BUILDING ON TRADITION: INDIGENOUS IRRIGATION AND SUSTAINABLE DEVELOPMENT IN ASIA[1]

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I. THE IMPORTANCE OF INDIGENOUS IRRIGATION

For as long as there have been farmers -- about seven or eight millenia, according to current archaeological thinking – those farmers have been tampering with the landscape, trying to improve growing conditions for their crops. The most fundamental condition that farmers have always been concerned about is water: all plants need it to grow, and some plants, such as rice, need a lot of it. Certain regions (e.g., deserts) impose more severe moisture constraints than other regions, such as rainforests. But in nearly all regions of the world, even the tropical zones of Southeast Asia, agricultural production can be improved through irrigation in certain seasons, and for certain crops.

The obvious benefits of irrigation provided the incentive for investing labor and capital in building structures that could convey water to the fields where and when it was needed. The early civilizations of Mesopotamia, Egypt, and China were founded, in part, upon the organizational requirements of harnessing large river systems for agricultural production, and the basic relationships between water and crop production are as true today as they were then.

The vast irrigation works constructed millenia ago have mostly disappeared under the dust of time, but one of the characteristics of irrigation systems is that they are surprisingly durable. Investments made hundreds of years ago can be almost as good as new, if properly maintained. Canal networks and stone terraces constructed by the Inca, for example, continue to be used by contemporary Peruvian farmers. Vast irrigated terrace systems, primarily for rice cultivation, are found throughout the mountainous parts of Asia and represent many centuries of labor. These terraces were build quite literally through a "step by step" process -- by which each succeeding generation inherits the fruits of all previous generations.

The dramatic terrace systems, which have become a tourist attraction in the Ifuego region of the Philippines, are only the tip of what we can call the irrigation "iceburg". Underneath the surface, so to speak, is an indigenous tradition of irrigated agriculture that contains the technical and managerial expertise to keep the physical infrastructure functioning and the crops growing. More to the point, indigenous systems of irrigated agriculture represent sustainable solutions to the demands of intensive crop production. This is the good news: indigenous irrigation systems as a group represent successful adaptations to local environments. They have proven themselves over the course of centuries to be environmentally sustainable, productively viable, and (not least) politically manageable.

But today the sustainability of indigenous irrigation systems is being severely threatened, not by natural forces, but by the outside government sponsored intervention known glibly as agricultural development. The same indigenous irrigation systems that are so nicely adapted to the local environment have become a favorite target of development planners. The fact that indigenous, traditional systems are using technology that has worked fine for centuries is seen from a development perspective as the use. of technology that is centuries out of date. Earthen channels will convey water, but not as efficiently as concrete. Mud can be used to block the water flow into one channel and divert it into another channel, but steel gates, preferably with built-in flow meters, are a more modern solution.

Should indigenous irrigation systems be "improved"? Development interventions have too often made matters worse for the local farming communities, while lining the pockets of the construction contractors. But many indigenous irrigation systems could be more productive. Not only physical and agronomic improvements but training and extension could result in a more efficient use of water, more area irrigated, and more food for an ever growing population. This paper explores the delicate process of "building on tradition" in ways that can enhance the sustainability of indigenous irrigation systems and the natural environments of which they are an integral part.

Background

The term "indigenous irrigation" has not been standardized in the literature, but for our purposes a working definition is the following:

> (1) the physical structures of water capturing devices (diversion weirs, dams, or wells), conveyance devices (canals, aquaducts, tunnels, flumes), and control structures (gates, outlets, dividers) by which water is delivered to agricultural fields, and (2) the management arrangements for designing, constructing and maintaining the physical works, allocating and distributing water among the users, resolving disputes, and addressing emergencies or other unforseen circumstances.

Indigenous irrigation systems are typically controlled by a village community, but there are many important exceptions. Some villages may be served by several irrigation systems owned by groups within the village, or cross-cutting village boundaries. Large systems can also be found that serve tens of villages or scattered hamlets along the way. The land area served by indigenous systems may vary from a few hectares to several housand hectares, but the vast majority of indigenous systems are in the range of 10 to 100 hectares. [As a rule of thumb for Asian rice-based irrigation systems, a single family is likely to cultivate between 1/2 and 1 hectare.]

<u>History and Extent of Indigenous Irrigation.</u> The distinction between indigenous irrigation systems and modern[2] systems is a relatively recent one. Until the advent of large-scale irrigation projects financed by national, generally colonial, governments in the late 1800S and early 1900S, the concept of "indigenous" irrigation was not necessary; it was simply "irrigation." There were small systems, as are still found in many remote hilly regions around the world, and there were large systems in flat river valleys, constructed by local rulers, or in some cases by ancient empires. While the remnants of large-scale indigenous canal networks have since been replaced or absorbed by modern government-built systems, a few are still in use. In Morocco, for example, a 12,000 ha canal network along the Tessahout River near Marrakech is still in use, some 300 years after its construction by local rulers. But even this artifact from another era is about to be incorporated into a state-of-the-art irrigation system controlled by a national government agency. We will return to the example of the Tessahout irrigation system later in this paper as a lesson in blending the old with the new in a successful production system that takes advantage of indigenous farming knowledge and social institutions.

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[2] By "modern" irrigation I am referring to all non-indigenous irrigation systems. Modern irrigation in this sense includes the large British colonial canal networks of Pakistan and NW India that are anything but modern, yet neither are they indigenous. Indeed, the "modernization" of the colonial era irrigation systems has been a high priority of agricultural development in those countries.

Most of the world's indigenous irrigation systems, as well as the majority of the world's modern systems, are found in Asia, which has slightly more than three fourths of the world's total irrigated area. The proportion of total area irrigated by indigenous systems has not been systematically compiled, so far as I know, but the figures are known for several key countries. In Nepal, for example, 75% of the country's irrigated area is served by indigenous systems. In the Philippines the figure is about 50%; in Sri Lanka, the figure is just under 40% (and declining as the area under large state-run schemes increases). In other countries, the figures are much lower, but still important. One estimate given for India is that only 4% of the country's irrigated area is comprised of indigenous irrigation. Yet in a country with more some 70 million hecatres irrigated, even 4% under indigenous irrigation would exceed the total irrigated area of most countries.

The exact figures are often in dispute because of confusion as to whether a system is really" indigenous". Many indigenous irrigation networks have been added onto or upgraded by government irrigation departments, and now come under the management control of that agency. The general trend is that not only is the relative proportion of indigenous area declining, as modern systems are constructed, but the absolute area of indigenous irrigation is decreasing as the systems are absorbed into new large-scale systems, or simply added to the portfolio of government agencies.

A related but more fundamental issue in conducting an inventory of indigenous irrigation is lack of agreement on what constitutes an irrigation system in the first place. In the Indian state of utter Pradesh, for example, the Irrigation Department does not include indigenous irrigation in its state-wide statistics for irrigated area. The reason is that the Department (though not the farmers) considers indigenous systems unreliable due to their "crude" construction methods of boulder diversion weirs diverting water into earthen canals and thence to farmers' fields. One of the biggest obstacles to introducing sustainable improvements to the indigenous irrigation sector is that government irrigation agencies have formed stereotyped assumptions about the nature of traditional irrigation systems.

Indigenous Irrigation and Environmental Sustainability.

As ecological adaptations with a proven record of sustainability, indigenous irrigation systems have much to offer the current debate about eco-development and trade-offs between environmental stability and economic productivity. The need for the outside world to learn these lessons becomes all the more urgent when the geographical context of the remaining indigenous irrigation systems is considered. The systems located in low-lying valleys of prime agricultural land have for the most part been absorbed long ago into large state-owned irrigation systems. The indigenous irrigation systems that are still intact are found in more remote regions where the long arm of the state has not yet penetrated. For the same reason, these areas also tend to be in the location of relatively pristine natural ecosystems and the habitat for endangered species.

The importance of indigenous irrigation systems to the outside world derives both from the lessons they offer about sustainable development, and the opportunities they offer for sustainable conservation of critical ecosystems. While the two aspects are closely inter-related, they are discussed separately in this section as two sets of "arguments".

The Conservation Argument. Indigenous irrigation systems are often found at the upper edges of watersheds, forming a buffer between government forest land above and agricultural lands below. In a typical Asian situation, for example, a river valley where indigenous irrigation systems were once common is now the site of a large-scale government irrigation scheme. If we continue upstream and turn up a tributary valley, we are likely to come upon indigenous irrigation systems that take water through rock and brush diversion weirs along the small river and channel the water 1 or 2 kms into their terraced fields. If we go upstream still further, we come upon forested land that is protected by the government forest department. Along the lower slopes of the forest we can see agricultural fields that are probably illegal, or some type of use right may have been obtained from the Forest Department. But these fields soon give way to fairly dense forest as we move uphill. Upon inquiry of local farmers, we find that the forest used to extend quite a bit further down slope, but each year the agricultural fields creep upwards, and if possible, an irrigation canal will be dug to provide irrigation water. This type of expansion has become more difficult since the Forest Department has begun enforcing land use regulations, but population pressure is so high that farmers will use the forest in whatever way they can. This may mean cutting trees at night, or bribing the forest guard and clearing a small patch of land for a seasonal crop.

This hypothetical example contains many of the elements that are resulting in loss of natural habitat around the world, and consequent loss of local biodiversity, and any locally endemic species. The trends are familiar to all of us: an expanding human population putting ever increasing pressure on the natural ecosystem. The classic development solution is to introduce new infrastructure, such as a large modern irrigation system to replace the indigenous ones, in the hope that this will raise agricultural productivity enough to meet the growing population pressure.

When applied to indigenous irrigation systems, the classic approach of irrigation development -- replacing indigenous systems with new infrastructure -- misses the opportunities for dealing with the biological resources surrounding the irrigation system. Irrigation is one part of a larger farming system that may include rainfed cultivation, fruit trees and other agroforestry crops, and livestock. And that farming system is one part of a larger watershed system that includes forests, pasture, streams, animals, and plants.

The objective of irrigation development in such a context needs to be broader than irrigation, and address the larger issue of resource use that is environmentally sustainable. As the most intensive production system in the watershed, irrigation systems have a special potential for spearheading local resource development. Irrigated agriculture can be highly productive, which is why farmers are willing to invest massive amounts of labor, and even capital, into their construction and upkeep. At the same time, irrigation structures such as dams, diversion weirs, and canals, are especially vulnerable to the flash floods and erosion that deforestation provokes.

Development assistance to indigenous irrigation systems can utilize these natural linkages in a whole-basin approach to resource conservation and development. Both through project design and education programs, irrigated farmers can become stewards of their watershed's plant, animal, and water resources. This is not an impossible dream, but it requires a systems perspective instead of a uni-sector perspective of "irrigation" or "agriculture", and it requires that some value be placed on the natural resources that would be conserved.

<u>The Development Argument</u>. While indigenous irrigation systems can provide an entry point into sustainable resource use at the watershed level, the indigenous systems also have an overlooked productivity potential in their own right. In many cases, replacing the indigenous infrastructure with more modern items -- concrete lined canals, iron gates to control water flow, etc. -- has little effect on agricultural yields, and may actually do damage to the indigenous management arrangements that make the system operate. The argument here can be summarized by the proverb, "If it ain't broke,

don't fix it!" And the corollary, for indigenous systems that are clearly operating at sub-optimal levels, is that outside development assistance should be based on a thorough understanding of the technical and managerial context.

The management of indigenous irrigation systems require cooperation of all the users, who typically comprise a village or a major portion of a village. The physical infrastructure combined with the indigenous management system can be viewed as a type of natural resource within the context of the watershed. The indigenous irrigation "resources" of a particular region need to be inventoried, and managed, as any other natural resource. The difference from other natural resources, however, is that indigenous irrigation systems are already being managed by the farmers who built and operated them. The role of the outside world -- whether local governments or foreign aid agencies, should be to offer support to those farmer managers, but not to replace them with bureaucrats. Similarly, the approach to the physical infrastructure should be to offer improvements if the farmer managers are interested and are willing to pay something for those improvements. But offering free gifts of modern equipment that is non-essential to the real work of the system is materially wasteful, and can be managerially disruptive as well.

At a higher level of national policy, the indigenous irrigation sector can be viewed as a national resource that contains the accumulated labor and engineering skills of many centuries. One does not have to advocate ancestor worship to suggest that a resource of this magnitude should not be ignored. One only needs to view that resource from an economic and environmental perspective to begin to appreciate the potential of the indigenous irrigation legacy for meeting future development goals.

II. INDIGENOUS IRRIGATION IN ECOLOGICAL CONTEXT

In this section we discuss the environment of which indigenous irrigation systems are a part. That environment can be divided into the "human" environment that covers economic/commercial and political dimensions, and the natural environment within which indigenous irrigation systems operate. In the second part of the chapter we explore the scientific knowledge base of indigenous irrigation systems, by which they fit into the larger human and natural ecologies of the broader environment.

The Environment: Human and Natural Dimensions

The environmental context of indigenous irrigation systems includes the man-made environment of off-farm employment opportunities, educational services, governmental policies, and commercial influences as well as the natural environment of the catchment or watershed and the soil, water, plant, and animal resources within it.

The Human Dimension. The impressive features of some irrigation systems and their terraced benches down steep hillsides, should not blind us to the fact that these same farmers also engage in other activities in addition to irrigation such as upland farming, herding, timber, fishing, and other on- or off-farm work. Furthermore, these farmers (or in many cases, non-farmers) are affected to some degree by political decisions taken in the capitol city, and in international board rooms, where foreign assistance policies or commodity support prices are determined. For purposes of our present discussion, however, we will confine ourselves to the national-level and local influences that affect the fate of, indigenous irrigation systems.

Government programs, often financed with international assistance from bi-lateral or multi-lateral agencies, offer to upgrade the physical structures of indigenous systems as a means of increasing national agricultural output. But from the farmers' point of view, material improvements to their technically rudimentary irrigation system might not be the first priority; they might be more interested in , an access road, a clinic, a school, forest access for fuel wood, or some other improvement to their current material situation.

Understanding how farmers, as well as non-farming local residents, view their economic priorities and their set of local resources is a critical part of development planning. Yet in the rush to meet externally-defined project goals, there is seldom time for understanding. Instead, blueprint development packages drawn up by hurried consultants meeting deadlines imposed by harried government or aid agency officials impose on local residents solutions to problems they may not have. The result is too often unsustainable and wasteful of scarce finances. By first understanding how farmers view their economic environment: how they use the irrigation system, and what else they do besides irrigated farming, and what their vision of a better life might be, a different set of development priorities begins to emerge.

The Natural Dimension. The watershed that collects the water which indigenous irrigation systems make use of provides a natural boundary for considering the local environment of indigenous irrigation systems.[3] Sustainable development downstream is linked to the environmental sustainability of the natural resources upstream. Deforestation or overgrazing upstream, for example, can put irrigated agriculture in jeapardy through soil erosion and diminished wateravailability.[4]5 More importantly, the high productivity of intensive irrigated agriculture can relieve land pressure within the watershed, and thereby help protect fragile soil zones and critical ecosystems from unsustainable resource exploitation.

The natural context of indigenous irrigation systems is no more static than is the human context. Although there is a clear trend that indigenous systems are absorbed into, or replaced by, modern irrigation systems constructed by government agencies, there is also a continual process of new indigenous systems being built in response to increasing land pressures. Following the dynamics of supply and demand, as land pressure in the upper watershed increases, more farmers are willing to invest their labor into construction of small irrigation systems to capture the water that would otherwise flow downstream to another community's irrigation system.[5]

The Knowledge Base of Indigenous Irrigation Systems

The management of watershed resources in an environmentally sustainable manner is not a new concept to most indigenous communities. Many of the watersheds where indigenous irrigation systems are found have been occupied for centuries, and in some cases millenia, without major environmental damage. The local strategies for using but conserving the soil, water, forest, and wildlife resources comprise the "software" portion of the indigenous irrigation legacy. Some of that knowledge has been lost; much has been superceded by contemporary events (e.g., traditional institutions of local leadership may run counter to state administrative structures), but elements of "the old ways" can usually be identified, rescued and put to new use. In northern Thailand, for example, an annual ritual involved representatives of each downstream community who met at the headwaters of the river, that was their common source of irrigation water. The ritual provided an opportunity to discuss inter-community irrigation needs, and avoid possible conflict. Today, a twice annual meeting of the same representatives is an important part of a new watershed management plan, which takes its social and political legitimacy from this traditional ritual.

Western-trained engineers, as well as national government officers trained through Western-derived curricula) tend to equate rudimentary building materials with lack of technical knowledge.[6] An earthen irrigation channel winding its way along a hillside, for example, is judged as an indicator of poor technical abilities in construction, and in irrigation management generally. A clay sluice gate in a locally constructed reservoir dam is seen as a quaint artifact of a bygone era, but in need of a modern iron replacement that can be padlocked closed. What is not readily seen, but which is of critical importance for sustainable development, is the knowledge underlying the material evidence:

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[3] In some situations, for example where an irrigation system taps water from a major river, a localized portion of the total watershed might be a more useful framework for understanding the human-natural dynamics.

[4] The links between deforestation and water table levels within a watershed are not clear-cut; in many cases, deforestation can actually increase water levels and total water harvest (Hamilton and King 1983). From a purely irrigation perspective, the greater danger of deforestation lies in the often associated soil erosion than in cutting per se. However, there are many other reasons for conserving forests than their water retention function.

[5] Depending upon, the local hydrology, much of the water used in upstream irrigation will still wind up in an irrigation system further downstream. Water can be reused many times, although some water is invariably lost along the way; irrigation subjects the water to greater evaporation, and the crops also take a share (which is the purpose of the exercise).

[6] The author offers apologies to the many Western-trained engineers and national government officers who do not fall into this stereotype, and who have a technical, as well as cultural appreciation of indigenous irrigation. These enlightened engineers are unfortunately still the exception, rather than the rule.

the software that drives the hardware.

Indigenous knowledge, however, is not only social software; it includes engineering knowledge that often only other engineers can appreciate, and understandings of crop-water-soil-pest relationships that only agronomists can fully appreciate. There are many potential categories of knowledge that pertain to indigenous irrigation. The three considered here are (1) engineering, (2) managerial, and (3) socio-cultural:

(1) The Engineering Knowledge of Indigenous Irrigation. Indigenous irrigation systems reflect time-tested tradeoffs between technical efficiency and opportunity costs of technical improvements. Even from a purely technical standpoint, the effectiveness of indigenous irrigation is often impressive. A study of irrigation system performance in an indigenous canal system in Nepal, for example, showed actual flows to secondary canals to vary less than 6% from planned flows (Martin and Yoder 1989).

Engineering features such as river diversion weirs, intake canals, structures to control the flow within the canal, tunnels through high ground, elevated channels, and division structures to divide the flow in fixed proportions are evidence of sophisticated technical knowledge. Less obvious but equally challenging engineering features include the degree of slope, the alignment and layout of canals, and the precise designs of structures which may appear ad hoc but contain particular design principles (e.g., the angle, depth, and construction materials used in a river diversion weir).

(2) Management Knowledge of Indigenous Irrigation. The cooperative effort required by irrigation implies complex management functions that indigenous societies have solved in various ways. The management problems that need to be addressed, however, are universal, determined by the physical properties of water and the physical structures to transport it. These universal management functions include planning and design of the system, construction, operation, and maintenance. In all these processes, labor must be mobilized, decisions have to be made, allocation rules need to be agreed upon, and inevitably disputes need to be resolved. The solutions to these universal problems, however, are unique to each indigenous system, depending upon the particular social and cultural traditions, the particular physical setting, and the particular individuals concerned. And clearly some solutions are better than others; it is easy to find poorly managed indigenous irrigation systems. But the very existence of an irrigation system is testimony to management functions that have been at least partially addressed.

The management roles in indigenous systems often involve traditional social institutions, such as the water master (vel vidane) in Sri Lanka who enjoys customary rights to a share of the harvest in return for fulfilling his duties in distributing water to the users and tending to system maintenance. The role of water guards (chowkidar) in mountain irrigation systems of northern Pakistan has also been institutionalized in the society, although not as rigidly as in the Sri Lankan case. In other cases, individual management roles may grow up around an unusually strong leader or a special set of circumstances. As contact with government agencies grows, local leadership often revolves around local residents who hold government positions and so command a hybrid authority.

In parts of Uttar Pradesh state in northern India indigenous irrigation management has taken a commercial bent. Local entrepreneurs earn their livelihood by contracting with groups of farmers to construct a small irrigation systems and maintain it for a set period (usually 7 to 10 years) in exchange for a share of the crop (normally around 10%). Recent development activities by the government have now rendered the contractor redundant, since the government does not charge for its improvements. Yet the government does not lavish the same attention on the farmers that the contractor had, and the sustainability of the government interventions is in doubt.

The most frequently needed management function in indigenous irrigation systems is labor mobilization. Particularly where streams are prone to flooding, the intake weirs that feed the main canal may need repairs five or even ten times during the cultivation season. Canal cleaning, repairs to earthen dams or sluice gates (in the traditional reservoir systems of Sri Lanka, for example) are also recurrent duties. But as any community development specialist knows only too well, mobilizing free labor is not a simple matter. Nor is it a discrete activity. For the farmers who contribute their labor in the construction and maintenance of their irrigation systems, their involvement is part of their community life and fits in with a complex set of economic, social, and often kinship relationships linking them with their fellow farmers and with the leaders who are managing the irrigation system.

(3) Social and Cultural Knowledge of Indigenous Irrigation. Management knowledge is interwoven with social and cultural values that give rise to particular forms of management. Nowhere are these interactions more evident that on the Indonesian island of Bali, where religious authorities oversee irrigation scheduling as part of their traditional roles. A recent foreign-assisted development project to "improve" the indigenous systems and change the water scheduling to meet the needs of new rice varieties threatened to disrupt a finely tuned religio-economic system. The danger was not only cultural, but economic; research into the cropping patterns over the past several hundred years has demonstrated the productive benefits of the schedules that were followed in minimizing insect damage and maximizing total yields over the long-term.[7]

While the particular circumstances of Bali's irrigation network and religious hierarchy are unique, the linkage between socio-cultural beliefs and traditions and the "workaday" realities of irrigated agriculture is probably universal. The tradition of community labor (shrmadana) in Sri Lanka carries religious overtones of service and duty. In northern Thailand, the annual mobilization of labor to repair the diversion weir across the river and clean the canal is celebrated as a religious and community festival involving homage to the deity of the weir, and a communal feast.[8] In the Hill region of Nepal, as in the India case mentioned above, indigenous irrigation systems are constructed through private investment. In the Nepal case, there are usually a number of shareholders who take the risk of constructing a canal, and then own proportional shares of the water, which they can buy and sell. Though not a religious tradition, it is based on social roles unique to that society. The irrigation expertise is provided by traditional specialists on whose skill the success of the enterprise depends.

The Ecological Significance of Indigenous Irrigation Knowledge

The knowledge reflected in the physical features of indigenous irrigation systems and in their management software is the product of a centuries-long learning process by which the irrigated

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[7] The research was conducted by an anthropologist (Stephen Lansing) and a team of computer specialists who devised a computer simulation model comparing historical cropping patterns with those proposed by the development project. The complex arrangement of religion and irrigation is discussed in Lansing (1990).

[8] This tradition continues in Thailand, in spite of the fact that the Royal Irrigation Department has recently replaced the indigenous weirs made of bamboo, rocks, and mud, with a concrete weir that no longer requires frequent maintenance. The canals, however, still need to be cleaned.

farmers have come to terms with their environment. We cannot say that indigenous irrigated agriculture is necessarily sustainable into the indefinite future; each case has to be judged on its own merits. But we can learn a great deal about the elements of sustainable production systems by looking at the indigenous irrigation sector as a knowledge resource.

Unfortunately, indigenous irrigation systems are not easily transposed into terms that are immediately transferable to the design of new systems. Indigenous systems are a product of the indigenous society of which they are a part, just as modern irrigation systems are basically reflections of Western society. While we tend to divide management functions into clearly defined roles such as "maintenance" which requires "labor mobilization" the indigenous categories are different. Is a Sri Lankan Buddhist farmer cleaning the canal or acquiring merit through community service?

When indigenous irrigation systems are absorbed into the management jurisdiction of a government agency (a process that we will examine in the next section), there is a danger that the socio-cultural context within which farmers manage their irrigation system may begin to crumble. Farmers often ask for improvements to their canal, but not a secularization of their entire life. The environmental implications of this process stem from the separation of the individual from the socio-cultural dynamic within which he traditionally viewed his use of natural resources. Once the forest, wildlife, and water are seen as the property of a faceless agency far beyond the community, there is little incentive to respect those resources.

We will return to this issue in the next section. We will see that it is not a question of keeping the government out of local life; rather, the challenge is for government to provide assistance to local communities in ways that enhance both agricultural productivity and local responsibility for natural resource management.

III. OVERVIEW OF ASSISTANCE EFFORTS

Government efforts to assist the indigenous irrigation sector pre-date the post-World Water II development thrust. Indeed, the earliest cases of such assistance may be found in the early civilizations of Mesopotamia, India, and China in the third millenium B.C. According to some political historians, those early government interventions in irrigation, which led to large-scale construction of dams and canals, sparked the highly centralized bureaucracies that put these civilizations firmly on the historical map (cf. Wittfogel 1957]. It is probably not an overstatement to claim that every major civilization outside northern Europe was based -- not exclusively, but importantly, on the economic benefits provided by irrigation.

The links between irrigation development and governmental stability were not lost on colonial administrations, particularly in Asia, where extensive irrigaton works were constructed by the British (India, Ceylon, Burma), Dutch (Indonesia) and the French (Indochina). Indigenous irrigation systems were in some cases absorbed into these larger works. In other cases, the colonial administrations made special efforts to provide material assistance to indigenous systems through upgrading the existing dams, diversion weirs, or canals that comprised the primary infrastructure. Legal oversight of water rights was also an important function to settle upstream/downstream disputes. Along with these administrative benefits came tax obligations, which were rarely enforced effectively, but pointed to the concept of a mutual obligation between the users of indigenous irrigation systems and the government.

In the recent era of post-war development efforts, not only by the newly independent governments, but by the. international bilateral and multilateral aid agencies (the West's follow-on to direct colonial rule), the irrigation sector received unprecedented attention. The fact that nearly every Third World country's economy was dominated by agriculture, and the fact that irrigated agriculture held tremendous promise for yield increases, motivated national planners and international donors to invest in irrigation. Most of the investments went not to upgrade indigenous irrigation systems, but to construct completely new large-scale projects managed directly by government agencies. Yet inevitably the indigenous irrigation systems came under official scrutiny, for many of the reasons that obtained during the colonial era. Large-scale projects often displaced indigenous systems, but in many cases, the indigenous systems found in remote regions of a given country were, and are, specifically targeted as an entry point for spreading the benefits of modern irrigation and high input agriculture beyond the prime agricultural lowlands.

An initial assumption of many government agencies that deal with small-scale irrigation is that the agency concerned (either an agriculture or irrigation agency) needs to take over some of the management functions from farmers. New physical structures (control devices, lined channels) may be introduced, or the entire system may be supplanted by a new, larger system that replaces a number of smaller systems. Experience suggests that purely physical approaches to small-scale irrigation improvement do not work in the long term. By introducing new materials and technologies that are then serviced by an outside government agency, the local initiative that underlies the historical viability of indigenous systems is undermined. The results are not only economically disappointing, but environmentally damaging or (in some cases) disastrous.

Types of Assistance

Three basic types of irrigation management assistance can be distinguished: (1) financial, (2) technical, and/or (3) organizational. In addition, assistance projects often include agro-economic components such as enhanced agricultural extension, input availability, or market services, which are not considered here since they relate to the agricultural production system in general, and not only the irrigated component.

Financial assistance. In Sri Lanka, the government does not require any repaYment from farmers for the capital costs it incurs in rehabilitating traditional irrigation systems, or in constructing new systems. In most other countries there is a level of subsidy, but farmers must pay some portion of construction costs; for example, in the Philippines, the National Administration (NIA) requires repayment of roughly 50% of capital costs in indigenous irrigation assistance.

The level of government subsidy is an important issue, since farmers' willingness to pay a portion of the costs is closely linked to the sustainability of the improvements. In many Asian countries, the opposing forces of donor agencies (arguing for low subsidies) and local politicians (arguing for total subsidies) result in an unenforced requirement that farmers pay a moderate (e.g., 20%) part of capital costs.

Not only the level of financial assistance, but the form of farmers' contributions (e.g., labor, crops, cash, land), the rate of repaYment, and the organizational arrangements for mobilizing those repayments, comprise policy options to be considered. Choices about the form of repaYment can have important impacts on the rate of repayment, and on the long-term viability of the irrigation system itself. When farmers feel a sense of ownership in the system, they are more likely to keep up with routine maintenance tasks (as the presence of centuries-old traditional systems will attest).

Technical Assistance. The engineering models used by irrigation departments in designing small-scale systems are not the indigenous irrigation networks that have evolved over centuries, but rather large-scale structures that the engineers studied in Western universities. Their designs, not surprisingly, are scaled down versions of these text-book structures which are often dramatically inappropriate to the context of local management.

When concrete structures break, their repair requires cash, yet farmers seldom have an institutional structure capable of mobilizing any resource other than labor. Water control structures, built at considerable cost to the implementing agency may be deemed unnecessary or undesirable by farmers. In some "improved" systems in Sri Lanka, farmers have circumvented such structures with simple dirt channels, resulting in wasted government expenditure but no real cost to farmers (Abeyratne 1988).

Inappropriate technical assistance is not always benign; it can also be detrimental. In a case from uttar Pradesh, India, Irrigation Department "assistance" rebuilt a canal which had been built and maintained by farmers, implicitly replacing farmers' responsibility for canal maintenance. When the new brick and mortar canal broke soon after construction, farmers were unable to mobilize their own resources to rebuild it, and reverted to rainfed agriculture. The challenge of technical assistance is to design physical improvements which farmers want and are fully capable of managing and maintaining on their own.

Organizational Assistance. With the growing recognition among aid agencies that farmer participation is a necessary component of sustainable development, great emphasis has been devoted -- at the planning and design stages -- to introducing new organizations for particular management functions. In a necessarily communal activity such as the distribution of surface irrigation water, the organization of farmers into some sort of irrigation committees or associations would seem a logical approach.

Unfortunately, traditional social arrangements that farmers are familiar with are often ignored in the process, leading to even greater confusion after the "development assistance" than before. One of the many ironies of indigenous irrigation assistance is that technical assistance to systems having effective traditional institutions for water management (e.g., a water headman) often undermines that authority structure, leaving it weaker than before at the very time it is most needed.

In most programs to improve the indigenous irrigation sector, a combination of approaches is used. The relative emphasis given to one approach or another depends not only on what the needs are, but also on the underlying, implicit, development assumptions of the sponsoring agencies. Most frequently it is the engineering approach that is given precedence, reflecting that dominance of engineers in planning and implementing assistance programs. In other cases, an integrated approach is attempted, but the program is not effective because of poor management of the program itself (and the all too frequent political interference in project implementation). The following section presents case studies from four countries of projects that have tried to improve indigenous irrigation systems.

IV. CASE STUDIES OF ASSISTING INDIGENOUS IRRIGATION SYSTEMS

Two case studies are presented here as representing different approaches to improving indigenous irrigation systems in the Asian context.[9] In each case, an outside agency has initiated the which that the intended involved development, work beneficiaries would have been unable to undertake on their own. The two projects are the following:

- Anuradhapura Dry Zone Development Project (ADZAP) in sri Lanka;
- Aga Khan Rural support Programme in Pakistan (AKRSP); and

Case #1: ADZAP (Sri Lanka)

Irrigation has been at the core of Sri Lanka's economy and culture since at least the 3rd century B.C. The peculiar geographic setting of the country render irrigation necessary, and possible. The mountainous center of the tear-drop island catch rain-bearing clouds from both the Northwest and the Southeast, providing two monsoon seasons to much of the country, and distinct wet and dry seasons in the lower lying north central portion of the country.

In this so-called "Dry Zone" comprising the north central part of the country, the distinct wet and. dry seasons rendered irrigation necessary for the secure cultivation of rice, the culturally preferred staple food. Village-level irrigation systems consisted of earthen dams constructed across intermittent stream channels to collect runoff from the intensive monsoon rains, and a sluice gate through the dam to release water into irrigation channels conveying the water to farmers' fields.

The gently undulating landscape provided many locations where such reservoirs ("tanks" in local parlance) were feasible. Where the topography was very steep, and streams were perennial, the storage reservoir was replaced by a simple diversion structure in the stream bed, to convey water into the canal system. These local irrigation systems may serve just a few families, an entire village, or portions of several villages, and irrigate from 5 to 80 hectares. The number of families that depend on a single system varies considerably, depending upon population pressure and opportunities for rainfed farming, but average about two families per hectare of irrigated land.

These village based systems continue to play an important role in agriculture, comprising roughly 35% of the total irrigated area but accounting for only an estimated 20% of total agricultural output.[10] From the perspective of agricultural development as well as environmental conservation, it makes sense to raise the productivity of these many small systems before, and as an alternative to, carving out new agricultural lands from the country's few remaining forested lands.

A further attraction in developing the ancient village-based systems is the presence of several

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9 The author visited all both projects while assigned to the International Water Management Institute in Sri Lanka.

10 This figure has dropped from an estimated 40% just a few years ago, as the government's massive Mahaweli irrigation and power project has become operative in stages. The Mahaweli project has in many locations displaced village systems, while creating new irrigated area in previously forested land.

thousand village tanks that have been abandoned over a period of centuries, because of disease, changing rainfall patterns, civil unrest, or other reasons. Even a glance at a topographical map (where these tanks are well recorded) suggests the potential for rebuilding these abandoned tanks, and capitalizing on the labor investment of previous generations. The farmers who currently live is these areas subsist on rainfed agriculture that, due to increasing land pressure, has become more of a settled fallow system than the traditional (and more productive in terms of labor inputs) slash and burn technology. The fact that this cultivation is taking place illegally on government land nominally classified as "forest reserve" adds to the logic that planned development of the abandoned tank areas should receive high priority.

In 1981 the government launched the Anuradhapura Dry Zone Agriculture Project (ADZAP) to develop 600 abandoned tanks in Anuradhapura District (comprising much of the country's north central region), and settle the so-called "shifting cultivators" in the process. The project was funded by the International Fund for Agricultural Development (IFAD), and the Asian Development Bank (ADB). The basic objective of the project was to resettle families away from their land-extensive, low output, and illegal cultivation to the vicinity of the refurbished tanks where the government would provide 3-acre plots of unirrigated upland per family, plus one acre of irrigated land. In addition roads, health services, drinking water, agricultural extension, housing grants, and low-interest financing would be provided.

The government was seeking a compromise: Give up illegal cultivation on "forest reserve" and you will receive legal title to smaller plots of more productive land. The encroachment of farmers on government forest land was viewed as a legal and administrative problem, as well as an environmental problem. As new irrigation development projects, such as the Mahaweli project, has displaced shifting cultivators, and as the overall population of both irrigated and rainfed shifting cultivators has increased, the forested areas have come under ever increasing pressure. The result: greater areas of forest are cleared, leading to soil erosion, siltation of reservoirs, dropping water tables, and gradually lower agricultural output, leading to a further search for new land for shifting cultivation.

As the project evolved, finding abandoned tanks, or currently operating but deteriorated tanks, that could support significant numbers of new farmers was not easy. Of the 600 tanks originally planned for rehabilitation, only 138 were identified by the Irrigation Department as having adequate irrigation potential. Selecting the tanks that would receive project assistance involved a complex negotiation among self-proclaimed spokesmen from the farming communities to be settled, field-level agricultural officials, local administrative officers, and staff from both the Irrigation Department and the ADZAP project office.

The involvement of so many actors led to long delays of typically two or three years between the time of the actual construction work by the Irrigation Department (responsible for constructing the dam, sluice gate, and main irrigation channel leading to the fields), and the time that "downstream" work of land clearing and levelling was done by another government department, the Department of Agrarian Services. Because of differing criteria between these two departments, only 83 of the 138 reconstructed tanks were accepted for downstream work, and later evaluation by staff of the Department of Agrarian Services concluded that the planned irrigated areas of as many as 50% of these were grossly over-extended; i.e., the estimates of water harvest from the tank catchments had been overly optimistic.[11]

For the 83 tanks that were ultimately included in the project, it remained to select the settlers who would reside around the newly constructed tanks. There would not be room for everyone; indeed, only a fraction -- a quarter at most -- of the estimated 13,400 landless families practicing shifting cultivation in the project area (who constituted the project's target population) could be given land. Those interested had to apply for consideration, and the selection process gave priority to landless cultivators already living in the area around the tank in question, and (in many cases) to members of the ruling political party.[12]

The settlement process involved a waiting game. The project encouraged the selected settlers to actually settle, while the would-be settlers waited for all the project facilities to be constructed. The promised wells for drinking water were delayed; the reservoirs were empty because of too little rain, or an error in calculating the catchment, or a leaky dam. In other cases, the would-be settlers had no intention of moving, but tried to lease out their new allotments to others less fortunate. Meanwhile, the Department of Agrarian Services was busy clearing the land and shaping the fields, both irrigated and upland. In the original plans, the new settlers were expected to provide much of this labor, but the project was already embarassingly behind schedule.

Slowly, the settlers have started to appear, though in many cases they continue to cultivate the government land the project was supposed to wean them of. But new settlements are taking shape. In most tanks, only a small fraction of the irrigated area can be cultivated, but the upland fields show more promise. The same catchment that provides only a meagre supply of water in the reservoir often does a better job of recharging the ground water table. Some farmers have invested in small diesel pumps to lift the water and irrigate patches of vegetables and fruit trees on these plots. In many of the new settlement areas, the aggretate area of these individual, and unplanned irrigation systems is greater than the area irrigated by the storage reservoir.

Discussion of the ADZAP Project

The ADZAP approach to agricultural development and forest conservation is gradually taking shape, but at tremendous and unanticipated cost. From a project perspective it is a discouraging scenario: The original targets had to be scaled down from 600 to 83 tanks, and even these have problems. Yet underneath the mismanagement, graft, and politicization lies an essential idea that is fundamental to the aims of environmentally sound and sustainable agricultural development: Extensive agriculture must give way to more intensive practices. If done properly, farmers can increase their production and the little remaining forest can be conserved. But is there an easier, cheaper way to do it?

The problems of ADZAP can be traced, perhaps, to the tempting logic of its basic concept: making use of abandoned tanks in the same area where widespread shifting cultivation is being carried our illegally and wastefully. It was such a good idea that no one bothered to study the situation in depth and learn how those farmers were conducting their agriculture and how their farming svstem might be improved. More to the point, there was no interest in working with the target population to

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11 Based on the report of a mid-proj ect assessment, led by the author, which was conducted by the International Irrigation Management Institute and staff of the Department of Agrarian Services (see Ekanayake et al 1989).

12 The politicalization of the selection process did not subvert the entire process, but did result in a number of land grants made to individuals who were not truly landless, and who then proved unwilling to take up residence on the modest plots they were granted.

design a project that made sense to the farmers, as well as to the government and the foreign aid agencies.

Involving farmers as partners in agricultural development serves as an antidote to the worst mistakes of omission which discipline-bound professionals are so prone to make. The shifting cultivators of Anuradhapura are not professional shifting cultivators; they rely on a diverse set of economic srategies including farming, hunting, wood cutting, and perhaps wage labor during the slack season. Their range of concerns is far greater than most of the specialists responsible for designing and implementing ADZAP. The farmers would not forget about the need for providing drinking water in a new settlement, nor would they ignore the resources in the surrounding forest, and in the upper catchment, as a necessary part of any development package.

The objective of ADZAP was to transform shifting cultivators to settled cultivators, to protect the forest land they were cultivating, and to increase agricultural productivity. There was also a clear social objective of equity, giving first priority to the landless. The abandoned tanks and the promise of irrigation, and the granting of land rights were the means of realizing these objectives. The means were not very economical, but they have proven to be more or less effective.

But let us imagine two other objectives which have been omitted from ADZAP. The first is conservation not only of the forest that the shifting cultivators were being lured away from, but of the soil, water, plants, and wildlife of the catchment that provides the tank water. The second objective is the social development of the farm families and the communities included in the so-called target population. The point that will be made throughout this paper is that these two objectives – conservation and social development -- can and ought to be mutually reinforcing. The ADZAP project missed an opportunity for encouraging local communities to take charge of the natural resources within the project area.

Case #2: AKRSP (Pakistan)

Pakistan is famous for its Indus Basin irrigation system, a combination of indigenous canal networks absorbed by British colonial schemes and expanded in the past three decades into the world's largest canal network with some 40,000 km of canals. But in the hills of Baluchistan, and the mountains of the Northwest Frontier Province and the northern areas are found substantial numbers of indigenous irrigation systems still managed and maintained by local communities. While the total extent of these systems has never been systematically recorded, estimates put the total area irrigated by indigenous systems at 400,000 ha. Development activities currently planned or already underway will add a further 50,000 ha to this figure.

High in the Hindu Kush mountains of northern Pakistan, local farmers have depended on irrigation from the time their ancestors first migrated here from parts unknown. Without irrigation, nothing at all will grow in this arid environment, yet there is plenty of water in local streams. It comes from melting glaciers within site of the arid valleys, and it flows quickly down the steep slopes into the Indus river far below. The challenge is to tap the water before it loses its elevation and guide it along the mountain slopes to terraced fields carved into the slopes, or for a few lucky villages, to the alluvial fans formed from ancient rains. These are close-knit villages forged by necessity, and by history. Local feudal lords known as *mirs* ruled the area until after Indian Independence and the partition of Pakistan in 1947-48. The *mirs* had the authority to construct irrigation systems that they and their vassals depended on. The area prospered; tales of Shangri-la and the longevity of Hunza attest to their success and to the stark contrast between the verdant orchards of apricot and apple, fields of alfalfa and wheat, and arbors of pomegranate and grapes, and the barren mountain slopes all around.

Independence brought freedom to the subject villages, but it also brought a power vacuum. Although there were village leaders, there was no higher authority to settle internal disputes, or to mobilize inter-village labor groups to construct new irrigation systems. Expanding the irrigated area was essential to support the growing population, yet the best locations for irrigation canals, the easiest spots to tap into the glacial streams, had already been exploited. Faced with increasingly difficult technical challenges and with limited organizational capacity, the villages needed help. Government projects were attempted, but resulted in little help other than generating wage labor in the construction of ill designed canals. As of 1986, only one of 20 government schemes constructed in the Northern Areas was still functioning. The engineers who designed them were unfamiliar with the physical and social requirements of irrigation systems in that particular context.

A different approach, and one that has proven remarkably successful, was introduced by a non-governmental charitable organization, the Aga Khan Rural Support Programme (AKRSP), drawn to the area initially because many of the villages comprised followers of the Aga Khan. The AKRSP has been careful to deal with villages on a district-wide basis, however, and not limit help to members of the Ismaili sect. As a charitable organization, the focus of the AKRSP was not irrigation but village uplift through productive enterprises which usually involve irrigation since all agriculture in this area depends on it.

In 1982, the AKRSP initiated work in Gilgit district, with the dual aim of building physical infrastructure for the local inhabitants and building self-sustaining local institutions. The two objectives were seen as critically intertwined. In practice, the AKRSP used the promise of material assistance as a stimulus to the village community to mobilize its own resources for construction, and in so doing, strengthen the institutional capacity of the villagers.

The AKRSP Approach

The AKRSP takes a village-based approach to rural development, since it is at that level that political institutions are found (village headman and councils), or can most easily be created. A number of field offices of the AKRSP have been established throughout the district. Each field office comprises a Social Organizer (SO), (usually having Masters degree in sociology or social work), and an Engineer. The SO establishes initial contact with villagers through a first "dialogue" which is followed by two further dialogues. The SO explains that the AKRSP will fund one project of the villagers' choosing, subject to a certain budget ceiling (usually about US$ 10,000), and on the condition that the villagers can come to a consensus as to what the project will be and how the work will be accomplished. The village must decide what project is of highest priority; it may be a road, a bridge, a community building, or (in 60% of the cases) an expansion of their irrigation system, usually by constructing an additional intake and canal.

A village organization is formed as a condition of the grant. The terms of partnership negotiated with the village organization include regular savings to build up the equity capital, weekly meetings, participation in extension training programs, and collective land development. AKRSP credit will also finance future projects if the village organization can mobilize 15% collateral from its membership. The credit is through banks, but is guaranteed by AKRSP. In Gilgit District the project has resulted in improvements to 166 irrigation systems at an average cost of US$ 8,175.

During the planning and design phase of the new canal (often an etension of an existing system), the AKRSP engineer advises on technical matters and helps the newly established village organization prepare a cost estimate. During the construction phase, which may last from a month to several years, the engineer provides advice as needed. One of the most valuable contributions of the engineer is the survey of the new channel alignment. The traditional method uses water flow in the completed portion of canal to show the grade in the new section of canal. A technical survey shows the exact grade before the canal is built, providing more flexibility in selecting among alternative routes.

Discussion

The watershed around villages in the Gilgit area offers little in the way of resources other than land and water, in the form of glacial melt. Sustainable development in this context is synonymous with sustainable irrigation systems. Elsewhere in the Hindu Kush region there is greater rainfall and grazing is an option, but in Gilgit irrigated agriculture provides the dominant form of subsistance. Recently off-farm opportunities are developing through service activities related to the Karakorum highway leading to China. This transportation link will bring new agricultural opportunities as well by openingup markets for commodities such as pomogranate which in many villages do not have a price, as they are grown for subsistence only.

Sustainable development in the Gilgit region must be viewed in institutional as well as environmental terms. The primary environmental benefit of local development in Gilgit derives from stabilizing the communities through enhancing agricultural productivity. Local community residents who are able to build and maintain their own productive resources, whether irrigation canals or bridges, can continue living, and growing, in their traditional homes. They will avoid the fate of "ecological refugees" who are forced from their degraded lands by economic necessity and take up new lives, impacting yet more land, elsewhere.

A further environmental benefit of the AKRSP approach is that it focuses on small-scale irrigation canals and literally builds upon traditional designs, without replacing the technical base. By emphasizing village-specific irrigation canals (although some include more than one village) the bias is in favor of a greater number of smaller canals, as contrasted with the large-scale approach normally favored by the Irrigation Department. The result is a far lower liklihood of serious breaches and canal induced landslides. And when a breach does occur, the response time for the villagers to repair it is far quicker than the time required for the far-flung Irrigation Department to react.

Two features of the AKRSP experience that have broad relevance to other parts of the world are (1) the NGO plays a highly technical role, as well as providing organizational assistance, and (2) villagers are asked to select a project reflecting their priorities, rather than the priorities of an outside agency.

The role of NGOs in technical assistance. Even in technically demanding areas such as irrigation, NGOs can play an effective role by recruiting technical experts, and providing a new context for them to apply their expertise. There is a clear potential for more NGOs to become involved in irrigation and in other technical areas of rural development. When NGOs that have goals of social development enter the arena of technical assistance, the technical aspects of the project become a means to an end, rather than an end in themselves. Such an approach tends to strengthen farmers indigenous technical skills rather than replacing them with a top-down approach. On the other hand, the NGOs in such situations need to work closely with government agencies that may be in a position to offer long-term support services to farmers after the NGO withdraws.

Whose priorities? There is always a tendency on the part of outside agencies to define villagers' priorities for them, and then wonder why the project is not received with more enthusiasm. The AKRSP approach requires community consensus in selecting a development project. Irrigation is not always the highest priority. If, and only if irrigation improvement is perceived to be important, the villagers will opt for it. And since AKRSP is not an irrigation agency, but a multi-function NGO there is little pressure for villagers to request an irrigation canal, rather than a road or a hospital. Under these conditions, when they do select an irrigation improvement as their highest priority, there is every likelihood that the improvements made under the project will be maintained and "sustained" by the community.

V. CONCLUSIONS AND RECOMMENDATIONS

Indigenous irrigation systems offer special opportunities for helping conserve critical eco-systems, while meeting urgent social and economic needs of local communities. The location of indigenous irrigation systems near forests and other biologically diverse areas renders the viability and improvement of indigenous irrigation systems environmentally significant.

Enhanced productivity of these systems can relieve pressure on surrounding areas, and the sustainability of indigenous irrigation systems is thereby directly linked to the environmental sustainability of the watersheds of which they form a part. From a social and cultural perspective, the institutional arrangements embedded in traditional irrigation systems are important both to the political stability of the immediate region, and for "the cultural integrity of the people whose land is to be irrigated.

Three Lessons for Improving Indigenous Irrigation Systems

Enhancing the productivity and viability of indigenous irrigation systems requires a thorough understanding of the local social and agricultural context. Successful cases of outside assistance to the indigenous irrigation sector share several features. First of all they are participatory, with the local community in full control of the development process. Secondly the assistance provided i's complementary to the existing irrigation infrastructure; it does not replace what is already there. And thirdly, the irrigation technical assistance is part of a larger multi-sectoral development program. These three common features are discussed below as three lessons for indigenous irrigation development:

> **1) Genuine Participation**. Local communities must be involved from the very beginning in identifying local needs and identifying options for development activity. Participation should start long before any work takes place. In the AKRSP case (above) social organizers were recruited to work with local communities both to strengthen that political structure, and to ensure that decisions taken enjoy the support of the larger group. But local farmer participation was omitted from the ADZAP (Sri Lanka) project. Here the government believes, quite correctly in the author's view, that the projects are helping local residents. The mistake is then to conclude that participation is not really needed because the project is already on the right track. The benefits that ensue from active participation of project beneficiaries is not only at the level of project implementation, although this is important. Participation can set the stage for a new type of relationship between local farmers and the outside agency providing the project support. Participation stimulates autonomous decision-making and a sense of responsibility for the physical components of the irrigation system (maintenance) and also for the natural resources that the irrigation system depends upon: the water and the watershed. This is the link between participatory development and sustainable management of natural resources.
>
> **2) Build on Existing Infrastructure and Knowledge.** Not only do indigenous irrigation systems represent a tremendous "sunk cost" investment, but the type of structures and their design and layout reflect social and management considerations, as well as technical knowledge. Replacing that infrastructure with entirely new systems is often uneconomic, unecological, and unmanageable. The starting assumption should be that indigenous

irrigation systems should be accommodated into new development plans, rather than replaced. There will certainly be cases where replacement is justified, but these instances will be the exception, and should result from careful analysis and dialogue with local farmers.

In the case of AKRSP in Pakistan, new irrigation development added onto the existing infrastructure in a complementary way that took advantage of local knowledge and management expertise. Most of the new canals constructed under the AKRSP follow alignments that local farmers had attempted themselves, but required dynamite or other technical expertise that they could muster on their own. The project provided what was needed, but *not* what was *not* needed.

3) Look Beyond Irrigation. The farmers who build, operate, and maintain indigenous irrigation systems are also involved in other economic activities such as rainfed agriculture, herding, fishing, crafts, wage labor, or even professions as school teachers, government servants, or medical doctors. In many indigenous irrigation systems, farmers derive only a minority share of the total household income from irrigated agriculture. Where farmers have strong competing demands on their time, low-maintenance irrigation technologies (e.g., buried PVC pipe, automatic control gates, etc) may be the preferred approach, even though these are not "traditional" and would require some new skills. In other areas, where non-agricultural employment is very limited (as with the two examples presented above), a farming system approach should be adopted where irrigation is addressed as one part of a larger farming enterprise.

On the other hand, simply including other components in addition to irrigation is no guarantee of project success, as the ADZAP experience demonstrates. Although both irrigated and rain-fed agriculture were included in the project (as well as roads and domestic water supply), the project suffered other flaws. The lack of local participation in the planning, design, as well as implementation stages can be implicated in much of the later problems of poor performance of project reservoirs. Poor coordination among the line agencies involved was also a continual problem which has not been discussed in this paper, but deserves to be mentioned. Effective participation of local farmers can often buffer the problems of poor agency coordination.

Organized farmers can lodge complaints through political channels and call attention to problems of project-level management. In the case of AKRSP (Pakistan), once a village selected an irrigation project, the development assistance was specific to the irrigation sector. However, the real objective of the was not the material improvements but strengthening the village organization. Irrigation-specific development became a tool for promoting more effective local level organization that could then address the diversity of other development needs beyond irrigation.

Recommendations for Donors

From the farmers' perspective, any outside agency that offers assistance to improve their indigenous irrigation system can be considered a donor, whether that agency is an NGO (such as the Pakistan AKRSP), a government agency (such as an irrigation department), a bi-lateral agency, or a multi lateral development bank (such as IFAD or the World Bank). Any outside agency that is interested in improving indigenous irrigation systems should be aware of the delicate management system that is being tampered with. While many indigenous irrigation systems could benefit from outside assistance, experience shows that good intentions are not enough. Development agencies need to know their subject matter.

The following recommendations are intended as guidelines that can help transform good intentions into sustainable development. The recommendations begin with the policy level and work towards the grass roots. Unlike the development process, policy change seems to be more effective when it starts at the top.

- Give more attention to the indigenous irrigation sector and look for ways of building on that base, as an alternative to entirely new projects that actually wipe out those systems.

- Prior to introducing changes in indigenous systems, conduct reserach on the indgenous technical, social, and managerial basis of the irrigation systems and their role in the total farming system.

- Spend more time on project feasibility and design. Look for ways of linking indigenous irrigation development with improved management of upper watershed resources (soil, forests) and with environmentally sound economic opportunities for the populations living in the upper watershed. Particular attention should be given to supporting the integrity of critical conservation areas through irrigation development that can relieve pressure on these areas.

- Adopt a flexible approach in project implementation and monitor the project closely with an eye towards new opportunities. As national land use policies change, or as activities of other projects take shape, modifications will inevitably be warrented in the original project design.

- Let the genuine needs of project beneficiaries and capacities of implementing agencies, rather than the supply of donor funds, determine the scale and pace of investments. Following this recommendation will normally result in much more modest projects over a much longer period of time than is the current practice.

- Include agency reorientation and capacity-building as part of indigenous irrigation development projects. Government agencies require new skills to play effective support roles vis a vis indigenous systems. The tendency now is for government agencies to take over management functions that are better left to local farmers.

- Local participation of beneficiary farmers should be a primary focus of indigenous irrigation development. Effective participation requires professional intermediaries (social organizers) to help farmers strengthen existing organizations or form new ones, and to work with the concerned implementing agencies in defining the scope of the project.

More important than following any specific recommendation is an open, inquisitive, and humble attitude that should precede any development action. There is a science of rural development that dates at least to the mid 1950s with the village development projects in India. Irrigation as a specialized field has a longer history than that; in Sri Lanka, the British colonial administrators were very much involved in rehabilitating indigenous irrigation reservoirs from the mid-19th Century, and considerable documentation exists of this experience.

In the past three decades there has been a resurgence of interest and investment in indigenous irrigation systems, resulting in the absorption or obliteration of many of them. Yet whether good or bad, there is at the very least a considerable body of experience that new projects can tap.

Indigenous irrigation systems have been an easy target for development projects; they tend to be small, there is some infrastructure already in place, and the farmers are already familiar with the technology of irrigation. There has been an unfortunate coincidence of interests among farmers requesting free improvements, irrigation agencies seeking to expand their budgets and jurisdictions, and donor agencies seeking to disburse funds. There has been a great deal of construction, followed by very little management, resulting in little real development.

And what about the environment? The environment surrounding the irrigation systems has been viewed as an externality that irrigation development should impact as little as possible. A separation between irrigaton projects and the larger environment was seen as in everyone's best interest. This paper suggests otherwise. Indigneous irrigation systems are respositories of fast- disappearing knowledge about how man can interact with his environment in a sustainable way. At the same time, these irrigation systems are located on the doorstep of endangered ecosystems. Pretending that irrigation and environment are two separate issues is missing out on a one-time opportunity for saving *both* indigenous irrigation knowledge and threatened biodiversity.

Indigenous irrigation systems need outside help, not to develop them into concrete and steel, but to enhance their prospects for managerial autonomy and economic viability. With the right kind of development, indigenous irrigation systems can serve as a keystone of integrated development and environmental conservation on a watershed basis. The required ingredients are not capital investments or new technologies, but a commitment to learn from the past and chart a new future.

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