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WOODEN PROPORTIONING WEIR: A PHYSICAL IRRIGATION STRUCTURE WITH SOCIAL IMPLICATIONS

Farmer-managed irrigation systems have a long history of adapting their technology to the topography, hydrology, water availability, water rights, and sociocultural conditions of their environment. This article describes a simple, but effective indigenous proportioning weir used in some irrigation systems to divide water in the canal according to the user group's prescribed water allocation rules. The social and technical functions that a proportioning weir performs are also examined. Such structures have been observed in many well-managed hill and Terai (plains) irrigation systems in Nepal and in many other Asian countries.

A wooden proportioning weir is a wooden beam with several rectangular notches of uniform depth cut into it along the top. The beam is installed across the canal so that all the water flows through the notches. It is carefully leveled so that the depth of flow through each notch is equal and the flow of water is automatically divided into two or more canals in a fixed proportion regardless of changes in discharge. The width of the notches is calculated to be proportional to the allocation of water for the area to be irrigated by that flow. Should the allocation of water for an area change, the notches can be adjusted by simply cutting the notch wider so that more water will flow through it, or water flow can be reduced by inserting a piece of wood to make the notch narrower.

Proportioning weirs perform the social function of minimizing water-related conflicts by distributing water in accordance with an agreed-upon allocation. From an engineering point of view, it is designed to distribute water by gravity flow to different sectors of a command area through different channels, allowing a specific discharge of water to flow reliably. Proportioning weirs may be installed only in the main canal, but they have been found in secondary and tertiary canals, dividing water into individual fields.

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Technical Considerations. In Nepal, the wooden log used for constructing a weir is usually a sal (shorea robusta) or khayar (acacia catachu) tree which is resistant to rotting in water. Wherever a proportioning weir is to be installed, the canal must have enough of a gradient to pond the water on the upstream side without overtopping the canal, and a small drop on the downstream side of the structure. Proportioning weirs are not seen more often in lowland irrigation systems because of the lack of sufficient slope.

The velocity of the flow needs to be adjusted to avoid turbulence that would cause unequal flows through the notches. This is done by widening the canal or adjusting the gradient. The gradient may be adjusted by raising the elevation of the proportioning weir by building a small, drop structure for water to fall freely from the outlet side of the weir so that downstream flow conditions do not influence the division of water. In some cases in Nepal, a "flow breaker," (a small log across the canal) is placed two or three meters upstream of the proportioning weir to reduce the velocity of the flow and distribute the water more evenly as it approaches the weir. If the gradient is steep at the installation site, first a stone dam is constructed and levelled and the proportioning weir is placed on the dam.

To compensate for possible differences in the flow across the canal or where there is concern for unequal hydraulic losses in different size notches, multiple notches of equal dimensions may be made. Downstream of the structure, water flow from two or more notches is then rejoined to make the proper proportions. The Dailatung irrigation system of Palpa District, Nepal uses this method to adjust for variances in the water flow because the proportioning weir is located at a bend in the canal.

Small notches easily become blocked by leaves and trash, causing the water level in the canal to rise, increasing the risk of disastrous breaching in the hilly environment. To avoid this risk, all the notches in the proportioning weir are widened proportionally.

During annual maintenance, beneficiaries check for leakage around and under the weir and to see if it is level. Measuring the vertical depth of flow in each notch is an easy test to see if the weir is level. Sometimes a hole is made at each end of the weir to insert a long wooden peg which is driven into the ground so that the proportioning weir cannot be moved or stolen.

Improvements in the proportioning weir have evolved over a long period of time as the farmers who used it adjusted and modified the technology to best suit their needs. In the oldest record found so far of the use of a proportioning weir in Nepal, the Raj Kulo irrigation system -- constructed in the 16th century -- originally measured the size of the notches in the weir by finger widths. This practice has now been amended so that notch widths are measured in standard inches. Raj Kulo has replaced the wooden weirs with concrete replicas at main distribution points to avoid water leakage and reduce annual maintenance requirements. This is largely related to the increasing cost of wood as the forests are cut.

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However, cement proportioning weirs are installed only after clearly defining where changes in allocation are not anticipated since the size of the notches of cement weirs cannot be easily changed.

Weir Functions. The most important task performed by a wooden proportioning weir is to minimize social conflict by providing reasonably equitable and reliable irrigation to most of the beneficiaries in an irrigation system. It helps coordinate human resources, water distribution, and resource mobilization principles and patterns with the water allocation the beneficiaries have agreed upon. It has been observed that the proportioning weir has been repeatedly effective in resolving conflicts over water sharing in the irrigation systems in Nepal, Bhutan, and Pakistan.

Water Allocation. At each division point that uses a proportioning weir, the ratio of the width of the notches is calculated to be the same as the ratio of the water allocation below that point.

In some irrigation systems, the notches are calculated to allow a flow of water to pass through which is proportional to the cash contributions made by a group of water users during the construction and improvement of the system. In other systems, the notches are proportional to the area irrigated by different users, and sometimes the notches are calculated on the basis of prior appropriation. Allocation differences may also prevail within a system. In some systems, a definite geographical area is delineated within which water transactions are permitted upon the consent of other water users and the water users' committee.

In the Badkapath system of Dang District and Chhattis Mauja of Rupandehi District, Nepal, water allocation and distribution are based upon labor contributions for canal operation and maintenance. In Badkapath, villages that contribute 16 laborers for operation and maintenance activities are allocated one "lathi" (a measuring stick approximately 36 inches long) of water, which is distributed through a notch in the weir about 36 inches wide.

Water Distribution. The proportioning weir is meant for automatic distribution of water by continuous flow, thus reducing management activities. When water discharge is very low, it is not feasible to divide water through a proportioning weir. Time rotation may be practiced if the supply of water should drop to a level that makes continuous distribution to all fields impossible. In some wooden proportioning weirs, vertical grooves have been cut to insert a board into the notch so it can be closed when rotation is practiced.

In the Chherlung system of Nepal, proportioning weirs are installed to divide water only from the main to the secondary canals. A farmer with land in different secondary canals can assign a certain portion of his total allotted water share to each proportioning weir to irrigate his fields located in different sections of the command area.

Social Norms. Irrigators must follow the norms, values, and traditions they have established if they want to minimize conflicts. When the water allocation or basis for resource mobilization has been established by the irrigators, the proportioning weir functions as the mechanism by which the irrigators can implement the allocation they agree upon. The proportioning weir serves this function because it can be visually checked at any time for accuracy.

Established norms and penalties for disregard of these have helped to insure the continued effectiveness of water distribution through the proportioning weir. Violators are charged fines or refused irrigation water.

The usual method of stealing water at the proportioning weir is by making holes under the weir so that water does not pass through the notches in the correct proportion. Another method of cheating is by placing weeds, brushes or stones in the notches to obstruct the flow.

The group of farmers who receive water from the weir are responsible for the repair or replacement of the weir at their own cost. All beneficiaries should be present at the time of the installation of a new weir or the adjustment of an old one. Complaints are not attended to at a later time.

<u>Government Programs</u>. Government intervention in existing farmer-built irrigation systems which seeks to promote the allocation of water on the basis of area irrigated creates conflict in those systems where water allocation has traditionally been based on investment shares, or prior appropriation. It is very difficult for the irrigators to shift to allocations based on area irrigated, because the carefully balanced present system, based on each farmer's investment would have to be completely revised and all the proportioning weirs readjusted.

Engineers often recommend the use of conventional structures, particularly the use of an adjustable gate, to distribute water. However, the proportioning weirs are already installed and functioning effectively at low cost in many systems. Installing gates would require a larger investment and additional manpower to adjust the flow through the gate, while the traditional proportioning weir functions automatically.

Adjustable gates affect water flow in a nonlinear way, making it difficult for farmers to visually calibrate the proportions for each canal. Frustration over calibration of the adjustable gates caused farmers in an irrigation system in Indonesia to break adjustable gates that were constructed during a rehabilitation project and subsequently install their traditional proportional divider. Thus, intervention in farmer-managed irrigation systems needs to be flexible to incorporate successful local technology where appropriate, instead of simply introducing structures that conform to a single new model.

<u>Conclusion</u>. Wooden proportioning weirs are simple, low-cost structures with a wide scope of applications in gravity-based irrigation systems. Coordination between farmers, social scientists, and engineers during the preparation and installation of proportioning weirs can insure that they are technically and socially appropriate for the system in which they are to function. The information presented in this article indicates that the proportioning weir aids in minimizing water-related conflicts. They function automatically and the division of water can be easily verified visually, making them easy for the farmers to manage.

In areas where government intervention is being contemplated, or if proportioning weirs are to be installed in an existing irrigation system, one should first analyze the existing water allocation principle, the needs of the irrigators, and existing local technology. Once the farmers determine that it is advantageous to install a proportioning weir, a description of the hydraulic command area and land information are required. Sectors and subsectors of a hydraulic command area should be grouped according to the geological features which facilitate easier water distribution.

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