Principles of Social Organization in an Indigenous Irrigation System

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For several decades numerous development efforts have been devoted to the installation of large-scale irrigation projects for the improvement of agricultural production. As Crosson has written, many of these modern projects have encountered operational difficulties:

> . . . the management of large irrigation projects is in the hands of public officials who are too far removed from the on-farm situation to know the conditions for efficient use, who lack economic incentives to achieve it even if they knew how, and who typically are bound by inflexible rules of water allocation impeding their response to economic incentives if they had them (1975:522).

In view of the organizational problems associated with many modern irrigation projects, one might ask what can be learned from the numerous examples of locally constructed and operated systems that exist in a variety of natural and sociopolitical settings. What can be learned from them regarding organizational alternatives for irrigation management? In this paper, these questions are explored through the detailed analysis of an indigenous irrigation system in the northern Philippines.

This report utilizes a research strategy similar to that suggested by Whyte:

> . . . a fresh look at organizations through case studies which look at the history and broad cultural environment of, and non-vertical relationships in new types of organizations which do not conform to the bureaucratic model (1976:47).

Principles, derived from field observations and information collected from various informants, are analytical statements and not necessarily known, in this form, by the irrigators themselves. The long-range objective is not only to identify such principles but also to consider the appropriateness of these locally derived principles for other settings in support of irrigation development policies.[1]

An Overview of the Irrigation System

The irrigation system studied is located on the Ilocos Coast in the extreme northwest portion of the island of Luzon in the Philippines. Wernstedt and Spencer (1967:328) provide a succinct description of the physical features of the Ilocos region. They describe the region as a narrow belt of coastal lowlands which is sometimes interrupted by mountain spurs that extend from the mountainous interior directly to the sea. Where these spurs do not occur, the coastal lowland area may extend eastward twenty or more miles until it reaches the mountains.

Irrigation in the Ilocos region is practiced on these coastal lowlands. Supplementary irrigation occurs during the wet season period (approximately mid-May to early October) as well as during the extended dry season (mid-October to mid-May).[2]

Within this region is Zanjera Danum, an indigenous irrigation system located in the extreme eastern portion of the coastal lowlands in the municipality of Dingras, province of Ilocos Norte.[3] Zanjera Danum is viewed as an irrigation system because it refers to a contiguous area of agricultural lands which receive their water from a common source through a set of technical apparatuses that largely are constructed and maintained by the cultivators who receive the water and who belong to an irrigation association whose membership is coterminous with the physical layout of the irrigation works. This system is one of the many traditional systems that have existed in the region for several centuries (Keesing 1962; Lewis 1971).

The national irrigation agency estimates that Zanjera Danum irrigates approximately 1500 ha of rice paddy in the wet season. The fields of the irrigation system encompass all the territory of one village (*baryo*) and parts of the territory of two other villages. These villages in turn are divided into smaller hamlets (*sitios*) which are compact residential units scattered throughout the service area of the system. Each of these hamlets has associated with it a group of irrigated fields which the villagers also refer to as a sitio. There are 32 hamlets and their associated field units in the system, all of which depend on the same source of water and common channels for conveying this water. The operation and maintenance of this system is independent of any government agency and rests with the locally organized Zanjera (Association) operated by those who are the users of this system.

Although the major crop produced is rice, the actual cropping pattern is complex and intense. The first rice crop is grown from May through August; a second rice crop is grown from September through December, and a third nonrice crop, which also requires irrigation, is grown from January through April. Important nonrice cash crops grown are tobacco and garlic. There are, of course, many exceptions to this general pattern. Variations are most directly related to the farmers' decisions to grow the traditional or modern rice varieties, with the shorter maturation period of the latter making them most suitable for a three-crop pattern.

Farmers in this irrigation system, as in many parts of the Philippines, are share tenants. Landowners are nonresident and may be found in the surrounding towns, the capital of the province, or as far away as Manila. The Philippine government has an ongoing agrarian reform program, and the initial surveys and land transfers from landowners to tenants are now occurring in Zanjera Danum. As will be discussed subsequently, both landowners and tenants have been a part of the social organization of this system and the agrarian reform changes may have significant impacts on the continuity of these patterns.

Principles of Organization

The operation of an irrigation system is a complex organizational enterprise that involves engineering and construction activities, the management of soil–water relationships, the allocation of water rights to groups and individuals, and other activities. While there are many tasks which must be organized to sustain the operation of an irrigation system, three are of fundamental importance: 1) the organization of water allocation; 2) physical maintenance activities; and 3) conflict management. The discussion of the principles of organization in Zanjera Danum will demonstrate the arrangements that have been devised to deal with these fundamental tasks.

While the discussion will emphasize organization arrangements, it will become clear that these organizational patterns, in part, derive their continuity from the pattern of the physical structures for conveying and distributing water and the patterns of land holding.[4]

THE ARRANGEMENT OF ENGINEERING STRUCTURES. Water for the system is obtained from a perennial river by means of a locally constructed bamboo-and-rock diversion structure placed in the river. This structure is located more parallel than perpendicular to the river flow and deflects a portion of the river water into an unregulated and unlined canal which carries the water approximately a kilometer to the upper fields of the system. After entering the service area, the main canal divides into three branches, each of which serves several sitios in the system.

Two important maintenance problems are associated with these structures. First, the diversion structure is subject to damage, sometimes total destruction, when the river floods. Repair activities often require the rapid mobilization of a large labor force to correct these problems. Second, the canals within the system are subject to the accumulation of gravel which is carried by the fast-flowing river and deposited in the more gentle gradient of the canals. The gravel must be periodically removed from the canals to maintain their carrying capacity; a task that requires routine rather than emergency procedures.

THE ARRANGEMENT OF LANDHOLDINGS. The lands irrigated by Zanjera Danum are divided into 32 named field units generally called sitios. Each unit is comprised of irrigated lands (of approximately 15–70 ha) farmed by tenants, most of whom live within the residential neighborhood located within the sitio fields. Sitio farmers usually are both residential and field neighbors, though some operators within a sitio may actually live outside the sitio.

Within each sitio there is a fixed number of membership shares (locally referred to as *atars*).[5] In the entire system of 32 sitios there are 564 shares and these are distributed across the sitios, though not an equal number per sitio.

Sitio size is usually referred to in terms of the number of shares it has rather than the number of farm operators or hectares of land that it includes.

Each of the shares has a claimant or in some cases, claimants. Likewise, some claimants have more than one share. The claimant holds the right to till the land associated with the share and has the responsibility and privileges that the irrigation association assigns to each atar. The main privileges associated with a share are the right to a portion of the system's water and a right to vote both within the sitio unit and the larger association. The major responsibility is to provide labor, and occasionally construction materials and other resources, as required to operate and maintain the system.

There is an additional complexity to the atar as a unit of land: it is composed of several parcels which are noncontiguous and located within different blocks of the sitio unit in a patterned arrangement (see Figure 1).[6] This pattern of noncontiguous parcels has been achieved by first dividing the land of the sitio into two or more blocks laid out perpendicular to the source of water. The number and size of the blocks in a sitio is apparently related to factors such as topography and soil type, though it is possible that they also represent historical stages of land development. Since they are arranged perpendicular to the canal system they also represent differential distance from the water source: some blocks (and parcels) are at the head of the canal, others at the tail.

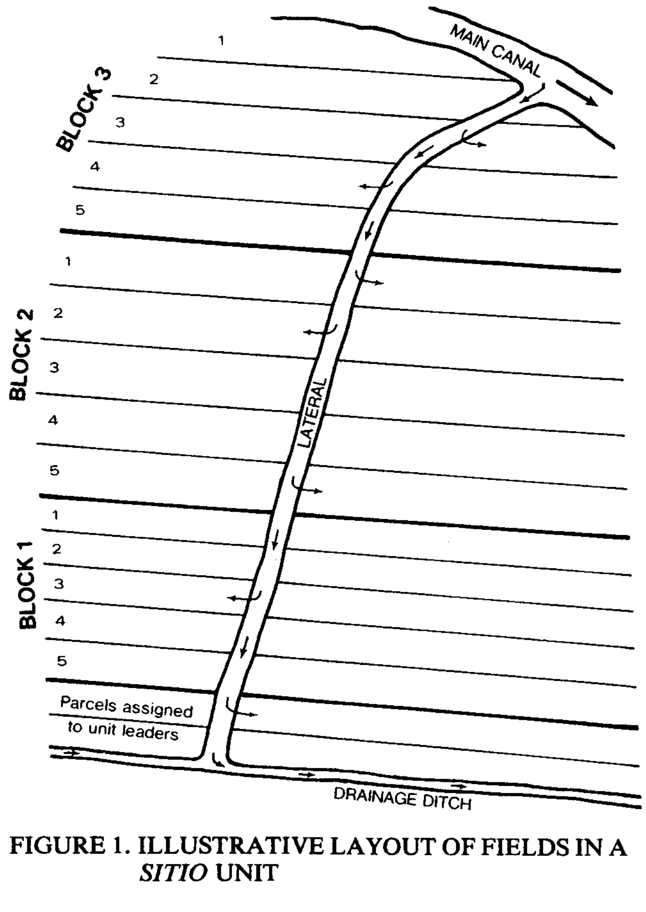

FIGURE 1. ILLUSTRATIVE LAYOUT OF FIELDS IN A *SITIO* UNIT

In addition, each of the blocks has been divided into strips of land; again, perpendicular to the water source. Within a block one parcel is created for each of the atars represented in the sitio. Ideally, these parcels are arranged so that the user of the first parcel in the first block will be the user of the first parcel in each of the other blocks. There are, of course, numerous exceptions in an actual sitio unit due to informal trades of field position, the division of an atar among more than one claimant, and other occurrences.

Finally, it should be noted that at the lower portion of each sitio one or more parcels of land are set aside for the use of the sitio's irrigation leaders. These leaders, selected by the water users of the sitio to perform a variety of irrigation-related duties that will be discussed subsequently, receive "payment" for their services by being given the right to farm these additional parcels.

Water Allocation Arrangements

The combination of engineering and landholding arrangements described above provides unusual possibilities for relatively equitable patterns of water distribution to all water users. The arrangement of landholdings attenuates the structural problem of conflict between those at the "head" of the canal and those at the "tail." Since water users have parcels of land in several different locations in the sitio, they have an interest in delivering water throughout the sitio unit.

Ideally this arrangement of canals and land also permits equitable adjustments to situations of water scarcity. If the system is unable to provide sufficient water to irrigate all the land of a particular sitio unit, water users may decide not to irrigate one or more blocks within their sitio. In so doing, all the farmers of that sitio would have their total farm size reduced proportionately (since all will have a parcel of land in each irrigated block) and the burden of scarce water will not fall upon a few water users who happen to be disadvantageously located.

This arrangement of canals and land and the resultant mode of proportional allocation of water is somewhat similar to that reported by Leach (1961) in a dry-zone village in Sri Lanka (the zone that experiences an annual wet-dry cycle). Leach describes a pattern of landholdings in which an individual's "farm" is composed of several parcels arranged perpendicular to the source of water and located within blocks of increasing distance from the water source. Leach notes that this design allows for a reduction in the total area irrigated in times of water scarcity in a manner that allocates the reduction across all water users and not just the group at the tail. As in Zanjera Danum, water users in this Sri Lankan village simultaneously have parcels in the head and tail portions of the system. However, in the Sri Lankan case the pattern of parcel locations in the upper portion of the irrigation system is the reverse of that in the lower portion. Thus, the irrigator with the parcel closest to the water supply in the upper portion is assigned the parcel furthest from the water source in the lower sections of fields. It may be that this further elaboration of field patterns in Leach's site is related to a relatively greater degree of water scarcity as compared to the situation in the northern Philippines.

It seems important to note that in both cases the possibilities for proportional allocation are embedded in the special manner in which land has been arranged relative to the source of water. That is, since each irrigator has his land holdings equally dispersed across different zones of the irrigated area, decisions not to irrigate a particular zone will have the same relative impact on all irrigators.

With this basic introduction to Zanjera Danum and the discussion of the arrangements for water allocation, the discussion will now turn to several important principles of organization that are utilized for the operation and maintenance of this system.

Proportional Rights and Responsibilities

A first principle that organizes behavior in Zanjera Danum is that rights and responsibilities in the irrigation system are proportional to the shares (atars) held by each water user. The supply of water available in the system at any given time is shared proportionally among the shareholders of the system, and likewise the resources required to operate the system are requested from the water users in proportion to the shares they hold.

A major characteristic of the technology of this irrigation system is the lack of water storage capacity in the form of a tank or reservoir. Irrigation water is diverted from the river and the total amount diverted, of course, is directly related to the amount available in the river. In addition, the water level in the river varies greatly between the wet and dry seasons. The interaction of technology and habitat produces a supply of irrigation water that is highly variable within, and between, cropping seasons.

In this context, a set of rules that defines one's water rights as a proportion of the system's total water supply, and one's responsibilities as a proportion of the total work to be done or other resources to be provided appears appropriate. Such rules may develop the expectation among water users that their individual share of water may be variable over time as there is variation in the overall supply, but that the beneficial or detrimental consequences of this variation will be experienced by all others in similar proportion. Likewise, obligations are variable, depending upon the total maintenance activities to be performed. In Zanjera Danum, the level of obligations may be very high during certain years or during specific times of the year, depending upon numerous factors, especially natural calamities, that increase the frequency and amount of damage to be repaired.

In Zanjera Danum this principle operates through the atar rule. Atar holders have the right to a proportion of the system's water supply for irrigating the parcels they farm. Likewise, labor for repair and maintenance is mobilized on the basis of atar holdings. The costs of an atar, in terms of labor performed, and the benefits of an atar, in terms of water received, are variable over time, both within and between cropping seasons, though equal to every other share at a given time.

Multi-Level Organization Pattern

A second principle of organization is that leadership roles occur at multiple levels in the irrigation system and each role is associated with a discrete territory of the total irrigated area.

The first component of the multilevel organization of Zanjera Danum is the sitio-level leadership structure. At the lowest level are the 32 sitio units into which the total irrigated area has been divided. Each sitio is composed of a relatively small land area operated by approximately 15 to 30 farmers. Each sitio has an irrigation leadership structure selected by the shareholders in the sitio. Irrigation activities within the sitio are coordinated by a man referred to as the *panglakayen* (literally headman or leader), often assisted by one or two additional persons. Each leader is subject to replacement at his own request or on the basis of the wishes of the sitio water users.

The main canal of the system divides into three branches after entering the command area. Each branch delivers water to a zone of the irrigation system, composed of several sitios. Each canal branch is headed by a branch headman (the *cabecilla*) selected by the total membership of the irrigation association. The cabecillas serve to coordinate irrigation activities within the zone irrigated by their respective branch. In performing these duties they interact with the sitio leaders within their zone, with one another, and with the system level officials discussed below. Thus, a second component in the tiered organizational pattern is the branch level leadership role which is intermediate to the sitio level and the total system level.

The final component of the organizational structure is those leadership roles which deal with the activities of the entire irrigation system. Leadership at this level is composed of three roles: President, Vice President, and Secretary. All are selected annually by the total membership of Zanjera Danum. Both the president and the vice-president are town-based elites who own land within the irrigation system. Their intimate contact with other elites, many of whom occupy strategic government positions, enables them to provide special representation for the association as required. They also represent an important and useful link between tenants and the other landlords.[7] This linkage with the landlords is important for controlling landlord actions that might jeopardize the integrity of the irrigation association.

The secretary is perhaps better thought of as the executive secretary, since he assumes a great deal of responsibility for the day-to-day operation of the system and the development of system level policy. He also assumes responsibility for routine contacts with numerous government agencies and other officials whose work relates to the irrigation system's operation.

Thus, the third component in the multilevel organizational pattern is the association-level leadership structure which acts both to deal with important external actors and to coordinate actions with the system at both the branch and sitio levels. Together the leaders at the association, branch and sitio levels are able to act in a manner that considers both the location-specific conditions of an individual sitio and the corporate needs of several, or all, sitios.[8]

Combinatorial Organization Pattern[9]

A third principle of organization is that work groups are aggregated and disaggregated in various patterned combinations to fit different maintenance and operation tasks.

The multilevel organizational pattern facilitates the recombination of work groups within the irrigation system as the tasks to be accomplished vary with regard to size of work force required, degree of task routinization, and other factors. The division of the entire irrigated area into 32 sitios which can be aggregated into various combinations under the direction of the branch and system level leaders is an organizational feature well suited to the variety of operation and maintenance tasks to be performed. Two examples will illustrate the operation of this principle.

The combinatorial organizational pattern provides needed flexibility for purposes of labor mobilization. A considerable amount of routine and special labor is required to keep Zanjera Danum operational. Particularly in the rainy season, the main diversion structure is subject to damage and destruction. Canals are in frequent need of clearing and repair. The various roads, culverts and small bridges found throughout the service area are likewise in need of frequent attention. During periods of water rotation, from approximately November through May, labor is needed to rearrange the flow of water within the main channels and to distribute water within the sitio units.

To handle these numerous functions, labor is organized using two different formats. One is *dagup* labor, an arrangement in which the total manpower of the system is mobilized, usually to accomplish major repairs to the diversion structure or to clean large portions of the canal system. Dagup labor is organized relative to the membership shares (atars): each atar must provide one labor representative. By their very nature, dagup activities are not routinely organized, but only as special needs for a large labor force occur.

The second arrangement for mobilizing labor is referred to as *sarungkar* and occurs in a routine fashion throughout the year. Each sitio is required by the irrigation association to organize its members into five sarungkar groups (the association officers use the ratio of two members to each sarungkar for every 10 atars in the sitio). Each sarungkar group is assigned a three and one-half day duty period, in sequence. This provides a two-week period of off-duty. A sarungkar group on duty is under the direction of the sitio's panglakayen or the other general officers of the association. During the time of its duty, there may be nothing to be done, there may be maintenance activities within the sitio or in conjunction with the other sitios, or there may be responsibility for rotating and distributing water.

Discussions with farmers verified the sarungkar concept. Farmers knew the sarungkar to which they were assigned (the usual designations were simply by number, one through five) and had an approximate idea of when their next work period would begin.

Some discussion of the water rotation activities will serve to illustrate functions of the sarungkar.[10] Beginning in October or November, when most farmers have already planted their second rice crop, Zanjera Danum initates a system of water rotation in which the service area is divided into two areas: the north area, which is most distant from the water source, and the south area, which is closest to the water source. During this period water is delivered to each zone from 4 p. m. to 4 p. m. on alternate days.

When water is flowing to the lower zone and is to be changed to the upper zone, this is achieved by having the on-duty sarungkar groups from the upper sitios open the canal inlets for their sitios and be responsible for the parcel-by-parcel distribution of water within their respective sitio units. When water is flowing to the upper zone and is to be shifted to the lower zone, the changeover is effected by having the on-duty sarungkar groups from the lower zone proceed to the upper zone and close the inlets serving the upper sitios. As the water moves to the lower zone, they also assume responsibility for the distribution to each parcel in their respective sitio.

The second example relates to the water rotation mentioned above. Since there are periods when the water supply is not sufficient to allow the simultaneous delivery of water to all fields, provisions must be made to create rotation zones: portions of the total service area that are small enough to be irrigated simultaneously. These rotation zones can be created easily by combining the appropriate number of sitio units to obtain a land area suitable for simultaneous water delivery. Often when rotation is first initiated in a given year the service area is simply divided into two zones and the sitios in the northern sector are aggregated into one zone with those in the southern sector aggregated into the second. Later as the water supply continues to diminish and the land that can be effectively irrigated in one zone is reduced, the number of sitios comprising a rotation zone also is modified.[11]

This ability to combine and recombine as the situation requires may be seen as a valuable organizational device for adapting both to the routine cyclical changes that occur in the agricultural year and to those more random events that the natural environment provides, including the often substantial damage from typhoons. As the period of water scarcity occurs in the months of December and January, the existing sarungkar groups begin to assume responsibility for implementing the water rotation plans. On the other hand, if flooding causes damage to the main diversion structure, an emergency can be declared and a large ad hoc group of workers assembled through the mechanisms of dagup. Thus, dagup and sarungkar work groups provide two alternatives for mobilizing labor needed under different circumstances and for the performance of different tasks. They provide the system with institutionalized patterns for recombining labor into groups of appropriate size and composition.

Reserve Organizational Capability

A fourth principle of organization is that a reserve capacity to perform operation and maintenance tasks is maintained.

This principle is most apparent with regard to the functions of the sarungkar groups. As mentioned above, each sarungkar group is on duty for a period of three and one-half days. While on duty, it frequently is the case that there is little work to be done during a specific duty period and members are free to pursue their personal activities. Thus, it may be the case that specific sarungkar groups, while identified and in place, perform few or no irrigation tasks. Nonetheless, the pattern of sarungkar groups is routinely maintained and these work groups are available and operational when work is needed.

In this sense, the sarungkar may be superfluous within limited time frames (not unlike the modern fire department). On the other hand, this pattern of routine organization avoids the difficult problems associated with creating ad hoc work groups as various needs occur in an irregular schedule. Every day there is a designated work force responsible for maintenance and repair activities as well as for the routine operational activities associated with rotation schedules when they are being used. Sarungkar members who are on duty but without a specific work assignment on a specific day are free to go about their usual daily activities. The principle of an organized reserve capacity to act, achieved through the creation of sarungkar groups, provides a solution to the need to mobilize labor for tasks that occur frequently, though somewhat irregularly.

Cross-Cutting Group Membership

A fifth principle of organization used in Zanjera Danum is that conflict is managed by forming subgroups composed of individuals with some shared, and some opposed, interests.

The literature on conflict management suggests that conflict resolution is facilitated when the potential antagonists share some social identities: kinship, residential location, occupational category, or important group memberships.

Downing (1974) has suggested the importance of cross-cutting membership for conflict management in a Mexican irrigation system. This small system is divided into approximately 70 irrigation sections (*tramos*), each composed of 13 to 41 irrigators. Each irrigator in a section is a member of that group and because of dispersed landholdings, most irrigators hold simultaneous membership in several sections. As a result:

> Conflicts between sections (*tramos*) are rare because the criteria for membership prevents sections from becoming corporate groups . . . . Multiple section membership creates conflicts of interests between members (Downing 1974:118).

In Zanjera Danum, cross-cutting memberships are the result of two aspects of the irrigation system's organization: the pattern of landholding that divides sitio holdings into several blocks and parcels, and the sarungkar work groups that assemble representative laborers from throughout the system.

The sitio landholding pattern serves to manage potential conflict between cultivators at the head and tail portions within the unit. By dividing a cultivator's farm into parcels located in several different positions within the sitio, the likelihood that cultivators at the head of the canal will act in a concerted way against those at the tail of the canal is attenuated. As in the case described by Downing, there is a "conflict of interest" created for each individual cultivator since he irrigates portions of land in both the head and the tail blocks of the sitio.

The sarungkar group is a second important arrangement for creating cross-cutting membership. The pattern of sarungkar formation is such that any particular sarungkar group is composed of individuals from each sitio in the system. The pan-system composition of each sarungkar group reproduces in miniature the spatial distribution of interests represented by the entire membership and serves to manage the conflict that occurs between the sitios that comprise the system. The sarungkar groups cut across sitios and do not structure intersitio relationships in a manner that emphasizes competition between sitios; the solution would be quite different if sarungkar groups were organized as sitio units.

The present mode of organizing sarungkar groups ameliorates the difficulties of mobilizing upstream tillers to work on downstream projects. Thus, for example, when a sarungkar group is rotating water, there is a high likelihood that there will be overlapping sitio membership between those receiving the water and some sarungkar members who are distributing the water. One can imagine that such overlapping will induce moderation that could be absent if a sarungkar composed of all "head-end" irrigators was delivering water to a "tail-end" sitio.

A Government-Managed Irrigation System

A little less than one-half the total irrigated area in the Philippines is managed through locally operated and nearly autonomous irrigation systems such as Zanjera Danum. The remaining irrigated lands are within irrigation systems operated and managed by the National Irrigation Administration (NIA), an agency of the Philippine government. To further highlight the principles of social organization identified in Zanjera Danum, this section will briefly note the nature of local level organization in one NIA system.[12]

Takahashi (1970) describes the operation of one section of the large Angat River Irrigation System (he reports the total coverage of the system was 26,980 ha). There are two important features of the organization of the system: 1) it is operated and managed by the personnel of NIA, and 2) there is no local level irrigation organization of water users. Contact between the irrigation agency and the water users is highly disorganized. As Takahashi has described it: ". . . the management of the irrigation system is in the hands of the government. At the village level, however, anarchy prevails over the use of irrigation water" (1970: 120).

Operation and maintenance activities at the local level are the responsibility of an NIA ditchtender who serves an area of 300 to 400 ha; in contrast to the Zanjera's sitio leader who serves 15 to 70 ha and has the assistance of locally organized work groups. One result of this pattern of local administration is that, "maintenance is not adequate, resulting in inefficient distribution of water" (Takahashi 1970:52). It is this inefficient allocation of water combined with the lack of local level organization that results in the village level anarchy that Takahaski identifies. In sum, the existing pattern of agency administration fails to provide adequately for system maintenance, water allocation, or conflict mangagement.

In this context, the principles of organization described for Zanjera Danum are inoperable. In contrast to the principle of proportional rights to water, the principle that seems to operate in the NIA system is that each water user defines his rights to water as that amount sufficient to irrigate the lands which he farms. To implement this principle, each individual opens and closes irrigation gates and diverts water to his fields with little regard for the needs of others. As Takahashi describes it: "There is no mutual regulation of the use of water among farmers" (1970:52).

While there is a tiered administrative pattern, with ditchtenders representing the smallest units of the irrigation system, water users are not part of this multilevel administrative pattern. Decisions regarding the operation and maintenance of the system are made by the NIA personnel with little or no input from the water users. The ditchtender who works at the small unit level is a member of the NIA bureaucracy and is neither selected by nor subject to the water users whom he serves.

Finally, since there are no voluntary irrigation associations of water users, there are no arrangements for a continuing work force to assist the NIA in implementing operation and maintenance tasks. Few farmers volunteer to assist the ditchtender in activities such as cutting grass in the canals (Takahashi 1970:52) and local people can be mobilized only on an ad hoc basis and with great effort by the NIA staff.

The contrast in local irrigation activities between Zanjera Danum and the Angat River Irrigation System is striking. While it is not assumed that the organizational forms of Zanjera Danum would be appropriate in Angat, the hypothesis that local people, if given the incentive and opportunity, have the ability to devise organizational variations suited to different local settings deserves consideration.

Summary and Conclusions

In summary, the people associated with Zanjera Danum have devised an elaborate form of human organization that fits with the natural habitat and the engineered environment which they created and operate. The social organization provides patterned solutions to the fundamental problems of system maintenance, water allocation, and conflict management. These patterns are built on important concepts such as membership shares, allow for the combination and recombination of both water users and land areas and place authority roles at several important levels of the association. The large total size of Zanjera Danum allows them to manage a relatively large water source while their ability to devolve many functions to small units facilitates behavior that depends on group interactions and high solidarity. While not suggesting the system to be utopian, there is a remarkable congruence of tasks, physical structures and human organization that results in an intensive mode of irrigated agriculture.

While not assuming that these principles could be transferred easily to other irrigation settings, the principles derived from Zanjera Danum increase our knowledge of the range of organizational alternatives available for implementing fundamental irrigation tasks. Indigenous irrigation systems exist in many parts of the world and many rich accounts of their organizational arrangements are available in the literature.[13] Considerable new knowledge can be expected from the careful synthesis of these materials (an excellent example of this approach is the work of Hunt and Hunt 1976) and from the further study of community arrangements for managing agricultural water.

Policymakers dealing with irrigation development are searching for alternative organizational arrangements. Irrigation is a human activity rich with historical and contemporary organizational variations. Currently, many decision makers are familiar with only a few alternatives or view each of the variations as simply a special case. As the numerous existing materials are synthesized and new studies of indigenous irrigation systems are completed, both of these difficulties can be addressed.

The study of indigenous irrigation organizations allows the researcher to pursue a proactive rather than a reactive approach to the analysis of rural change. These systems can be analyzed not only for the purposes of documenting the consequences of increased government intervention or some other external process, though this may be both appropriate and important in various situations, but also to identify the important organizational principles illustrated in local experiences.

NOTES

[1] As will be noted below, the principles discussed in this paper derive from a system which operates in a humid tropical rather than an arid zone. For that reason, the applicability of these principles in an arid setting needs further examination. It is important to note, however, that this system operates in both the wet and dry periods of the year. One might argue that irrigation conditions during the dry period are similar to those found under arid conditions.

[2] Lewis makes the following comments about rainfall patterns in Ilocos Norte:

> A large part of the heaviest precipitation may occur during the two or three days of the season when typhoons occur, dumping twelve inches or more in a twenty-four-hour period. Thus, neither the seasonal nor the yearly rainfall total gives an accurate picture . . . (1971:16).

[3] Zanjera Danum is a pseudonym for the actual irrigation system in which these observations were made. *Zanjera* is an Ilocano word of Spanish origin translated as "cooperative irrigation society" (Lewis 1971:129). *Danum* is the Ilocano word for water.

[4] In his discussion of village irrigation in Ceylon (Sri Lanka), Leach elaborated the thesis that patterns of social organization among the villagers of Pul Eilyah are, to a high degree, patterns that derive from their activities in "a piece of territory laid out in a particular way" (1961:300).

[5] The concept of shares is used to describe the allocation of water in other indigenous systems. As expected, the concept of shares is associated with a variety of specific organizational forms. For discussions of contrasting arrangements, see Geertz (1967), Gray (1963), and Leach (1961).

[6] This is a sketch of one of the 32 sitio units. In this sitio there are 5 atars and each is composed of three parcels of land (one parcel is located in each of the three blocks). If atar #1 belongs to a single claimant, this claimant would irrigate the parcels labeled #1 in each of the three blocks.

[7] At this time, the historical involvement of landowners in the creation of the irrigation system is not well understood. Further work on the historical development of this and other zanjeras needs to be undertaken.

[8] This principle of tiered organization has been found to be an appropriate form of local organization for agricultural and rural development in a number of settings. Uphoff and Esman note:

> The more successful systems of local organization function with several levels of organization, most commonly as two-tier structures, though three or four tiers may be practicable. The primary level of organization tends to be the hamlet, the neighborhood or some other group of from 30 to 100 families . . . . All these cases point to the need for distinct but linked organizations specializing respectively in meeting the solidarity and scale requirements of local organization for rural development (1974:67–68; 70).

[9] In an early reading, Norman Uphoff suggested the term combinatorial organization for this principle.

[10] Rotational irrigation is best known in terms of the technical procedures followed in operating irrigation systems in Taiwan (VanderMeer 1968; Levine, et al. 1976). What is less well recognized are the various forms of water rotation that occur in indigenous irrigation systems.

[11] One reviewer raised a question regarding farmers who may not wish to irrigate during certain periods of the year. In the land-scarce situation of Ilocos Norte, should an individual not wish to irrigate during a particular season, he probably would make arrangements to rent his land to someone else who did wish to use it for a given period.

[12] The material in this section draws on the work of Takahashi (1970). Other writings that corroborate Takahashi are Wickham (1972) and Coward (1973). This NIA system operates in an environment of seasonal aridity broadly similar to that of Zanjera Danum. I appreciate the suggestion of Robert Hunt that this case be used for comparison.

[13] While the material on indigenous irrigation systems is rather extensive [see Coward (1976), International Rice Research Institute and Agricultural Development Council (1976) and Hunt and Hunt (1976)], of particular interest are materials from the following countries: Ecuador (Anderson 1973); India (Chambers 1974 and Harriss 1974); Indonesia (Geertz 1967 and Satya Wacana University 1975); Laos (Coward 1971 and Taillard 1972); Mexico (Downing 1974); Peru (Mitchell 1976); the Philippines (Lewis 1971); Sri Lanka (Leach 1961); and Thailand (Bruneau, 1968; Frutchey 1969; Moerman 1968; and Wijeyewardene 1965, 1973).

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