

RECENT IRRIGATION POLICIES AND ENVIRONMENTAL SUSTAINABILITY IN
NEPAL¹

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ABSTRACT

This paper explores the recent changes in irrigation related policies and legal provisions of Nepal in view of the fragile Himalayan ecology. The urgency of meeting food availability for an ever rising population, the choice of technology in a labour surplus economy, and the institutional and policy framework are considered as factors that shape the management of environments.

This paper therefore focuses on the state of Nepal's policies and addresses the environmental concerns faced during irrigation expansion and development. One specific case study is cited where the recent government efforts of increasing food production through irrigation development began with total oblivion of the environmental impacts. Increasing advocacy for environmental concerns, preservation of biodiversity, and support of local community managed irrigation systems forced both the lender and the government of Nepal to reformulate the original objectives of this irrigation project and support community collective actions and accept environment-friendly development project.

This paper attempts to show that the currently presented objective of economic growth through increasing food production by irrigation need not be contradictory to the objective of environmental sustainability. In fact, they can be pursued to be complementary and mutually supportive with proper policy and implementation frameworks. This paper emphasizes the need for the integration of both the decentralized, community based approaches to environmental management as well as the formal, governmental legal and administrative processes.

I. INTRODUCTION

For centuries the farmers of Nepal have been involved in irrigation management. There is an adequate documentation of

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farmer managed irrigation research. Originally, most of these systems were created and managed through local efforts. There were some irrigation systems however that were state created. This century has witnessed an increasing role of state intervention in irrigation development. The rationale behind this was a conception of the role of the state whereby it was felt that state should control and provide services to the civil society. The state made its presence felt in the hinterlands through "development" activities, revenue collection, and local administration. State intervention in irrigation development was also justified due to the need for meeting food requirements for a rising population. State intervention was blessed and supported by donors likewise. After the ousting of the Rana regime, state intervention was undertaken in a planned mode with targets, budgets, and an irrigation bureaucracy. Such state interventions when evaluated were found to be performing below expectations and were compounded by adverse environmental impacts. Such poor performances were partly due to natural disturbances in this fragile Himalayan ecology and to an extent due to poorly planned, designed, and implemented irrigation projects with inadequate participation of the real stakeholders.

The purpose of the paper is to briefly review the environmental impacts of irrigation projects and to suggest measures to bring about compatible objectives of increased food production and environmental sustainability. The paper will briefly present the irrigation-environment interaction scenario, review the recent irrigation policies and legal provisions from an environmental perspective, and conclude with the policy and research recommendations to meet these twin objectives.

II. NATURE OF IRRIGATION-ENVIRONMENT INTERACTION

In general, irrigation projects can have four different types of environmental effects : (a) disruption of human settlements and human activities, (b) the creation of favorable habitats for parasitic and waterborne diseases, (c) physical or chemical disruption generally resulting from the alteration of land use and changes in the surface or groundwater regime, and (d) the impact on indigenous flora and fauna, including aquatic ecosystems (Kindler, 1992). In the context of Nepal, the severity of these effects varies by type of technology and geographical area. The first two effects are commonly observed in large irrigation schemes built in the Tarai, particularly multi-purpose schemes involving the construction of large dams. The fourth effect can be seen in medium and large surface schemes in the vicinity of national parks located in the Tarai. Two prominent examples of this type of effect that has received attention in recent years are the East Rapti Irrigation Project and the Karnali Multipurpose Project. The third type of effect is common in most irrigation schemes. The environmental effects of irrigation schemes in the hills and Tarai are separately discussed below.

Hill Irrigation Schemes

Hill irrigation systems are mostly farmer constructed and managed gravity systems providing supplementary irrigation during the monsoon period. In these systems the diversion is by means of a stone bush dam which is temporary and easily damaged during floods. The inflow is crudely checked by simple overflow arrangements near the intake. Canals are hand dug or cut into soft rock and generally unlined without any escape facilities to remove runoff from uphill areas. Cross drainages are made of dry stone walls with overflow crest. In some systems water is carried across gullies and other obstacles by means of wooden aqueducts made out of a hollow tree trunk. Water is distributed to field channels through cuts in the embankment of the main canal, while stone, bushes and soil are used to control the flow in these openings.

Several factors contribute to adverse environmental effects in hill irrigation systems. These include unique geology and climate, design and construction defects, inappropriate land use, and inadequate beneficiary participation.

The hills and mountains of Nepal possess a unique geology and monsoonal tropical climate. In geological terms, the hill landscape is still very young. The climate is characterized by high temperatures with high and intense seasonal rainfall. The main canal alignment in hill irrigation schemes is usually located in degraded middle slopes above the river valleys, and in active lower slopes above the existing river channel and its nearest terraces (HMG/UNDP/ILO/WB, 1992). The alignment of secondary canals is usually found in recent side terraces and valley floor. In this environment, the steep hill slopes are subject to frequent landslides and soil erosion. These processes are further aggravated by the extreme pressure put by high population on the land which results in overgrazing and deforestation for fuel, timber and fodder.

Improper design and construction of irrigation canals can also lead to environmental degradation in the hills. Most hill systems lack proper flow control and so cannot safely dispose excessive runoff. Flood flows easily enter the canal on steep slopes and serious gully erosion occur where the water overtops the canal banks.

Experience shows that inappropriate management of water is another major source of adverse environmental effects in the hills. Following development of irrigation schemes in the hills, farmers almost invariably convert their upland terraces into rice fields sometimes without considering the suitability of the land for rice crop. In such areas landslide erosion is caused due to water saturation of steep slopes or lubrication of soil layers in

geologically unstable situations due to losses from irrigation canals, over watering of fields or excessive infiltration of rain on terraced slopes (IIMI 1990, FAO 1984).

One of the reasons for environmental problems in agency constructed irrigation schemes in the hills is their inability to incorporate farmers' knowledge in design and construction stages. Farmers have adopted different technologies and materials to suit topographical conditions. Although farmers find it increasingly difficult to maintain these systems due to floods and landslides, many systems have been gradually improved each year. One of the greatest threats to their viability is rapid deforestation (Pradhan and Yoder, 1988). Declining forest cover contributes to higher silt loads, more destructive floods, and more frequent landslides which forces the farmers to work harder to keep their systems operational. Farmers have traditionally depended upon forest products like tree branches and brush for maintaining diversions and repairing breaches in the canals. But deforestation has drastically reduced the supply of these products.

Farmers in these systems have developed innovative organizational structures to fit the needs of their systems in their particular environmental settings. The nature of the organizational structure has been affected by factors such as, the abundance of water relative to the available land area, soil type, nature of land holding, topography of the command area through which the canal must travel, distance from house to field, and social structure (Martin and Yoder, 1988).

Farmers realize that large canals are not only extremely costly to build but are also environmentally risky in steep mountain slopes. FMIS in the hills and mountains have always been small and farmers usually resort to building another parallel canal a little below the first one, rather than enlarge the capacity of the first (Acharya, 1990). In hill systems with long canals excavated through landslide zones farmers have utilized tunnels for certain stretches along with high gradient and narrow canal cross sections for slope stability.

Tarai Irrigation Systems

The Tarai has a potential net irrigable area of 1.34 million ha (World Bank, 1990). About 0.74 million ha is presently irrigated, of which some 11 percent is served by groundwater schemes. An additional 260,000 ha of agricultural land is irrigable by groundwater and there is an additional potential for groundwater development for conjunctive use in the surface command areas of the Tarai in about 200,000 ha. Further development of surface water for irrigation is constrained by the high costs involved in harnessing the large flood-prone and unstable rivers, and by the technical problems posed by the very high sediment loads the rivers carry

during the wet season.

In the Tarai the high rate of sediment deposition in dams, irrigation canals and on farm land is one of major environmental problems. Environmental impact assessments of irrigation projects like the East Rapti and the Karnali Multipurpose Project indicate that large surface irrigation projects can have other environmental problems. Some environmental effects of groundwater and surface irrigation schemes in the Tarai are discussed below.

Groundwater: Two types of environmental problems can arise in the development of groundwater resources in the Tarai, namely well interference and soil salinity. Soil salinity does not appear to be a serious problem in most schemes. However, the problem of well interference has been observed in several areas of the Tarai. Decrease in water discharge over time was observed by some shallow tubewell farmers in Morang and Rupandehi districts (ADB, 1988). In Bhairahawa and Lumbini areas in the Rupandehi district where high capacity deep tubewells were installed under two World Bank-assisted projects, farmers in the nearby areas complain that their shallow tubewells are in operation. The substantially increased groundwater withdrawals from deep tubewells result in substantial declines in groundwater level over broad areas, making suction lifting in shallow tubewells infeasible.

Surface schemes: Possible environmental problems in Tarai surface irrigation schemes include water-logging and salinization, adverse impact on flora and fauna, higher incidence of water-borne or vector-transmitted diseases, possibilities of harmful agricultural chemicals being contained in irrigation return flows, and sedimentation of canals and reservoirs due to pumping of silt laden water from river. The last problem is common in many Tarai schemes, most prominently in the Chitwan Irrigation Project and the Sunsari-Morang Irrigation Project. The Chitwan Project was closed down recently due to severe siltation problem and it is estimated that 300,000 cubic meters of silt has to be removed annually from the Sunsari-Morang Project. Other environmental problems are also becoming important in medium and large schemes as revealed by the environmental impact assessment of selected schemes. However, no information is available about the severity of these effects.

Irrigation development related problems

The National Conservation Strategy report (1988) presents a series of irrigation development related problems (actual and potential) from an environment sustainability perspective. They are:

- i) irrigation projects that are poorly designed and managed and inadequately maintained have led to inequitable water distribution and siltation of canals, at times rendering

such facilities inoperable. Siltation of croplands results in loss of agriculture production and similarly lack of effective monitoring and improper control of the use of groundwater can lead to an irreversible loss in the aquifer's capacity

- ii) insufficient attention given to potential cross-sectoral implications in the planning and design of new irrigation systems. Such poor designs can lead to increased erosion, water logging and drainage problems, siltation and the wastage of irrigation water; and conversely, poor land use practices leading to forest depletion, soil loss and the loss of water supply can have a detrimental effect upon the operation and life of the irrigation scheme
- iii) defective planning and design of tubewell irrigation in the Tarai have led, in some cases, to the deposit of sandy soil on fertile land
- iv) conservation information concerning sound irrigation practices is not readily available to farmers, nor is it clear which agency (or agencies) has the responsibility or capacity to disseminate such information. It is postulated that improper use of water may lead to soil salinity or leaching, and the inadequate replacement of nutrients may eventually lead to less, rather than more, productive cropland.
- v) the Department of Irrigation is primarily concerned with design, construction, operation and maintenance of irrigation schemes. Thus, very little attention has been given by DOI to conservation issues, such as land management, soil regeneration, and water application. Though it is responsible for conservation related issues such as flood control and river training, its current mandate needs to be expanded, its technical expertise strengthened or increased, and administrative working procedures established if it were to assume additional conservation responsibilities
- vi) until recently, the emphasis had been on the construction of new irrigation systems (and many a time upon areas where local irrigation systems were already existing), while the maintenance and timely delivery of water through existing systems has received insufficient attention. Since the linkage between irrigation and drainage development has received only limited attention, there are ample cases of the problem of salinity of irrigation areas and therefore the full benefit of irrigation investment in raising agricultural productivity has not been realized.

Irrigated Agriculture and the Environment

A change from rainfed agriculture to irrigated agriculture, and that too a change from traditional agriculture using locally available biomass resources to one derived from the green revolution with a heavy dependence on external inputs have shown changes in the environment. The irrigation practices and agricultural chemicals used in one rural community affect the productivity of neighboring ones. An inappropriate use of pesticide, chemical fertilizer, water application has endangered the very sustainability of the irrigated land. Not only has the soil but also the water table under it has been found to be unfit for household consumption. With the slow erosion of traditional varieties and seeds and widespread adoption of external technology packages, the changes in the agricultural land composition are more rapid than ever. The escalating population, the search for higher yields, and state promotion of external input intensive technology all have contributed to the rise in irrigated agriculture.

Given these outcome and processes of the irrigation-environment interactions, institutional and legal framework should be established that addresses environmental sustainability not only in terms of the physical environment's preservation or for obtaining current sustenance from it but also in terms of future generation's right to use and benefit from that environment.

Irrigation and Health

Needless to say, water is a critical resource that affects the welfare of primary producers throughout the world. The human well being and productivity in developing countries are directly affected by the nature, source and use of water for agriculture production, household consumption, and waste disposal (Small, 1986). Thus, the nature of the irrigation system and its management may also affect the irrigators' general health besides mere agricultural productivity. The principal vector-borne diseases that are associated with irrigation development are malaria, schistosomiasis, and Japanese encephalitis. In places water from irrigation systems are used for non-irrigation purposes too like drinking, cooking, washing and recreation. Gastro-enteric and diarrhoeal diseases are also linked to irrigation. Wastes discharged by a village or municipality into a local river affects the quality and the catch of fish of those communities downstream.

It has been noted that despite the complexity of relationships between irrigation engineering and the creation of vector breeding places, efficient water management can impede the creation of the

latter (Speelman and Top, 1986).

III. REVIEW OF NEPAL'S LEGAL AND POLICY FRAMEWORK

Several legislation and policies related to irrigation development and quite separately on environment conservation and utilization have been formulated. There is yet a lack of working procedures and implementation of the recently adopted policy based on the National Conservation Strategy (NCS) completed in 1987 with the assistance of IUCN (the World Conservation Union). Since 1989, IUCN has been assisting in the implementation of the NCS. The NCS of Nepal gives priority to the creation of new laws and institutions for environmental protection and conservation. The NCS Implementation Project has been involved with the review of legislation, administrative procedures and institutional arrangements relating to land use and resource management towards a more coherent institutional and legislative framework for a comprehensive governance of economic development activities and environment sustainability. However, several other policies and legislation have come into effect after the initial review of the legal-administrative environment. The irrigation policy and the water resources act had not been formulated then. These two do deal with some of the environmental concerns.

We now turn to the recently repealed and current irrigation related policies, acts, and legal provisions and note specific environment issues "covered within them."³

The Canal, Electricity and Related Water Resources Act, 1967 stated that no person while generating electric power or using water resources in accordance with the Act was to carry out any activity that would lead to soil erosion, landslides, flood or cause any adverse effects on the environment. The irrigation rules and regulations that were derived from this Act recognized the role of indigenous farmer managed irrigation systems. Authority was given to users committees (in consonance with Decentralization Working Arrangement Rules, 1984) to take over the management of local irrigation projects. The Act, other than the cursory reference to environmental concerns, makes no provision for water quality monitoring. The administrative responsibility for the Act resided largely with the Department of Irrigation.

The approach to the Eighth Plan (1992-1997) advocates locally available technologies and methods for community irrigation schemes

³The earlier ones are includes to portray the trend in legislation coverage regarding irrigation and environment interaction.

that are to be constructed and managed by the users themselves. Even in the case of larger irrigation systems, they are to be demarcated into smaller units to be managed by the users. For lift irrigation alternative forms of energy rather than fossil fuels were to be promoted.

The Eighth Plan based on and improvised from the Approach mentions that one of the very pressing and important role of the government would be to conserve the environment for sustainable economic growth. It states that sustainable economic growth implies the management of biophysical resources available in the country in the most productive manner without damaging or depleting these resources, i.e., the demand for such bio-physical resources should not exceed their sustainable supply capacity. The eight plan attempts to bring about intersectoral linkages. Within the soil and watershed management component of the forestry sector, afforestation activities were to be undertaken at the watershed areas of large hydropower plants and irrigation projects as well as along river banks.

In pursuit of the environment and resource conservation, the Eighth Plan notes that environmental impact assessments were to be taken into consideration in the formulation and implementation of projects. Programs were to be introduced to minimize negative effects at the planning stage of large scale physical and industrial development works which could jeopardize the environment. Detailed legal provisions, which placed priority on sustainability, were to be prepared and enforced to facilitate environmental management. Very recently, the guidelines for environment impact assessments were passed by the government and has been published- in the gazette for enforcement. Public awareness of the environment were to be raised and the involvement of NGOs encouraged.

The Eighth Plan states the following objectives for irrigation with an environment focus: i) increase agricultural production through the application of irrigation technologies appropriate to diverse climatic and soil conditions and with minimum detrimental effects to the environment, and ii) provide irrigation facilities for maximum area of land by implementing economically, technically and environmentally sustainable projects with the participation of the farmers. In terms of specific programs, the Eighth Plan notes that people's participation will be encouraged in river control programs to control the loss of agriculture land. With subsequent policies, five year plans, and Acts, the government attempts at decentralization and local involvement due to several factors a strong factor for this reasoning is the lack of funds on the part of the government as well as the lack of the capacity of the government to undertake all development activities in its entirety. The notion that only governments "do" development is slowly being changed and to a great extent accepted by the government itself. A need for irrigation management training programs for the

sustainable and reliable management of irrigation projects are to be launched during the period of the plan.

One of the key objectives of the Irrigation Policy 1992 is to optimally develop irrigation services through cost effective investment in the irrigation development and extension programs while ensuring that they are sustainable from the technical, financial, institutional and environmental perspectives. Thus projects were to be executed in a way that maintained the necessary environmental balance and effective utilization of the irrigation system; formulation and execution of river training works only if they related to the irrigation project were to be carried out on the basis of the demand of the farmers and their participation; and emphasis was to be given to the development and promotion of modern irrigation technology by identifying less expensive sources of energy which could be used in such technology.

The recent Water Resources Act, 1992, in its very preamble, states environmental concerns: " WHEREAS, it is expedient to make arrangements for the rational utilization, conservation, management and development of the water Resources that are available in the Kingdom of Nepal in the form of surface water, underground water or in whatsoever form, and

WHEREAS, it is expedient to make timely legal arrangements for determining beneficial uses of water resources, preventing environmental and other hazardous effects thereof and also for keeping water resources free from pollution. " Under section 8 on Provisions Relating to License the following environment related requirement is prescribed:

- (1) An individual or a corporate body, who desires to conduct survey or to utilize water resources, shall be required to submit an application to the prescribed officer or authority along with the economic, technical and *environmental* study report

Similarly under section 19 on Water Resources not to be Polluted, the following prescriptions are made:

- (1) His Majesty's Government will prescribe the pollution tolerance limit for water resources.

- (2) No one shall pollute water resource by way of using or putting and putting any litter, industrial wastes, poison, chemical or toxicant to the effect that the pollution tolerance limit of the water resource as prescribed above by the government.

- (3) The prescribed authority may, as required, examine or cause the examination to determine as to whether or not the

water resource has been polluted.

A specific section on proscribing substantial adverse effect on environment (section 20) states that while utilizing water resources, it shall be done so in such a manner that no substantial adverse effect be made on environment by way of soil erosion, flood, landslide or similar other cause.

In Nepal we witness two parallel systems of resource management. At the formal level, there is the centralized, bureaucratic-legalistic system of management constituted with numerous departments, agencies further divided into various sectors implementing numerous laws and policies (as described above) to basically regulate the society with certain perceptions of governance. At the other more informal level, local communities have been practicing environmental, natural resource management supported a network of community structures and organizations, traditional and indigenous practices, customary rulings and laws, and enforced by the society or community concerned. The vast literature on farmer managed irrigation systems is a case in point regarding the irrigation sector. This informal traditional practices usually go unnoticed in development activities. Only recently, due to increased awareness, the government is slowly incorporating these institutions into the mainstream development path or has accepted as an alternate path to economic development activities.

Regardless of the spirit and policy or legal provisions, what is sorely lacking for sustainable development are working procedures to translate these policies and an effective enforceable system. Due consideration for what is actually practiced through customary rulings and traditions should be given such that they are not rendered ineffective due to the rising formal legal structures and provisions. Lack of intersectoral and interdepartmental coordination has to an extent created a vacuum while addressing issues of interfaces, e.g., of fisheries and irrigation, irrigation and drinking water, hydropower and biodiversity, irrigation and biodiversity, etc.

The government lacks the financial and human resources to adequately respond to environmental management. Given Nepal's terrain and the problem of accessibility to various parts of the country, the government will not be able to respond to environmental management nor enforce environmental regulations unless it supports the role and contribution of community practices in environmental management. Rather than the government dissipating its limited resources on a bureaucratic and legalistic system that cannot fulfill its mandate it should support and provide resources to indigenous systems of environmental management which will allow them to succeed (NPC/IUCN, 1991).

IV. A Case study of Environmental Implications of an Irrigation Project

The East Rapti Irrigation Project (ERIP) presents an example of a case in which environmental consequences were ignored by both the donor agency and the government in the initial project formulation. However, issues raised by both national and international agencies about the possible adverse effects of this project on the environment led to reformulation of the project with due consideration of the environmental effects.

In 1987 His Majesty's Government of Nepal (HMGN) and the Asian Development Bank (ADB) agreed to implement ERIP with the objective of increasing agricultural productivity, enhancing rural incomes and accelerating rural development. The main component of the project was to construct a diversion weir across the Rapti river to provide irrigation and drainage facilities to 9,500 ha of land.

But during the detailed project design, several local and international environmental groups raised serious concerns about the severe negative environmental impacts that the project could have on the Royal Chitwan National Park (RCNP) located adjacent to the project area along the Rapti river. These groups included the King Mahendra Trust for Nature Conservation, the International Union for Conservation of Nature (IUCN), the Asian Wetland Bureau and the World Wildlife Fund. Eventually, HMGN and ADB agreed in 1990 to undertake a full fledged Environmental Impact Assessment (EIA). The EIA prepared by ADB consultants in 1990 suggested various mitigating measures. However, several issues remained questioned by HMGN, ADB and various NGOs as to the adverse environmental impacts. These issues included: (i) whether increased irrigation activities will adversely affect water flows and water tables, (ii) the potential negative impact of increased fertilizer and pesticide use expected to be induced by the project, and (iii) whether it would be possible to adjust the operations of the irrigation system in a timely manner to ensure that adequate water flow would be released to the RCNP area. A more recent independent study conducted by a well known environmental specialist, Dr. Lee Talbot in 1991 confirmed that the construction of the diversion weir would most likely cause significant adverse environmental impact on the RCNP and wild life in the Rapti river.

Following these developments, HMGN and ADB agreed in 1991 to reformulate the project. The redesigned project excludes the construction of the controversial diversion weir and the scope of

⁴ This park was designated as a World Heritage Site by UNESCO in 1984 in recognition of the uniqueness of the area. It is one of the last remaining habitats of the one horned rhinoceros, the Bengal tiger and various plant species.

the project has been scaled down to minimize the potential environmental threats. The main components of the reformulated project include rehabilitation of about 86 existing farmer managed irrigation systems to strengthen irrigation facilities in about 5200 ha, construction of about 10 kilometers of river training works, and plantation of fast growing multipurpose trees on the right bank of the Rapti river for river bank stabilization.

V. POLICY AND RESEARCH RECOMMENDATIONS

One of the stated goals of the government is to meet the basic needs of the people and to improve the quality of life. A prerequisite for this will be a rapid increase in agricultural production, which can only be achieved through sustained irrigation development. For this, it is essential that environmental protection aspect is incorporated in the irrigation development process. A number of measures can be taken to achieve compatibility between irrigation development and environmental protection.

Design and construction improvements to protect environment: Experience has shown that agency managed hill irrigation systems do not consider design factors which help meet the ecological needs of hill farming community. This is in part due to inadequate knowledge and experience in hill irrigation of agency technicians who are mainly oriented in plain irrigation. In addition, agency officials do not adequately take into consideration local materials, skills and techniques in designing and implementing irrigation schemes. In order to minimize negative environmental effects in hill irrigation schemes, appropriate conservation and construction measures should be taken by making use of local materials and skills as far as possible. These include revegetation on denuded slopes, inclusion of flow controls and sediment exclusion structures; proper dimensioning of canal cross-sections in relation to longitudinal gradient; providing proper landslide crossings through pipes or covered channels; improvement of cross drainage and gully crossings with flumes, syphons, etc.; provision of safe escape spillways to discharge run-off inflow from the system.

Appropriate cropping patterns: The focus of irrigation development in the hills has been on supplemental irrigation of the paddy crop. On many rice soils in the hills, irrigation duty is very high, often exceeding 5 liters per second per hectare (Carson, 1992). In pervious irrigated soils excessive soluble nutrients including nitrates and potassium are lost through deep leaching. A feasible way to reduce consumption of water is to irrigate crops other than rice on coarse-textured soils.

New irrigation technologies: In the hills much of the land suitable for rice has already been irrigated. Therefore, attention should be paid to alternative techniques of irrigation which might be suitable for high-value crops like vegetables, and fruits.

Sprinkler irrigation for vegetable crops and lift irrigation for nonrice crops have been successfully tried by the Agricultural Development Bank in several hill locations. These technologies should be expanded in other areas.

Optimal Use of Groundwater schemes: Uncoordinated and uncontrolled expansion of groundwater schemes in the Tarai has resulted in the problem of aquifer depletion in many areas. This calls for close coordination among agencies involved in the development of groundwater resources including the Department of Irrigation, the Groundwater Resources Development Board (GWRDB), the Agricultural Development Bank of Nepal (ADBN). The ADBN, which is the major agency for implementing shallow tubewell program, should devise and implement a policy of maintaining minimum well spacings and maximum well densities. Likewise, the GWRDB should implement a program for monitoring groundwater levels and the densities of shallow tubewells.

Environmental Impact Assessment: In view of the closing of the land frontier in Nepal, the increase in food production to feed the growing population will have to come from productivity increases. Irrigation development will continue to remain the main avenue for this growth. The goal of the government to increase food production through irrigation development and subsequent adoption of new agricultural technology has to be compatible with its attempt to maintain environmental balance. In order to achieve this, all new irrigation projects should incorporate environmental impact assessment during project preparation and design stages.

The National Planning Commission, in collaboration with the World Conservation Union (IUCN) has prepared National EIA Guidelines with the objective of ensuring that environmental considerations are reflected in the administrative decision-making process for project authorization (NPC/IUCN 1992). These guidelines have listed small scale irrigation schemes in Schedule-1, which implies that these schemes are likely to have significant but easily identifiable adverse impacts on the environment. Mitigation measures can be readily prescribed for these impacts and these schemes require an initial environmental examination report. Medium and large scale irrigation schemes have been included in Schedule-2 and these are likely to have significant adverse impacts on the environment so require an environmental impact assessment report.

In Nepal, where development is largely project-led, EIA can be an effective means of combining the aims of conservation and development. The Eighth Plan of Nepal has recognized this and it requires that development projects be adequately assessed on environmental grounds before their implementation. The challenge is to implement this policy effectively.

New Uses of Irrigation: Since the expansion of irrigation in the hills and mountains for growing cereal crops particularly rice

is becoming less and less feasible, the possibility of profitably using irrigation water for other commodities should be explored. For example, pastures are limited in high altitude areas and it may be possible to improve these by irrigation from glacial streams. Likewise, the possibility of improving low quality forests along the hill slopes with the use of sprinkler irrigation should be investigated. These developments will contribute to increasing livestock production and will also help in environmental protection.

Appropriate soil fertility management: There should be a promotion of appropriate soil fertility management practices that emphasize optimum utilization of locally available biomass resources, improvement of productive capacity of soils, and a reduced dependence on external inputs. Thus agricultural development and pest management programs should be fully integrated with considerations for environmentally compatible farming practices with an objective of sustaining productivity and farm income.

Conservation Strategy Suggestions: The NCS report (1988) had proposed several studies, which still remain valid, concerning the long term viability of irrigation schemes (in the context of increasing agricultural productivity so as to meet the needs of the rising population). Some of these are:

- * groundwater surveys with respect to potential capacity; determination of acceptable rates of depletion, including the optimal density of tubewells for different areas; and the design of a country wide-monitoring system
- * the impact of irrigation and specific crop rotation on soil nutrients and the formulation of improved irrigation and cropping practices to reduce depletion of such nutrients
- * the impact on soils within the irrigation project areas, of clearing forest land, the downstream impact of such projects in terms of siltation and water availability; and the recommendation of measures that would minimize detrimental environmental effects
- * the erosion and siltation processes occurring in irrigation canals and recommendations for new designs and operating procedures to reduce such occurrences.

VI. CONCLUSIONS

In terms of institutions or institutional arrangements that can adequately respond to the challenges of environmental management and enforcement, the governmental and local systems of

environmental management should be brought together in a cooperative and supportive framework. The report by NPC/IUCN (1991:1) notes the following scenario if there were to be a divided effort, i.e., the two systems acting separately or against each other:

"To understand the basis of the divided effort, it is necessary to consider a number of circumstances. First, the spread of market economic relations and the introduction of new governmental policy processes in the pursuit of economic and political modernization can often result in the fragmentation of traditional communities with the responsibilities for decision making being taken away from individuals and groups. In Nepal, the tradition of community self regulation has been increasingly replaced by governmental control through new laws and central institutions. In environmental affairs, government has largely sought to supersede local environmental systems with its own legal and administrative processes. Communities have increasingly been denied effective participation in decision making processes."

In the last few years, the government has been pursuing decentralization and alternative forms of governance (much propelled by the advent of multiparty system and the cumulative fiscal and credibility crises of the government). The operationalization of this concept of governance is being worked through various experimentation as policy reformulations.

To an extent, the above mentioned trend of government supplanting local initiatives has been influenced by conventional and stereotyped notions of the contributing role of local land users to the "Himalayan ecological crisis". The report notes that this perception has in fact misguided the direction of legal and institutional reforms in Nepal because such conventional analyses have pointed to the farmer, herder, fuel collector as other local people as the primary sources of increased deforestation, soil erosion, and general environmental decline. Such analyses claim that local people are ignorant of the destructive nature of their actions, conservative so do not adapt to changing circumstances, and focus on short term goals of maximizing their immediate returns regardless of the long term environmental cost due to their acute poverty.

Recent studies have shown otherwise. These studies point to the role of the natural causes in environmental disturbances (Ives and Messerli, 1989); the role of the wider political economy and class relations (Seddon, 1983); and the need to accept subsistence farmers or local land users as part of the solution given their traditions in local resource management (Thompson, et. al 1986).

Although traditional social systems can be highly successful in regulating and managing community use of local natural resources

such as forests, land and water, they are seldom able to take into account or regulate the broader regional ecological interactions of which they are an integral part. It is in this sphere that the integration and cooperation of the two systems, informal/local and the legal-administrative, and customary and formal-legal processes needed.

In sum, environmental sustainability in irrigation development can be achieved if appropriate technology is used, proper planning of the consumptive use of surface and groundwater, a shift away from rice-bias both in cropping pattern and meal pattern, control of natural resource management in the hands of the stakeholders and genuine users, and a sound environmental policy that takes into account the fundamental problems of ecological problems, coordination between different sectors, and sustainable development that improves the quality of human life within the carrying capacity of supporting ecosystems.

For irrigation development as in any other natural resource management in Nepal, existing participatory approaches to community management should be integrated into a new framework for environmental planning, management, and assessment. Support should be provided to indigenous management systems. This framework would integrate both the decentralized, community based approaches to environmental management as well as the formal, governmental legal and administrative processes. Both alone would be inadequate to address the country's current environmental problems. The formal legal processes would have to take the social reality into considerations and a legal anthropology perspective might help.

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