A PRACTICAL METHOD FOR VOLUMETRIC DELIVERY OF WATER

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ABSTRACT

Volumetric delivery of water in irrigation networks has been recognized as a major step for optimum use of water for agricultural purposes. This requires an appropriate water demand management, associated equipment, and an information system. In this paper, a summary of a guideline for volumetric water delivery in irrigation networks of Iran has been presented. In this regard, the principles and prerequisite conditions for volumetric water delivery have been discussed. Also the processes of signing an agreement with the water users and details of water delivery have been defined. Furthermore topics of training for different stakeholders in the irrigation network including managers, water distributors, and representatives of the farmers have been introduced.

INTRODUCTION

Water scarcity and the need for more agricultural products requires paying close attention to optimum use of water for agriculture. In this regard, the high loss of water, especially in the case of surface water usage, is a fact which should be seriously considered.

Volumetric delivery of water for irrigation is the first step for controlling water demand for agricultural purposes and reduction of water loss for this type of demands. Most of the irrigation networks in Iran are equipped with water level regulators and gates capable of volumetric delivery to the water users. However, actual water allocation and fees are based on the cultivated area and not on the volume of water consumption by the farmers. That is the main reason that the accuracy of the volumetric delivery system is not high. Furthermore, since water users do not pay on a volumetric basis of consumed water, they do not care much about reduction of water uses.

To address the above mentioned issues, the current status of water delivery in selected irrigation networks of Iran was first investigated. It has then been tried to propose practical ways to improve the current situation by advising application of appropriate technology and equipments for volumetric water distribution in these irrigation networks.

The finding of this study showed that for volumetric delivery of water in irrigation networks as well as charging farmers on the basis of volume of water consumed for production of agricultural goods, it is necessary to provide the three following conditions:

- Principles and conditions which should be prepared and agreed on for volumetric water delivery.

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- Processes for signing an agreement with the water users and details of water delivery should be defined.

- Training topics for different stakeholders in the irrigation network including managers, water distributors, and representatives of the farmers should be introduced.

PREREQUISITE CONDITIONS

To deliver water in an irrigation network on a volumetric basis, certain principles and conditions in water management, information database and application of reports must be met. The system for regulation, delivery and measurement of water in the irrigation network should also have minimum requirements for this purpose. In this paper, it is mostly assumed that an upstream control system is used for the open canal irrigation network. The above-mentioned principles are discussed below.

Water Distribution Management

Volume of Water as the Basis for Water Delivery and Fees. Water should be delivered on the volumetric basis and the water fees should be calculated and charged accordingly.

Role of Users' Demand in Water Delivery. Each water delivery for certain days should be carried out upon request of the users (or their representatives). Therefore, water distribution according to a schedule with pre-specified rotations, in which water would necessarily be delivered to their representatives, will not be possible in this system. If water users are going to pay for the volume of delivered water, they themselves should request it. The water distribution institutions, however, can match the requests with the situation and change the quantity and timing of the requests according to monthly quota, subject to the users' agreement.

Unit of Delivered Water Volume. In this system, unit volume for water is liters per day (24 hours). For instance, 50 liters per second for 24 hours would be equivalent to 4320CM.

Point of Water Delivery to Users. Selection of delivery point is vital in the volumetric system of water delivery. Considering the capacity of each water delivery gate and the need to regulate(variation) them once per day, the delivery point should be selected such that the minimum required time for users of that irrigation rotation would not be less than 24 hours. The larger an area which a delivery point covers, the higher would be the water demand and the longer period of delivery. If the irrigation rotation is less than 24 hours, it would be necessary to regulate gates in three working periods per day which would be an expensive and complicated job. The water, received by the users, will be distributed to the farms in multi hour rotations which is a responsibility of the water users' representatives.

Water Users' Association. For volumetric delivery of water, it is necessary to have organized users downstream of each delivery point. It is preferred that such organizations be formal or somehow registered in legal forms such as cooperatives, associations, and stock companies. However, a simple way for this purpose could be that users downstream of each delivery point

elect one representative or waterman among themselves, even if a formal association does not exist. In this case, the total volume of water for the users, requested by their representatives, must be sufficient for irrigation in multiple days (i.e., 1, 2, … day).

Allocation of Water to Users. The required water for farms, supplied by an irrigation network, should somehow be determined (e.g., project study reports, agreements, etc.) and reported to the users. This amount of water will be calculated according to cropping pattern, crop water requirement and accepted efficiency figure for the cultivated area supplied by each off take (or representative of farmers) for each irrigation season.

Table 1 depicts required water for different crops per year. In each cell of this table, required water for different type of crops for each month of a year will be written. The sum of these amounts for all of the mentioned type of crops will be written in the row entitled Total. Assuming that a portion of required water can be supplied from other sources (e.g., water wells, springs, …), the remaining amount, which has to be supplied by the irrigation network, will be written in the next row for each month. The mentioned rows are only applicable to those networks which use surface and ground water conjunctively.

Table 1. Required Water for Different Crops per Year (CM)

Month of irrigation season / Type of Crops-ha	1	2	3	4	5	6	7	8	9	10	11	12	Comments
Crop 1													
Crop 2													
Crop 3													
Crop 4													
Crop . . .													
Total													
Reduce: supplied water from other sources													
Allocated water from irrigation network													

Signing Agreement with Water Users. In the volumetric system of water delivery, it is very important to sign an agreement with the water users/representatives. Table 1 should be used in the text of the agreement. Also, the code or number of the gate and name or names of representatives of the users who can request for water should be mentioned in the agreement. As mentioned before, this would serve as the basis for trading of the volume of water in the amount and distribution over the operation period as defined by Table 1.

One important point which should be mentioned in the agreement for volumetric water delivery is that the amount of water mentioned in Table 1 is a predicted value and the actual delivery of

those are subject to water availability. For any un-foreseen condition such as drought, the volume of delivered water will be less than the predicted values in Table 1.

Calculation of Water Fees. The charges for water should be transformed to volumetric-based fees according to current laws and regulations. Fees, calculated in this way, have a fixed value for an irrigation network or a district which has a cropping pattern similar to those in the agreement.

No Need for Measurement of Cultivation Area in the Volumetric Delivery System. On the basis of cropping pattern and the gross required water, certain amount of water will be delivered to the user and fees would be charged according to the volume of water requested by the user. In this system, it is the user who decides what combination of cropping pattern he should select which would have the maximum benefit for the available amount of water which he has paid for. On the other hand, the water distribution organization does not need to survey the cropping pattern and water usage. In this way, the organization would not face difficulties in water distribution. Since the volume of delivered water is limited to the required water for the cropping pattern, the users automatically will be inclined to select a combination of cropping close to the defined cropping pattern. Therefore, in the volumetric system of water delivery, measurement of cultivation area will not be carried out with the objective of calculation of water fees.

Collection of Water Fees. water fees can be collected by cash or credit. For the cash sale, water fees are transferred by the users/representatives to the specified account at the time of approval of the request and water will be delivered to the user according to the distribution schedule. It is also possible to calculate the total amount of delivered water at the end of each irrigation season and collect fees accordingly. Alternatively, users can pay some deposit and after delivery of water the fees can be deducted from the credit. If any of these payment methods are going to be applied, they should be mentioned in the agreement with the users.

Inclusion of Water Loss. Considering that water fees will be calculated on the basis of volumetric water delivery, it is important that the agreed amount of water actually be delivered. In this regard, water losses in the transmission system terminating to the delivery point should always be considered. Therefore, the inflow of the network including the losses should be higher than the sum of amounts which should be delivered to the users. In other words, the operating organization is responsible for the volume of water loss in the system.

Equipment for Water Delivery

In the volumetric system of water delivery in irrigation networks, required equipment for delivery plays a major role. If the users are going to pay for each cubic meter of water, the equipment for water delivery should be sensitive enough for this purpose. For volumetric delivery the equipment should not only show amount of discharge at the off take but also be capable of controlling the flow rate according to the request of users. Therefore, the networks which are based on the volumetric system of water delivery and pricing should be equipped with accurate water delivery systems.

Automatic System of Water Level Regulation at Offtakes. It is necessary to have automatic water level regulators at the offtakes so that the water level would remain relatively constant at these locations. Therefore, application of automatic systems for water level regulation at offtakes is vital.

Water Measurement and Delivery System. Two types of gates are used in these systems. Modular gates are the best for volumetric water delivery. The gates are capable of water delivery with an accuracy of more than 90%, even if water levels slightly vary at the offtakes. It is of course necessary to regulate water level at the intakes.

Slide and radial gates. Slide and radial gates are used for volumetric water delivery in those tertiary networks with no modular gates but with automatic regulators. The required water discharge could be delivered by adjusting the gate openings in relation to requested water, assuming that the water level at the offtakes is constant. In these cases, water discharge can be measured by a Parshall flume, weir, or a calibrated gauge at certain stations.

Application of Information for Volumetric Water Delivery

In the volumetric system of water delivery, access to timely information is very important. Considering the role of water user's demand in the process of water distribution, it is necessary to have time and accurate information of the daily demand of network canals. Such as number of water requirements that have to be met in each day, regulation of canals flows based on the water requirements and the off take supplying water and the ones without water in a specific day.

Therefore, the following information is required for volumetric water delivery.

Full Information of Water Users. Name of representative or representatives and their subscription number, land and cultivated area, type of crops, name of village, assigned canal and delivery points, water demand according to Table 1, date and reference number of the agreement, etc.

Water Demand Information. This includes: the requested discharge in terms of liters per second, date of start and period of each water delivery in terms of days, the location of water delivery point, name of the representative requesting water and the person who receives it.

Daily Schedule of Water Distribution. This is required at gate locations of the main canal, primary canal, secondary canal and the water supply point.

PROCESS OF VOLUMERTIC DELIVERY OF WATER

As shown in Figures 1 and 2, the process of volumetric delivery of water includes the following components:

Process of Signing Agreement with Water Users

Introducing the Representative of Water Users for each Delivery Point. The first step for volumetric delivery of water is to introduce a representative for users downstream of each delivery point. Users can also introduce one representative for more than one offtake. It is advantageous that the representative would be introduced upon co-ordination and approval of the local agricultural unit. Otherwise, all of the users can select their representative and introduce him to the operation organization in writing.

Providing Cultivation Schedule and Required Water. Following introduction of the representative/s, the cultivation schedule and water demand will be provided by him. At this stage the operation organization checks the requested water with the cropping pattern and the regulations (quota). If there is no controversy, the cultivation schedule and water demand will be passed to the relevant organization for signing an agreement.

Signing Agreement with the Representatives of Water Users. Agreements will be signed with the representatives of water users. It is clearly mentioned in the agreement that water will volumetrically be delivered to the users according to the table included in the agreement upon each request of the representative. Water fees, per cubic meter of delivered water, will then be collected from the users at the approved rate.

In the process of signing agreements, it is important that the water distribution organization keeps a record of its commitments for water supply and delivery to users and makes sure that the total amount of required water for each region will not exceed from the canal conveyance and the maximum amount of deliverable water of the irrigation network. For those networks which are directly fed by rivers and might face some uncertainties in water supply, the forecast will be carried on the basis of minimum river flow for the month with maximum demand per year.

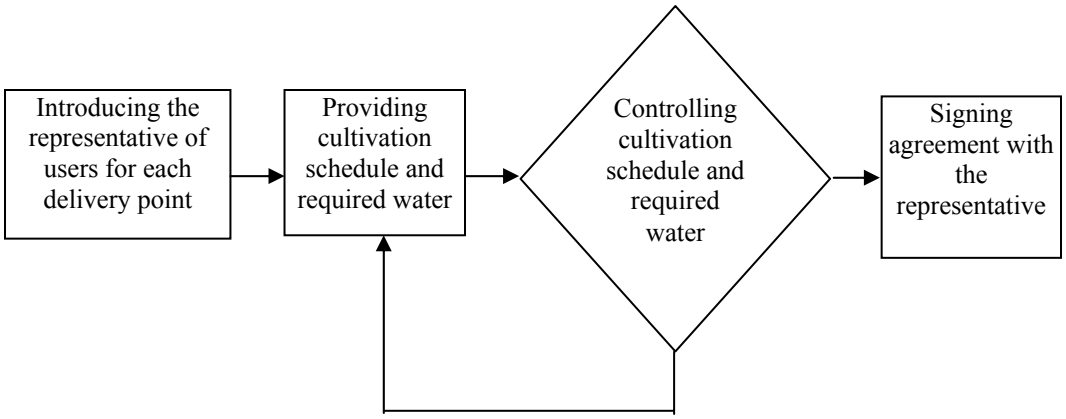

Figure 1. Process of Signing Agreement with Water Users

Process of Water Delivery to the Users

Those users who have signed their agreements are eligible to receive their required amount of water. As shown in Figure 2, the process of water delivery to the users includes the following components:

Request for Water by the Users. For each irrigation rotation, request for specified amount of water (lit/s) and associated duration (days) will be given in writing. In the request information such as name of the representative, reference number of the agreement, intake gate, amount and duration of water and the start date of water delivery will be included. This request will be checked against the irrigation schedule, included in the agreement, and if there is no controversy will be approved. Then, start time and discharge of irrigation will be agreed with the representative and recorded on the request form which will be ready for delivery.

Approval of the Request. Upon approval of the water request by the manager of water sale or any other responsible person in the operation organization, the request will be delivered to the canal responsible person.

Request by the Canal Responsible Person. Considering the total amount of requested water as well as the total amount of requests which their delivery will be finished per day, the responsible person for the canal will request for increase or decrease of discharge in the canals under his management.

Water Discharge Regulation in the Canals: A summary of requests, made by the responsible persons of the canals, will determine the variation of discharge in the main and secondary canals and the managers for the upstream canals will regulate them accordingly.

Water Delivery to Users' Representative: For each offtake, water delivery will be carried out at a certain time of the day. The amount of water, agreed with the canal manager, will be released through gates, measured and delivered in presence of the user's representative. The water release will be terminated at the pre-agreed time.

Recording Possible Water Delivery Variations: Further to submission of requests, the responsible person for the canals will finalize and report any changes in the processes of water delivery.

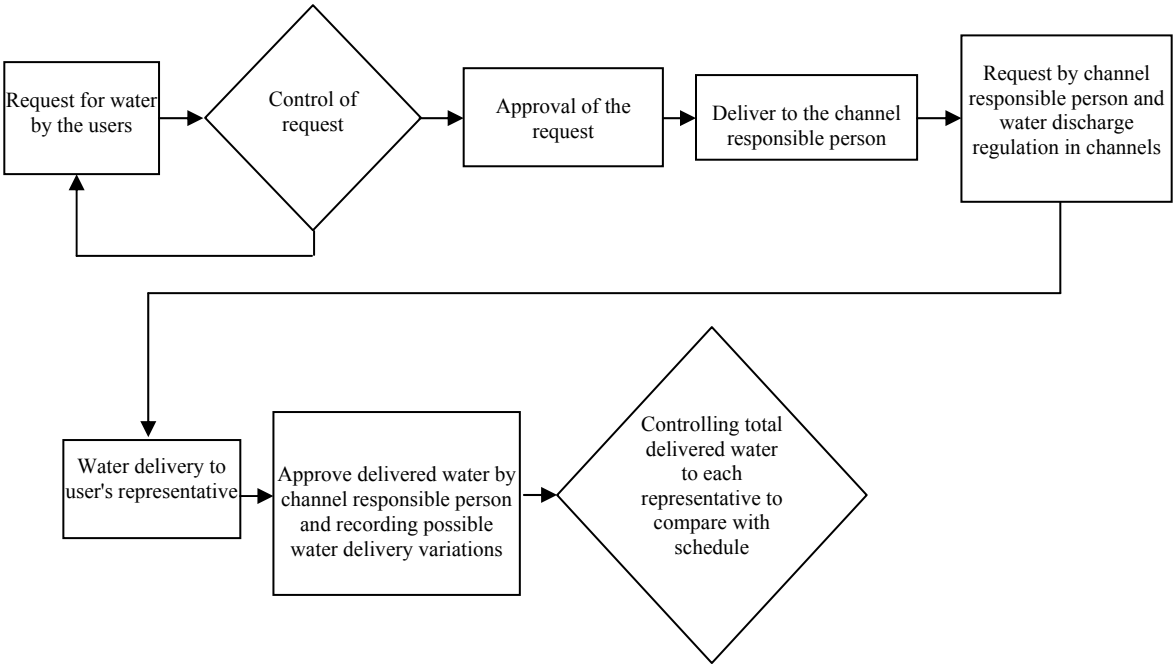

Figure 2. Process of Water Delivery to the Users

TRAININGS FOR VOLUMETRIC WATER DELIEVERY

To deliver water on volumetric basis, required on the job training, should be provided at three levels:

- Training for mangers and responsible persons of the irrigation network
- Training for water delivery operators
- Training for representatives of water users

Training for Managers and Responsible Persons

Training includes the following:

-Introduction to water distribution planning in irrigation networks

- Forecast of yearly water resources supply
- Forecast of yearly demand of irrigation network
- Planning water for distribution in the network per month

-Introduction to water control in the main network

- Network response to variations of inflow and demands
- Performance of equipment for water level regulation, measurement and delivery
- Loss in the main canals of the network
- Comparison of cropping pattern required by the users with the network pattern

- Calculation of monthly need of water users groups on the basis of gross water demand according to agreed pattern
- Methods for mitigation of flood and drought effects
- Method for calculation of water fees per cubic meter of water

-Introduction to database of irrigation network
- Method for collection and generation of data
- Preparation of schedule and tables for water distribution in the canals for the managers
- Application of information for supervision and performance control of water distribution and delivery in the network

-Introduction to laws and regulations for water distribution management

Training for Water Delivery Operators

-Introduction to cropping pattern and water demand table of water users groups

-Introduction to volumetric water delivery and calculation of its daily discharge on the basis of volume of water, specified in the agreement

-Introduction to operation of water delivery and regulation system
- Structure of equipment and their application
- Periodic and daily demand
- Method of regulation and performance monitoring of the installations
- Usual problems of the facilities and their trouble shooting

-Methods of communications and guiding water users/representatives
- Introduction to irrigation rotation in the networks under management of the representatives
- Introduction to laws and regulations for water distribution and delivery
- Introduction to preparation of forms for information and formats of reports
- Methods of interaction with the water users and confidence building

-Introduction to calculation of water loss in the canals

Training for Water Users

-Introduction to collection of users reports for yearly cultivation in accordance with the cropping pattern and water demand

-Introduction to calculation of water demand for crops and converting volumes to daily discharge

-Introduction to water circulation in the area under management of each representative and fair distribution of water among them

-Introduction to water fees and ways of it collection from the users

-Introduction to laws and regulations for water delivery and distribution in the network

-Introduction to water measurement using facilities and equipment in the network under their management, offtakes and daily services and maintenance of such facilities