, therefore, give an unduly poor impression of rural life.

The major economic activity in Turan is the winter grazing of the transhumant flocks. Besides many that pass through Turan to areas further to the southeast, between three and four hundred of these flocks enter the area between mid-October and mid-November. The flocks average 400 head, consisting of approximately 90 per cent sheep and 10 per cent goats. They lamb in late February, take full advantage of the spring in Turan until mid-April to mid-May, and then slowly follow the spring back up into the mountains to the west, taking some six weeks to cover 450-600 km. The animals are milked in the summer pastures only. Lambing percentages (live births) average 85 per cent of breeding female of which in turn 85 per cent probably survive to weaning, and in the case of males to sale. Of the combined sheep and goat pre-lambing flock some 70 per cent are breeding ewes, 3 per cent sires and 27 per cent replacement females. The general opinion is that flock size and animal population throughout the area among the Sangsari is constant from year to year. Variation occurs in the amount of barley consumed. This information suggests the following model of income and expenditure for a transhumant flock:

/Sales

	$US	Rials
Sales		
Sale of male offspring 100 @ $US 35 (Rls 2,500)	3,546	250,000
Sale of females 70 @ $US 50 (Rls 3,500)	3,475	245,000
Sale of milk products @ $US 8.50 (Rls 600) for 220 breeding ewes	1,872	132,000
Total sales	8,893	627,000
Costs		
One chief shepherd @ $US 200 (Rls 14,000) per month	2,383	168,000
One assistant shepherd @ $US 100 (Rls 7,000) per month	1,191	84,000
Feed barley at 37.5 kg./head (300-750 grammes/day/head/ for 75 days @ Rls 10 kg)	2,234	157,500
Miscellaneous expenses - food	681	48,000
Total costs	6,489	457,500
Profit margin (total sales less total costs)	2,404	169,500

The rate of profit as a percentage of capital employed (400 head @ $US 50) is about 12 per cent - rather a modest return.

While flocks of transhumant pastoralists tend to a normal size of 400, the flocks of the area's residents vary widely in size. On average, breeding ewes form a lower proportion, since some holdings are primarily "fattening" rather than breeding operations. Lambing percentages in resident flocks appear to be slightly higher (reflecting genetic as well as managerial differences). Mortality may be lower as may be feed costs because of the availability of crop straws to supplement barley grain. The value of milk production per ewe/doe is higher than in the case of transhumants, in reflection of the fact that the animals are milked for a longer period. The estimated value of milk output per annum per ewe/doe is $US 14 (Rls 1,000). The proportion of the flock sold is slightly lower (since animals on average are kept longer) but the unit value heightens in reflection of higher weights at sale. A local resident who gives roughly equal emphasis to pastoralism

/and

and agriculture in his economic strategies is likely to have a minimum holding of 30 animals, mainly goats. On the basis of a 35 head flock of sheep and goats of which 60 per cent are breeding females, sales and expenses might be:

	$US	Rials
Sales		
Sale of milk products - 19 ewes @ Rls 1,000	270	19,000
Sale of 5 male lambs @ $US 35 (Rls 2,500)	177	12,500
Sale of 4 one-year old males @ $US 57 (Rls 4,000)	227	16,000
Sale of 7 cull ewes @ $US 50 (Rls 3,500)	348	24,500
Total sales	1,021	72,000

Costs per head are lower than in the case of transhumant flocks and possibly 50-60 per cent of sales will represent profit - say $US 600 (Rls 40,000-45,000) per flock of 35 head. In fact, however, many of these products are often consumed in the family.

Agricultural crops in general appear to be more important for supplying domestic needs than generating income, with the exception of cotton and tobacco which are cultivated explicitly as cash crops, and surplus grains from dry farming in good years. Current farm-gate prices per kg for these crops are:

	$US	Rials
Cotton	0.70	50
Tobacco	0.60	42
Cereals	0.17	12

The amount sown per year by individual families fluctuates according to several factors. The ability to command labour at the right time is one of the most critical of these, and severely restricts the opportunities of some families. But the possibility of adding several hundred dollars to the annual family income by these means is always there.

Livestock development can be thought of in terms either of the value and volume of total output or of livestock output per inhabitant. They may, but need not necessarily be the same thing, for a constant livestock output coupled with a declining human population may lead to a rising per capita output. What then are the factors limiting the total value and volume of livestock output from Turan? Prices of livestock and livestock products, relative to the prices of other goods are not, at present, unfavourable in comparison to relative prices elsewhere in the world. It is unlikely that

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in the foreseeable future the value of livestock output will be raised by government policies designed, as in Europe, to bolster (pastoral) producers' incomes by raising prices to consumers. There may be some scope for reducing costs and margins in the marketing chain, but high costs or margins are not conspicuous in the present system.

Losses from livestock diseases, while not yet quantified, do not appear to be serious. Fertility, especially of sheep, is somewhat low in comparison to some countries, but this appears to be as much due to the low incidence of twinning as to absolute infertility. More twins may not be desirable with present levels of feeding. In transhumant flocks wool yields are very low, and milk yields, at an apparent 25-45 kg per lactation, also rather low. Proper data on weight gains do not exist but it would appear that male lambs can be sold off at six months without supplementary feeding at about 25-35 kg live weight, and that with feeding a live weight of 50 kg at 11 months old can be achieved.

Livestock specialists tend to stress the importance of performance per animal (e.g., milk yield per lactation per ewe, daily rate of live weight gain per head). Where the most important costs (of labour, mainly, or of medicines, housing etc.) are proportional to the number of head kept, this emphasis on productivity per animal is useful. Where the most critical scarce resource is feed, however, it may be more useful to emphasize conversion efficiency (feed into milk or meat or wool) and not performance per head per day. Conversion efficiency is hard to measure, and livestock specialists argue that performance per head per day is very closely correlated with conversion efficiency; that selecting in terms of productivity per head is tantamount to selecting for conversion efficiency. It is possible to demonstrate this under conditions where ample feed is available in front of the animal's nose, but where feed is scarce and difficult to find (hidden away in crevices and under thorny bushes), it may not be so since 8 legs (2 small animals) may gather more food than 4 legs (one large). The conversion rate applicable is then not "product per feed consumed" but "product per feed available if looked for".[23/]

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23/ Stephen Sandford, Some Aspects of Livestock Development in India, Pastoral Network Paper 5c/1978 (London, Overseas Development Institute, 1978).

The last two paragraphs argue that, while the present performance of livestock in Turan is not impressive (whether or not it is presently causing degradation), it may not be very easy to improve it without a radical change in the level of feeding. Whether such improvement in feeding can be obtained by "managing" (protecting, rotating, reseeding etc.) the range, or whether it will require a complete change from "range resources" to "intensive feedstuffs" (implying an abandonment of the range resources to wildlife) is obviously a matter for discussion. But the focus of such discussion should always be the need to determine the most productive use of the resources of arid lands in the long term. In any case, it is not clear whether feed is the critical constraint on livestock production at the moment. The high level of barley fed (an innovation dating from the 1960s) suggests that it is. On the other hand the low level of rents paid for sheep pens (rent for grazing is illegal since nationalization in 1963), a mere 3 per cent of the value of output from an area, suggests that it is not. Livestock owners and shepherds, in discussing reasons for limiting holdings, put the emphasis on shortage of labour, not of feed. On the other hand, the last few years may have been exceptionally favourable climatically.

The main pressure on existing systems of livestock keeping in Turan appears to come from a growing labour scarcity (and consequent high cost of shepherding) arising from strong competition from urban industries. The present profitability of transhumants' livestock operations is low. Costs of production appear to come to 70 per cent of the value of output, and 55 per cent of total cash costs are labour costs. There are other non-cash costs involved in the labour required for milking herds, although abandonment of milking in favour of concentration on meat production might not be very serious for transhumants since there would be some compensatory gains in heavier weights of lambs at sale. There appears to be some scope for increasing labour productivity in shepherding, with the implication that, unless total livestock numbers in Turan can be increased (for example, by range management), a lower human population would be supported by livestock activities. There may be valid technical reasons for determining 400 as the optimum flock size among the transhumants, but output per head of sheep could be improved, and even if this meant no greater total output per unit area, it might mean more output per shepherd. Undoubtedly, additional equipment and communication devices, and more frequent watering points, could lead to reduction in the need for "assistant shepherds", and probably a 50 per cent gain in labour productivity could be achieved in this way, although at the expense of some capital investment and higher equipment costs.

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This economic review suggests that the outlook for transhumant pastoralism in Turan is uncertain unless productivity can be increased and shepherding be made more attractive. Economically, the self-employed resident mixed farmer does relatively well. However, the viability of this latter adaptation during the coming decades will depend on the interest of the younger generation and the rate of migration to the cities. Apart, therefore, from arguments concerning the ecological efficiency of these two adaptations, there is room for serious doubt about the survival of either unless they are included and encouraged in long term management and development programmes.

That overgrazing has been an important factor in the history of the vegetation of Turan has been demonstrated by comparison with experience from ecologically similar protected areas immediately to the north (miandasht and the central and eastern parts of Khosh Yeilaq). Shepherds and flock owners alike in Turan today deny that overgrazing can occur in the long term because it would automatically reduce their profits. However, in one particular part of the area, there is evidence that overgrazing is occurring as a conscious strategy. After a group of nomads settled with much reduced flocks in the early 1960s, the transhumants took advantage of the situation and used the new nationalization law and their close contacts with the central administration of the province to obtain permits to graze the areas left vacant by the reduction of the nomads' flocks. Because of the commercial nature of their pastoralism the transhumants were able to adapt more efficiently to the drought conditions and build up their flocks more quickly afterwards. During the recent succession of good years, the settled nomads have built up their flocks again to the point where they are forced to challenge the transhumants for rights to their old grazing areas. In order to make their challenge effective, they appear to have chosen to overgraze as a calculated risk.

The degree of overgrazing appears therefore to have varied historically in response to particular sets of circumstances but derived from exogenous factors. An underlying constant has been the orientation of the pastoralist towards his basic resource, the vegetation. The primary concern of the traditional pastoralist appears always to be in the condition of his animals, which he considers to be his basic capital, not the vegetation which he seems to believe will always recover.

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An extremely important but secondary danger to the vegetation comes from wood collection - which could be obviated by management programmes that would include provision for alternative fuels and construction materials, possibly by plantation in the area - that is, by investment.

Solutions

This discussion of pastoralism in Iran seeks to show the relationship between a number of variables that are commonly left unrelated in the planning of pastoral development. To sum up briefly, in Turan the range has been judged to be degraded and the degradation has been laid at the door of the pastoralists who are presently using the area. On the national level, pastoral products have not increased in value as fast as the cost of living and although shepherds' wages have risen sharply, they are not high enough to compete with wages for labour at comparable levels of skill in towns (given the added attraction of urban facilities). The result is a shortage of shepherds. Rural (as well as urban) population has increased, The animal population has probably also increased, though there are no figures. It is likely, therefore, that the stocking ratio has increased and that herding efficiency has declined, which suggests that not only pressure on the range, but the rate of degradation has increased.

As with irrigation, the perception of the planners has hindered the investigation of a number of questions that are directly relevant to the problems of ecologically efficient pastoral development. These questions generally have to do with the definition of the problem and are of two basic types. The first concerns the significance of past practices that are no longer current. For example, there is evidence that past use of ligneous vegetation for firewood, charcoal production, and construction has been an important factor in the composition of the present vegetation. This factor has been greatly reduced by the introduction of paraffin and the prohibition of charcoal burning. Another example may be seen in the removal of camels from the ecosystem by replacing them with motor vehicles. The second type concerns organization and decision-making. There is little or no analysis of the factors involved in decision-making for the individual pastoralists or the relationship between the assessments on which they base their decisions and the assessments made in scientific paradigms.

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The analysis of the state of pastoralism in relation to range quality in Turan is not complete without emphasis on the fact that this is an isolated area which, although it represents some of the most favoured winter grazing in the northeastern quadrant of the country and forms part of a single transhumant pastoral system with the best summer grazing in the mountains just north of Tehran, suffers from marginalization. The problem of organization is more complex here than in the irrigation cases discussed above because the area is used by several pastoral systems (of which only one, the transhumant, is economically significant at the national level) which differ in herd composition, in range of products and in markets, and which to some extent compete for grazing. Further, whereas the effects of irrigation on the environment are generally known and understood, there are almost no scientific data on the interaction between different grazing animals under different herding strategies and different vegetation communities in south-west Asia.

The most obvious mistake in pastoral development programmes so far has been the determination to replace traditional systems with exotic technologies instead of using foreign experience to build on traditional systems with the participation of the individual pastoralists. Once again the challenge is to develop an administrative form of organization that would comprehend these interrelated pastoral communities and allow the individual pastoralist to participate in the planning of pastoral development.

2. The experience of Afghanistan

In the light of this discussion of pastoralism in Iran the Herat Livestock Development Project in Afghanistan is particularly interesting. Livestock production in Afghanistan is estimated to contribute about 10 per cent of GDP and 30 per cent of exports. The most economically important of the national herd is sheep, estimated at 14 million in 1976, down from over 21 million before the drought in the early 1970s. The major factor limiting growth is the condition of the range and shortage of supplementary feed, especially in winter. Although total GNP is thought to be growing at about 3.3 per cent per annum (1965-1974), *per capita* GNP at the equivalent of about $US 110 (1974) is the lowest in the region. Some two thirds of the population are involved to a greater or lesser extent in livestock production. The development problem is not only to raise productivity but to harness existing production for the national economy, especially for exports, but pastoralism is implicated in serious environmental degradation by overgrazing. At the

commencement of the project, there was almost no scientific information available on the ecology of the country's rangelands (beyond a few brief general reports and surveys by consultants and anthropologists), the dynamics of its production and marketing or the strategies of herding and management of the traditional pastoral systems.

The first Livestock Development Project was begun in an area of 12,000 km^3 along the Hari-rud River in the district of Herat in northwestern Afghanistan in 1974. In 1976 the second stage of the project was expanded to cover an area of 100,000 km^3. The small ruminant population of this area is estimated at 2,000,000 sheep and goats, approximately half of which are owned by villages and half by transhumant families. The focal aim of the project was to raise export earnings by providing a slaughter house and sheep improvement centres and integrating them into the traditional pastoral systems. A subsidiary aim was to develop co-operatives among small producers to enable them to take advantage of institutional credit facilities.

The project provides for a range improvement specialist responsible for the establishment and operation of a range improvement centre with field stations. But this component does not appear to be closely integrated with the major aims of the project. However, a particularly impressive part of the results of the project that are available so far is a series of reports that derive from this component. These reports go into considerable detail concerning the quantity, quality and composition of range vegetation in northwestern Afghanistan and the usage patterns and organization of transhumant pastoral communities in relation to it. Although they constitute one of the most comprehensive sets of data available on the interaction of traditional pastoral systems and vegetation processes on arid and semi-arid ranges and as such are an invaluable contribution to pastoral development, there is one inadequacy in their coverage which is significant given the argument of this paper. These data are exclusively behavioural. As such, they fail to explain the strategies of the pastoralists. They have been gathered according to a research design which is not socio-centric and will not help towards the aim of structuring participation of the pastoralists in the process of planning the development of their own human use systems. Even so, the data are invaluable and the addition of the perceptual perspective could make the Herat Livestock Development Project in Afghanistan a unique step towards solutions to the problems of pastoral development without pressing too hard against the limits of range productivity.

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III. CONCLUSION

The two most serious environmental problems associated with the development of food production in south-west Asia have been isolated and illustrated with reference to particular situations. It has been argued that environmental and human problems are not unrelated, and that not only should the human population involved in any proposed development project be considered a resource of equal significance with the natural resources in the system to be developed, but that if they are to function efficiently, they must have incentive and responsibility, which is to say that they must be involved in the planning process as well as the implementation, not simply as observers, but as partners. Their participation in this process will work only if full value is granted to their perception of the environment and of their problems. It is not sufficient simply to encourage participation; participation must be organized by means of an administrative structure that would harness the general structure of the society for the purpose of production.

The disappointments of the development record so far derive from the fact that both development strategies and corrective measures have been ad hoc, focused on specific projects, or the treatment of specific systems rather than holistic programmes based on adequate theory explaining the relationships between all the relevant variables. Similarly, impatience and rash optimism prevented the integration of research with application and of theory with practice. The theory of environmentally efficient development must be pursued further by generalizing from the experience of specific processes. The theory will suggest the definition of indicators that will allow us to monitor specific development processes for their environmental and socio-cultural effects.[24/]

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24/ See annex and Priscilla Reining (compiler), Handbook on Desertification Indicators (Washington, D.C.), American Association for the Advancement of Science, 1978).

The final argument for the integration of environmental and social planning, and for participation by target populations in the planning process, as well as in the implementation of development projects, should be derived from the observation that there is no logic whereby one social group can claim to know infallibly what is environmentally or culturally right for another; but insofar as the environmental impact of the activities of one social group may be felt by a larger population, both currently and in the future, there must be the widest possible participation in the political processes leading to policy decisions.

This discussion may be summarized in one general recommendation. The solution to environmental problems that arise in the process of development requires redefinition of the problems. The problems should be redefined socio-centrically in terms of human use systems. In this new paradigm, the human populations should be assessed as resources, integral to the system. Planning for development should start from the study of their perceptions and decision-making processes in relation to the development problem and the environmental potential. It should design the organization of the population that is to operate the developed system and design it in relation to existing general structures. Finally, the planning should be holistic in the sense that it should be based on trans-disciplinary dialogues, and organized supra-disciplinarily.

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THE CAMPAIGN TO COMBAT DESERTIFICATION IN SOUTH-WEST ASIA AND THE SOUTH-WEST ASIA TRANSNATIONAL MONITORING PROJECT

The campaign to combat desertification which had been evolving gradually in each country as particular government agencies sought to deal with particular environmental problems has achieved co-ordination and direction since 1976 under the encouragement and sponsorship of the United Nations Desertification Conference Secretariat and its successor, the Desertification Unit of the United Nations Environment Programme.

As part of the preparations for the United Nations Conference on Desertification, the Secretariat of the Conference invited representatives from Afghanistan, India, Iran and Pakistan to meet in Tehran at the Department of the Environment in August 1976 to discuss regional problems of desertification and to appoint a study group to investigate the feasibility of regional co-operation to combat these problems. The Secretariat wished to encourage the establishment of a co-operative monitoring project which would pool resources, standardise procedures and share experience in order to promote regional efficiency and independence in combatting desertification processes. These particular four countries were chosen by the Secretariat with an eye to their overlapping cultural legacy and historical experience, their shared problems of desertification and - most specifically - the coming availability of a satellite tracking and receiving station in Iran.

The Tehran meeting established an international study group consisting of one member each from the participating countries, with the brief to produce a report on the feasibility of establishing a Transnational Monitoring Project. The report was financed by the United Nations Environment Programme and produced under the auspices, and with the facilities, of the Department of the Environment in Tehran. The first draft of the report was produced in November 1976, and circulated to the four governments.

A second meeting was held in Jodhpur in January 1977 in order to produce a final draft of the feasibility study report. The meeting decided to press for the establishment of a regional committee on desertification which would function as the Board of Governors for a regional centre. Since the main emphasis in the project was the application of remote sensing technology to the problems of monitoring desertification processes and corrective measures, the meeting expressed strong hopes that the government of Iran would be able to

host the regional centre so that it could be established in a close working relationship with the satellite tracking and receiving station.

The Regional Centre will also be able to carry out other functions that will allow the four countries to make the best use of the total facilities and expertise available in the region and maintain a working relationship with remote sensing and desert research agencies in other parts of the world. These functions will include:

1. formulating a Regional Training Programme;
2. establishing a regional documentation centre to complete national centres;
3. assist in raising public conciousness of desertification processes;
4. develop improved monitoring techniques, and
5. facilitate regional implementation of the Plan of Action to Combat Desertification.

In addition, National Committees would be formed, which would select pilot areas for the development of experimental projects.

The Transnational Project was presented to the regional preparatory meeting for the UN Conference organized by the ESCAP in New Delhi in April 1977 and received that meeting's positive endorsement.

With this encouragement, the Secretariat suggested to the government of Afghanistan that the first regional meeting of the Regional Committee on Desertification should be held in Kabul. The government of Afghanistan responded enthusiastically and the Committee meeting was held in Kabul in July 1977. The meeting was disappointed to learn that Iran was unable at that time to offer to host the establishment of the Regional Centre. However, as a stopgap measure, until some alternative arrangement could be made, it was agreed that the Department of the Environment in Tehran would function as a co-ordinating office for the project.

The project was once again strongly endorsed at the United Nations Conference on Desertification in Nairobi in early September.

In Spring 1978, a project document was completed for presentation to the first meeting of the Consultative Group on Desertification Control, which met in Nairobi, May 2-5, 1978, under the Chairmanship of Dr. M. Tolba, Executive Director of the United Nations Environment Programme. A second meeting of the Regional Committee was scheduled to be held during Autumn, 1978 in Tehran but has been postponed until January, 1979 and is now expected to be held in Delhi.

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Each of the four countries has supported the project fully and between them they have undertaken to bear a major proportion of the total cost. National committees have been appointed. Pilot areas have been selected. Experimental projects are in various stages of formulation and execution. Each country has also appointed an executing agency. The executing agencies are:

Afghanistan - Department of Forest and Range, Ministry of Agriculture.

India - The Central Arid Zone Research Institute.

Iran - Research Organization, Ministry of Agriculture.

Pakistan - The Irrigation Drainage and Flood Control Research Council.

In each case, these executing agencies have been selected because of their centrality in the campaign against desertification in the particular country. The Central Arid Zone Research Institute (CAZRI) at Jodhpur, India, requires special mention in this context. Under the Indian Council for Agricultural Research, CAZRI is responsible for the full range of basic and applied research related to developing the efficient use of India's arid lands. It employs a hundred professional scientists and celebrated its Silver Jubilee in February, 1978. The most significant of its recent publications are listed in the Bibliography. In the field of environmental problems related to the development of food production systems in arid lands, CAZRI is a unique institution, and is well-suited to serve as the scientific base for the regional campaign against desertification.

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