Indigenous Proportional Weirs and "Modern" Agency Turnouts: Design Alternatives in the Philippines

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ONE FORM OF agency assistance to farmer-managed irrigation systems is the rehabilitation of existing irrigation structures and facilities. When some irrigation agencies provide this kind of assistance they expect farmers to take active roles in the operation and maintenance of their irrigation systems after rehabilitation work is completed. The experience of the National Irrigation Administration (NIA) and its participatory programs in national- and communal-irrigation system development demonstrate how an agency helped develop these systems with the close interaction and participation of the people who use them. The National Irrigation Administration's emphasis on cost-recovery measures was one factor which prompted it to encourage farmers to participate in planning and design decisions on the irrigation facilities being constructed. It also encouraged farmer responsibility for operation and maintenance of these irrigation systems through its structure of irrigation fees and amortization payments (Korten and Siy 1988:148).

The design criteria and procedures of these agencies need to incorporate and build on farmers' technical expertise where appropriate so that farmers can operate and maintain rehabilitated or newly constructed irrigation systems without further agency assistance. Few detailed accounts discuss particular cases of farmer experience and how this expertise is incorporated into the design of structural improvements in irrigation systems. This paper examines a Philippine case where the NIA, with input from a farmer-irrigation organization, chose between two design alternatives for flow-dividing structures -- an indigenous proportional weir and a "modern" agency turnout.

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The paper looks at three parts of this case. First, it describes the project context of the design alternatives and the parties involved in the design activities. Second, it considers the two alternative flow-dividing structures. Third, it looks at the decision-making process followed by the agency and the *zanjera*[i] as they appraised the two alternatives. Agency and farmer arguments for and against the two structures are analyzed to see how the choice of an improved, indigenous, and proportional weir might have an impact on farmer operation and maintenance.[ii] The paper examines the different priorities that the National Irrigation Administration (NIA) and farmers gave to a variety of design criteria -- including water-management efficiency, technology, existing versus new operation and maintenance procedures, training needs, and actual experience -- when designing and selecting a structure.

PROJECT BACKGROUND

The choice between the two flow-dividing structures was made in the context of the National Irrigation Administration's Ilocos Norte Irrigation Project (INIP). The INIP is located in eastern Ilocos Norte where almost 200 communal-irrigation systems called zanjeras are operating, some existing for over 200 years. In 1978, the plans for the two-phase INIP designed by the National Irrigation Administration included a pilot area with a total project area of 22,600 hectares (ha). The National Irrigation Administration created the INIP as a "new," large-scale irrigation system which would absorb the zanjeras and be operated by the Administration as a "national" system. The INIP plans aimed to increase agricultural production which would benefit 17,500 farm families in the area through the provision of improved irrigation facilities (JICA 1980:3). Zanjera officers and members were seldom consulted in the preparation of these initial INIP plans. As a result, farmers protested loudly against the project. The Administration also ran into implementation and scheduling problems. The NIA administrator from Manila and some social scientists investigated the project's problems for themselves. Based on their reactions, the agency decided to undertake a revised, more participatory planning approach in October 1981 (Visaya 1982; Siy 1987; Yabes 1990). The case discussed in this paper occurred during the revised planning approach period.

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[i] The term zanjera is derived from the Spanish word zanja which means ditch or conduit. Zanjeras are organizations that build and maintain irrigation ditches. They are known worldwide in the irrigation field for their enduring, gravity-fed, communal-irrigation systems, and for their rules and regulations governing water allocation and distribution, system operation and maintenance, and conflict management (Christie 1914; Lewis forthcoming; Lewis 1971; Siy 1982, 1987; Thomas 1978; Coward 1979; Coward and Siy 1983; Visaya 1982; Yabes forthcoming).

[ii] The impacts of the improved proportional weir on farmer management and operation were not known when research for this paper was conducted (1985-86).

Three parties were involved in making the choice between the two dividing structures: 1) the National Irrigation Administration's INIP managers; 2) one of the INIP's divisions, the Agricultural Coordination Division (ACD); and 3) one of the communal-irrigation groups included in the INIP, Zanjera San Marcelino. The Ilocos Norte Irrigation Project (INIP) management staff composed primarily of civil engineers, makes the final design and implementation decisions at the project level. It is only when required by the NIA central office, does the INIP management forward designs to the central office. Personnel from the ACD include staff from agricultural engineering, economics, and other nonengineering fields. The ACD staff coordinates the institutional and agricultural activities of the INIP. The Agricultural Coordination Division (ACD) staff often fields both requests and complaints by zanjera officers and members, and forwards this information to the INIP management. Zanjera San Marcelino, with approximately 960 ha and over 550 members is one of the largest and strongest zanjeras in the INIP area. Zanjera San Marcelino was incorporated into the INIP's Madongan Right Irrigation System.

THE TWO ALTERNATIVE STRUCTURES

In its irrigation projects the National Irrigation Administration (NIA) often used turnouts to allocate and distribute water to rotational areas. Thus, the NIA/INIP planners designed double-gated turnouts to distribute irrigation water throughout the project area. However, Zanjera San Marcelino used a type of indigenous proportional weir to allocate and distribute water to 33 subunits each called a *gunglo*. In September 1985, the zanjera with the support of the ACD, asked the NIA to consider using the proportional-weir structures, with improvements, instead of the double-gated turnout for water allocation in their area.

Double-Gated Turnout (Calibrated)

The double-gated turnout is located at the junction between lateral canals and main farm ditches. It measures and controls the volume of water which flows into the farm ditches (Reyes 1982:23). The turnouts are designed to serve areas of 30-50 ha. The double-gated turnout includes two spindle gates that are raised and closed with a hand wheel. One gate opens to the lateral canal while the other gate opens to the main farm ditch. There is a pooling area between the two gates. The gates are opened and closed according to a water-delivery schedule with calibrated measurements made in the pooling area by the gatekeeper. Measurements are made according to flow charts which correlate specific levels of water in the pooling chamber with the area to be served in the rotational area. The hand wheel is removed from the turnout structure and kept in the possession of the gatekeeper when not in use. The size of the turnout is designed to correlate with the rotational area served by the turnout.

The double-gated turnout was installed in the INIP's pilot area, and it was used by the agency and the zanjeras to allocate and distribute water. Farmers in the pilot area had complaints about water distribution and problems with operating and maintaining the turnout of the pilot area irrigation system. Some farmers in the area could not read. Many of the farmers did not understand or know how to calibrate or record the measuring devices. The gatekeepers did not open or close gates according to the schedules agreed upon by the agency and the affected zanjeras. Water flowed when it was not scheduled, and did not flow when it was expected. The double-gated turnout was subjected to damage due to natural causes and apparent sabotage. The spindles on the gates were bent so the hand wheels could not move. Thus, the gates were frozen in an open or closed position until the spindles were replaced. Siltation and floods also damaged or completely destroyed some of the turnouts which were not designed to handle the excess water flow. Damage also occurred in the turnouts when the National Irrigation Administration's field data underestimated actual flows to be handled by a turnout and the turnout was undersized.

Existing Padila and Tablon[8]

Zanjera San Marcelino diverts water from the Madongan River through two brush dams into a main canal which distributes the water into three lateral canals. The zanjera is subdivided into three zones which correspond to the laterals: eastern, central, and western. The zanjera is sectioned into 33 subunits, called gunglos, each with its own farm ditch served by one of the three laterals.

San Marcelino's pattern of organization reflects its physical irrigation system. There is a major headman, a secretary, a treasurer, and one headman for each of the three laterals. Each of the 33 subunits is headed by a leader. When the zanjera was organized sometime in the 1850s there were conflicts over water allocation and distribution (Cabanos 1983). The *tablon* and *padila* structures were built by the zanjera to mediate these conflicts (Viernes 1986).

According to Viernes, tablon (no translation) is a term used for a piece of thick lumber reinforced with concrete which is installed on the canal bottom of the section where water is divided (1986:4) (Figure 1). The tablon is supported by a *sangi* or concrete protection wall. On the same page, Viernes describes the function of the tablon and its relationship to the padila:

> This tablon serves to maintain a level crest on the canal bed of the said section. On the same section the *padila*, a tongue-shaped structure, is also constructed with its tip pointing upstream and resting on the tablon.

Like the National Irrigation Administration's double-gated turnout, the padila divides water between earthen, unlined lateral canals and farm ditches (Figure 1). The padila is a form of

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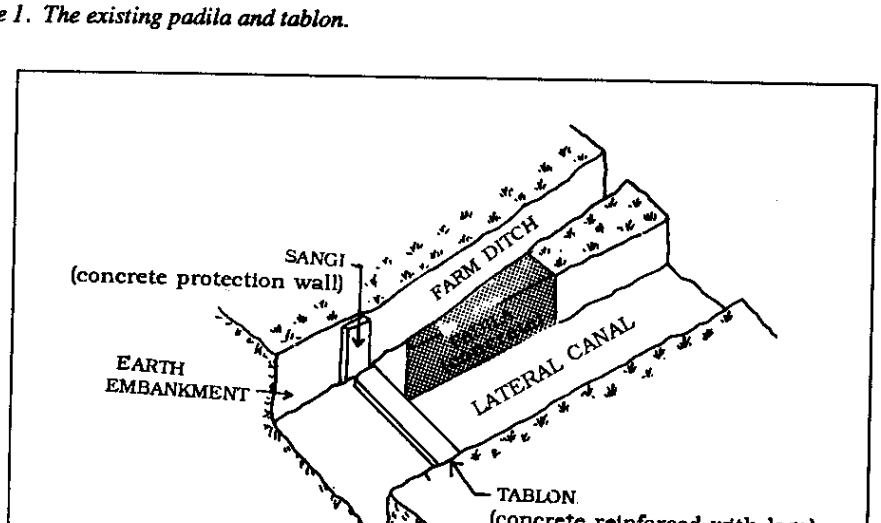
[8] These two structures were found specifically in Zanjera San Marcelino and are not widely used by other zanjeras in the INIP area.

proportioning weir used to allocate water. Originally made of wood and/or bamboo, some concrete padilas came into use beginning in 1919. The width of the farm ditch and lateral intake openings on each side of the padila corresponds with the area to be irrigated by each intake. In Zanjera San Marcelino a two-centimeter canal width is proportioned for each membership share[1] served by the intake (Viernes 1986:5). Padilas divide water into farm ditches which serve subunits with areas of approximately 7-40 ha.

Figure 1. The existing padila and tablon.



Source: Viernes 1986.

During periods of water scarcity water is rotated among the three laterals and numerous farm ditches by blocking off the farm ditch intakes with sticks, bamboo, leaves, rocks, and sand. The intakes can be blocked partially or fully according to the zanjera officers' decision. However, when a farm ditch has been "fully" blocked to divert water to other farm ditches, precious water often leaks through these porous blocking materials.

The tablon and padila structures and the proportional widths of the intakes combine to equitably divide whatever water is diverted by the zanjera's brush dams:

> Since the tablon maintains a constant elevation of the canal bed on the section where water is divided and since the width of the intakes is also constant, whenever water

[1] One membership share, locally known as atar, is equivalent to about one-and-a-half ha of land in San Marcelino.

> is released into the canal, it is automatically divided into the different intakes along the way. So, as soon as it reaches the end check, all gunglos along the canal will have taken [a] proportionate share of water (Viernes 1986:5).

Zanjera San Marcelino organizes labor in *sarungkar* (working) groups for routine maintenance and repairs, and operation of the irrigation system during water-rotation periods. Subunit members are assigned into these groups which work on three and one-half duty periods in rotation with other sarungkar groups from the other subunits (Coward 1979:3).

During periods of water scarcity the zanjera uses a water-rotation system where the zanjera is divided into two parts, the north (lower zone) and the south (upper zone). When under a water-rotation schedule, water is delivered to each zone from 4 p.m. to 4 p.m. on alternate days (Coward 1979). The sarungkar groups are responsible for the operation of the padilas to open or close the intakes during the rotation period. Unlike the few "specialized" gatekeepers who operate the agency's double-gated turnout, the sarungkar groups rotate the responsibility for the operation and maintenance of their irrigation system during periods of water rotation:

> 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 [gunglos] open the canal inlets for the [gunglos] and be responsible for the parcel-by-parcel distribution of water within their respective [gunglo] 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 [gunglos]. As the water moves to the lower zone, they also assume responsibility for the distribution to each parcel in their respective [gunglo] (Coward 1979:32).

According to the zanjera's officers no cases of water stealing have been reported since the padila and tablon were installed. But because water leaks through intakes blocked with sticks and brush some zanjera members have complained that these structures do not provide enough water to their gunglos.

Proposed Improvements in the Padila and Tablon

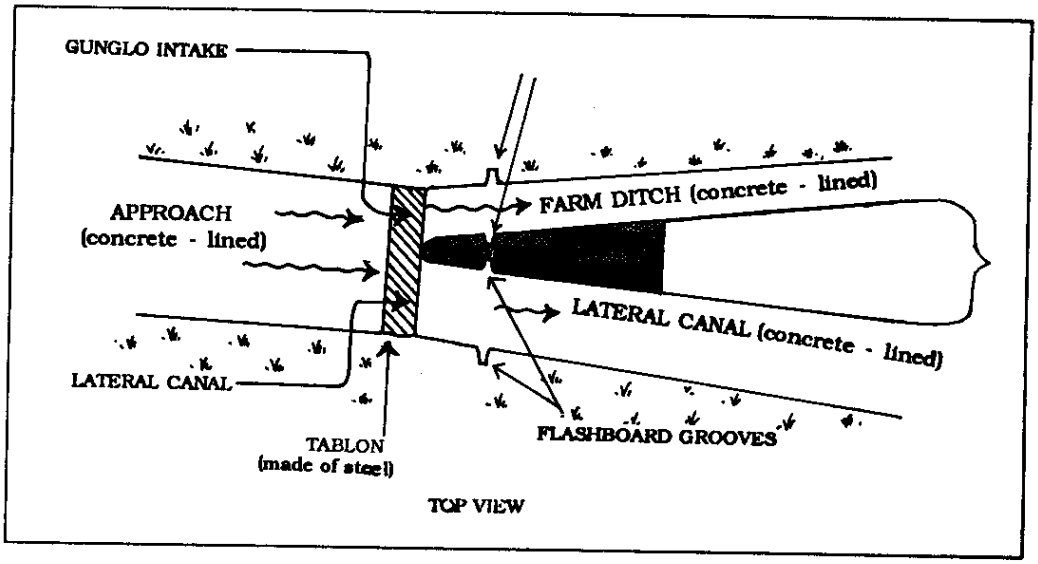
In a zanjera resolution Zanjera San Marcelino asked the National Irrigation Administration (NIA) to either use the existing padila or to construct a turnout structure very similar to the padila instead of the double-gated turnout designed by the NIA (Zanjera San Marcelino 1985). The zanjera asked the NIA to retain the same location and numbers of turnouts to correspond with the existing padila and tablon structures. Retaining the equitable division of water among the subunits was emphasized by the zanjera, as described by Viernes (1986:5):

> If the canal sections at the site of the [padila and tablon] are maintained [retained], the elevation of the tablon and the width of the padila should be maintained. Any

change in the section should have a corresponding change in the elevation and width of the tablon and intakes respectively. But this has to be approved by the zanjera.

With the caveat that further study of the technical feasibility and viability was needed, the ACD position paper recommended keeping the existing padila and tablon structures but rehabilitating them with a few improvements including: 1) lining the canal bed and embankment with concrete, 2) changing the tablon from a thick piece of lumber and concrete to a piece of steel, 3) inserting grooves on the sides of the padila and the canal embankment for flashboards, and 4) providing measuring devices for monitoring water discharges (not shown in Figure 2).

Figure 2. Proposed improvements in the padila and tablon.



Source: NIA blueprints 1986.

These two flow-dividing structures, the NIA's turnout and the zanjera's padila-tablon were discussed and analyzed for over four months by the agency and the zanjera. This four-month period was marked by a series of activities where the National Irrigation Administration (NIA) and the zanjera interacted in the effort to decide which dividing structure should be used ultimately by Zanjera San Marcelino in the INIP's Madongan Right Irrigation System.

THE DECISION-MAKING PROCESS

In mid-1985, the National Irrigation Administration proceeded to prepare detailed designs for the Ilocos Norte Irrigation Project (INIP) canals and structures along the main canal and laterals in the INIP's Madongan Right Irrigation System which included Zanjera San Marcelino. In line with the guidelines for the INIP's revised, more participatory planning approach most of Madongan Right Irrigation System canals were designed to follow San Marcelino's existing zanjera canals.[4] But these plans failed to acknowledge or consider the zanjera's padila and tablon as a viable alternative to the agency's standard turnout for measuring and controlling water distributed to farm ditches.

When some of the members of Zanjera San Marcelino heard that the NIA was going to install double-gated turnouts they presented the INIP management with a resolution on 3 September 1985. The zanjera asked the NIA to construct padilas or an improved turnout like the padila and tablon currently used by the zanjera instead of the double-gated turnout (Zanjera San Marcelino 1985).

The INIP management asked the Agricultural Coordination Division (ACD) to informally follow up and investigate the zanjera resolution. After the ACD staff held discussions with Zanjera San Marcelino farmers and the NIA engineering staff and made several trips to look at the indigenous structures, the ACD prepared a position paper for the INIP manager recommending that the possibility of adopting the proportional weir structures, with some improvements, be studied further (Viernes 1985, 1986). During a routine NIA meeting in October 1985, the INIP management, representatives from the Engineering, Construction, and Agricultural Coordination Divisions, and the INIP contractors reviewed Zanjera San Marcelino's request. Based on the recommendations of engineers from the Design Section and Construction Division, the INIP management refused the zanjera's request and adopted the double-gated turnout as the dividing structure for the Madongan Right Irrigation System.

Despite the INIP management's decision during the next two months several INIP engineers made formal and informal visits to the Madongan Right Irrigation System area to assess the strengths and weaknesses of the padila and tablon for themselves. Also, most of the zanjera and gunglo officers from Zanjera San Marcelino visited the INIP's pilot area to examine the pros and cons of the double-gated turnouts. Because of ongoing discussions among the INIP management, engineers, the ACD staff, and the zanjera farmers, the INIP management eventually reversed its decision, and agreed to improve the padila and tablon in Madongan Right Irrigation System instead of building new turnouts. This reversal was formally adopted as an INIP policy in a workshop in December 1985 at the NIA central office. During the workshop it was agreed that the INIP should use improved, existing zanjera structures for turnout purposes and officially discontinue the use of the double-gated turnout (NIA 1987:5).

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[4] Four guidelines for the revised planning approach were recommended by the social-scientist team and endorsed by the NIA administrator and the NIA central- and project-field offices: 1) preserve the identity of the zanjera groups; 2) follow existing canal lines as much as possible; 3) conceive the project as rehabilitation of existing communal-irrigation systems, not as construction of a new, large-scale system; and 4) involve farmers in planning and implementing the project (Visaya 1982:4).

The NIA and Zanjera Debate on the Two Structures

Irrigation agencies and farmers have differing goals and viewpoints about irrigation systems. Common goals of farmer-operated systems cited by Maass and Anderson (1978) include the orderly resolution of conflict, popular participation, local control, increased income, justice in income distribution, and equity. In a more recent literature survey of local-irrigation systems, Levine and Coward (1986) concluded that a fundamental principle of the systems studied was equity operationalized through a fair allocation and distribution of water (Coward and Levine 1986:19). On the other hand, agency improvement programs emphasize system performance, "water efficiency," irrigation fee payment, and administrative control (Coward and Levine 1986; Robinson 1982; Bottrall 1981).

These different agency and farmer perspectives on irrigation-system goals were reflected in the NIA-zanjera discussion on the padila-tablon versus the double-gated turnout. Both parties raised and emphasized different points about the two flow-dividing structures. The pros and cons for each structure (double-gated turnout, existing padila, improved padila) as argued by the NIA and zanjera farmers are highlighted in the remainder of this paper.[§]

THE NIA/INIP management and the ACD criteria and arguments. During meetings and in informal conversations, the NIA management argued that the double-gated turnout allowed "efficient" water management, with "exact" measurements, and little or no leakage when the gates were closed during the rotational period. The INIP engineers preferred the turnout's design for a standard rotational area (30-50 ha). They were trained to design the turnout's "modern" technology, not to design or improve indigenous structures.

Some of the ACD staff pointed out the following problems with the turnout. The turnout is only as effective and efficient as the operators themselves who open and close the gates. The turnouts require skilled operators with sufficient technical background and mobility to travel from one turnout to the next in order to open and close the gates. System operation is affected when an operator is absent or doesn't know when or how to properly calibrate or operate the gates. In the pilot area the spindles in the turnout gates were bent so the hand wheels could not open the gates. One possible reason for this suspected sabotage was farmer frustration with the turnouts and the corresponding rotational areas which did not match the preexisting zanjera-irrigation systems and organizations in the area. Pilot area farmers were not involved in project-planning activities; the NIA staff recognized that this may explain why few pilot farmers participated in the operation and maintenance of the pilot's irrigation facilities.

The NIA/INIP management initially disliked the padila-tablon, with or without improvements because "it is a type of structure being used by non-technical people" and it "doesn't give enough control" (comments at a NIA meeting). Also, the zanjera frequently used the padila for continuous flow of irrigation water, not checking the intakes, which the NIA considered "inefficient." Even when the padila-tablon was checked, according to some of the engineers, strict water management was not possible because water leaked through the checks. After

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[§] These were compiled from research notes of meetings and ongoing discussions between the NIA and Zanjera San Marcelino, and from relevant secondary documents (Zanjera San Marcelino 1985; Viernes 1985, 1986).

examining the structure, the NIA engineers also concluded that the existing padila could not allocate water exactly according to their fine-tuned, calibrated standards or distribute exact amounts of water to different locations. Another general but unconfirmed apprehension was that the padila-tablon improvements would be much more costly and time-consuming to construct since there were at least 49 padilas needing improvements as against 37 NIA turnouts.

The ACD suggested three advantages of using an improved padila-tablon instead of the NIA turnout: 1) construction-cost savings, 2) simplicity and economy in operation, and 3) zanjera acceptance of the structure (Viernes 1986:5, 28). First, the estimated per unit cost of improving the padila-tablon was US$150 as against an average cost of US$500 for constructing a double-gated turnout. Originally, 37 turnouts were designed for construction, compared to 49 improved padila-tablons, or a total cost of US$18,500 (turnouts) as against US$7,350 (padilas).[1] Second, the ACD argued that the simplicity of water division is retained with the proportional canal-intake widths and the improved padila-tablon. The zanjera's existing operating and maintenance sarungkar activities would not change much with the substitution of flashboards for the previous leaves and brush which checked the canals. The same rotating gunglo work teams would open and close the flashboards. The ACD argued that the additional training which farmers would require to read measuring devices and record data would not be too difficult. Third, the ACD emphasized that members of Zanjera San Marcelino had expressed their preference for the padila-tablon. The ACD pointed out that if the padila-tablon were adopted "it will facilitate the turnover [future operation and maintenance] of the whole system" (Viernes 1986:28).

Zanjera arguments. Most Zanjera San Marcelino farmers were doubtful about the NIA turnout as many of them had never seen a double-gated turnout before. After seeing some of the turnouts in the pilot area some farmers commented that the turnout seemed complicated to operate, with calibrations, pooling areas, and gates which had to be opened and closed according to exact measurements. In the zanjera's resolution to the INIP management they indirectly referred to the fact that the proposed NIA turnouts did not match the number or location of the existing padila-tablons. Thus, the turnouts would require a new set of operation and maintenance procedures entirely different from the existing and well-functioning practices of the zanjera. Another zanjera concern was that the turnout would be used for rotational irrigation practices year-round while farmers were used to a continuous-flow system. A few Zangera San Marcelino farmers mentioned in conversations that they favored the double-gated turnout because of the turnout's perceived ability to tightly control water management, thus reducing leakage and hopefully providing additional water supplies from the source from where water supplies were previously wasted.

The zanjera listed several advantages of an improved padila-tablon structure some of which overlap with the ACD's list of padila benefits. Improving the padila would retain the existing number and location of padilas, and not change their corresponding zanjera and gunglo operation and maintenance organizational set-ups. The zanjera also emphasized how the padila helped water-sharing practices rather than focus on exact measurements: "...Whereas since these structures [padila] were built, problems regarding water sharing, including operation and maintenance

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[1] Actual expenditures are not available for discussion here. The total-cost figures do not reflect the cost of additional NIA staff-time which was required to re-inventory the Madongan Right Irrigation Systems area in order to enumerate and field-check all of the padilas and tablons for the paper designs.

work, stopped'' (Zanjera San Marcelino 1985). Not much more training would be necessary for the zanjera members to learn how and when to insert the flashboards at the canal and farm ditch intakes to rotate water. Zanjera farmers also mentioned that the improved padila would not have expensive parts like the turnout's spindles, gates, and hand wheels which were subject to damage in the pilot area and which often took a long time to be replaced, if at all.

CONCLUSIONS

> If, for example, one views a turnout not only as an element that defines a unit of service area but one that also defines a unit of management organization, it follows then that the location of turnouts should be based not only on questions of physical performance but also organizational performance (Coward 1977:15).

After several months of discussion on the two structures, the NIA agreed to improve the padila and tablon instead of building double-gated turnouts. In supporting the choice of an improved padila, the zanjera stressed simplicity of operation and maintenance, equity, location, and cooperation, without much emphasis on water efficiency or acute measurement accuracy. The NIA emphasized strict water management, control, and cost in recommending the adoption of the double-gated turnout. Later, the NIA was willing to reverse that decision and choose the padila, because with improvements, the agency realized that the padila could control water almost as efficiently as a turnout in a cost-effective manner.

In the design of irrigation structures in farmer-managed irrigation systems there is a need to assess existing and future expected operation and maintenance activities. Design decisions about turnout structures in this case discussed how the indigenous proportioning weir facilitated the zanjera's existing operation and maintenance practices when choosing flow-dividing structures. Thus, in the design of turnouts water-efficiency criteria valued by irrigation agencies should be considered and, equity, operation, and maintenance factors important to the farmers who will operate and manage the irrigation systems should be examined.

References

Bottrall, Anthony. 1981. Comparative study of the management and organization of irrigation projects. World Bank staff working paper no. 458. Washington, D.C.: World Bank.

Cabanos, Esteban, to E. Walter Coward, Jr. 5 January 1983. Personal files of E. Walter Coward.

Christie, Emerson B. 1914. Notes on irrigation and cooperative irrigation societies in Ilocos Norte. The Philippine Journal of Science IX(2):99-113.

Coward, E. Walter, Jr. 1979. Principles of social organization in an indigenous irrigation system. Human Organization 38(1):28-36.

Coward, E. Walter, Jr., and Levine, Gilbert. 1986. Studies of farmer-managed irrigation systems: Ten years of cumulative knowledge and changing research priorities. In Public Intervention in Farmer-Managed Irrigation Systems. International Irrigation Management Institute and Water and Energy Commission Secretariat of the Ministry of Water Resources. Government of Nepal, 1-31. Digana Village, Sri Lanka: International Irrigation Management Institute.

Coward, E. Walter, Jr., and Siy, Robert Y., Jr. 1983. Structuring collective action: An irrigation federation in the northern Philippines. Philippine Sociological Review 31(1-2):3-17.

Japan International Cooperation Agency. 1980. Overall plan for Ilocos Norte irrigation project in the Philippines.

Korten, Frances F. and Siy, Robert Y., Jr., (eds). 1988. Transforming a bureaucracy: The experience of the Philippine National Irrigation Administration. West Hartford, Connecticut: Kumarian Press.

Levine, Gilbert and Coward, E. Walter, Jr. 1986. Irrigation water distribution: Options and opportunities for production and equity. Paper prepared for the World Bank.

Lewis, Henry T. 1971. Ilocano rice farmers: A comparative study of two Philippine barrios. Honolulu: University of Hawaii Press.

Lewis, Henry T. Forthcoming. Ilocano irrigation: Corporate groups and oriental nepotism. Honolulu: University of Hawaii Press, book manuscript.

Maass, Arthur and Anderson, Raymond. 1978. ...and the desert shall rejoice: conflict, growth and justice in arid environments. Cambridge, Massachusetts: MIT Press.

National Irrigation Administration. 1987. Turnover guidelines for the Ilocos Norte irrigation project (INIP). Memorandum for the administrator, Federico N. Alday, Jr., from the department manager, Avelino M. Mejia, Institutional Development Department. Quezon City, the Philippines, 27 February 1987.

Reyes, Pacifico A. 1982. Dagiti estruktura iti komunal a pasayak. Pangawidan ti Amianan (The Turnout of the North) VI(12):22-23. From Primer on communal irrigation system structures, translated to Iloko by Reyes.

Robinson, David M. 1982. Water users' organizations in two large Philippine irrigation systems: Constraints and benefits of a participatory approach to water management. Unpublished Ph.D. dissertation. Ithaca, New York: Cornell University.

Siy, Robert Y., Jr. 1982. Community resource management: Lessons from the zanjeras. Quezon City, the Philippines: University of the Philippines Press.

Siy, Robert Y., Jr. 1987. Averting the bureaucratization of a community-managed resource -- The case of the zanjeras. In Community Management: Asian Experience and Perspectives, David Korten (ed.), 260-273. West Hartford, Connecticut: Kumarian Press.

Thomas, William L. Zanjeras, communal irrigation systems in the province of Ilocos Norte, Philippines: A corrective note and updating. Unpublished manuscript.

Viernes, Villamor. 1985. Notes on position paper on adopting a time-tested structure of Zanjera San Marcelino, Madongan Right. Solsona, Ilocos Norte, the Philippines: Agricultural Coordination Division, National Irrigation Administration.

Viernes, Villamor. 1986. From the zanjeras: Another priceless heritage. Pangawidan X(1):4-5, 28.

Visaya, Benito P. 1982. The Palsiguan River Multi-Purpose Project and the zanjeras. Paper read at the Conference on Organization as a Strategic Resource in Irrigation Development, Asian Institute of Management, Manila, the Philippines, 15-19 November 1987.

Yabes, Ruth Ammerman. 1990. New wine in old bottles: Obstacles and opportunities of a participatory planning approach in the case of a large Philippine irrigation system. Unpublished Ph.D. dissertation. Ithaca, New York: Cornell University.

Yabes, Ruth Ammerman. Forthcoming. Zanjeras: Philippine communal irrigation systems in the North. In Traditional Community Irrigation in Asia: A survey of customary rules and regulations, Gooneratne, Wilbert (ed.).

Zanjera San Marcelino. 1985. Resolusyon a naaramid kalpasan ti miting dagiti opisyales ti Zanjera San Marcelino, Dingras, Ilocos Norte Idi Setyembre 3, 1985. Dingras, Ilocos Norte, the Philippines. Zanjera resolution, typed document.