ASSESSMENT OF SUPPLY AND IRRIGATION DEMAND FOR DAGAI DISTRIBUTARY OF THE MAIRA BRANCH OF UPPER SWAT CANAL IRRIGATION SYSTEM.

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ABSTRACT
This paper evaluates the supply and demand at tertiary level in Dagai Distributary of the Maira Branch of Upper Swat Canal. It is a crop based irrigation system with high water allowance of 0.7 l/s/ha, which is more than 3 times the average in Pakistan. Daily water supply to three sample outlets of the Dagai Distributary was monitored from April 2004-December 2004. The daily water supplies to the outlets were determined through daily water level (stage) measurements from which stage-discharge relationships of the outlets in the field were developed. The water supplies were compared with the irrigation demands, which were computed through CropWat software for a cropping intensity of 175%. The results indicated that the three sample outlets received more water than their requirements. The Crop Based Irrigation Operations in the irrigation system in the months of November and December saved a reasonable quantity of water during the period.

INTRODUCTION
Irrigation canals which are designed to meet the peak irrigation requirements, excess water supply is expected in the periods of low demand. Water being a highly valuable commodity, needs strategies for its optimal use. Lack of financial resources and infrastructure are a major obstacle to improving the efficiency of the system in developing countries. Efficient operation and management of the system is, therefore, the feasible alternative Mishra et al (2001).

In the traditional large scale supply based irrigation systems in Pakistan the common objective is to irrigate maximum area with the limited water supply having design cropping intensities of 75%. Recently in Pakistan some of the supply based systems have been changed into demand based systems which are able to meet water requirements even in the peak summer season for cropping intensities of up to 180%. The operation of such systems is the responsibility of the Irrigation Department. They still operate them as supply based systems, having minimum interference with the system. As a consequence of such operation the result is an over supply with a lot of wastage of water in the periods of low demand.

A comparison of the irrigation demand and water supply was made by Hussain (1980) for different canal commands of the Indus Basin. He found an over all shortage of 30 percent in supply. Halsema et al (1997) and Khan et al (2005) compared the irrigation supply and demand in the irrigation systems in Peshawar valley and found that there was an over all excess supply to the tertiary units.

MATERIALS AND METHODS
Study Area
Dagai Distributary is situated in the head of Maira Branch of Upper Swat Canal (USC) with a design discharge of 1.87 cusecs. It is 3.2 kilometers long and consists of Dagai and Dandoka minors. These are 10 and 5 kilometers long with design discharges of 0.73 and 0.85 cusecs respectively. Dagai Distributary consists of five outlets of which, four were Crump weirs (Bos, 1976) and one AOSM (Ali, 1993). Dandoka Minor of Dagai Distributary has 14 outlets of which 13 were Crump weirs and two AOSM. Dagai Minor consists of 13 Crump weir outlets.

The USC system underwent a remodeling in mid 1990s. In which its water allowance was changed from 0.4 l/s/ha to 0.7 l/s/ha (3.5 mm day\(^{-1}\) to 6 mm day\(^{-1}\)). This amount is close to the maximum irrigation requirements. Dimensions of canals and outlets were also increased to accommodate the increased supplies. The problems of water shortages in winter in the tail sections (Maira Branch) of the system were addressed through the construction of Pehur High Level Canal (PHLC).

This study was conducted in the Dagai Distributary of the Maira Branch of the Upper Swat Canal, NWFP, Pakistan. The period of study was from April 2004-December 2004.

Objectives of the study were as follows:

i. Determine the stage-discharge relationship for outlets of selected tertiary units of the Dagai Distributary.

ii. Measure the daily supply to the selected tertiary units of Dagai Distributary.

iii. Compare the water supply with the irrigation demand of the selected tertiary units.

Three outlets 3485/L, 10450/R and 15850/R were selected representing the head, middle and tail outlets of the Dagai Distributary were selected for the study. All the three outlets were Crump weir outlets.

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Outlet Calibration
The tertiary offtakes were calibrated through the determination of stage-discharge relationships. The discharge of a weir outlet depends on the water level (stage) in the parent canal. In order to determine the stage-discharge relationships for the sample outlets, discharges of the outlets were measured at different water levels in the parent canal (Distributary) by using current meters. The actual discharge coefficients ($C_{d_a}$) were determined for all the outlets. The equation for discharge of a weir is (Bos, 1976) as follows:

$$Q = C_d (0.66)(\sqrt{2g}) (B)(H)^{1.5}$$

Where $C_d$ = Discharge coefficient

$g$ = Gravitational acceleration ($m^2 s^{-1}$)

$B$ = Width of the weir crest ($m$)

$H$ = Head over the weir ($m$)

The theoretical average value for $C_d$ of a Crump weir is 0.67 and the combined product with the other constants results in a coefficient of 1.98.

Daily Water Supply to the Tertiary Units
Flows to the sample outlets of Dagai Distributary were determined from daily water level monitoring in front of the outlets and stage-discharge relationships were developed. Water levels were measured once a day due to little variations in water levels on daily basis. The daily water levels were measured by placing reference marks along the walls of the canal upstream of the outlets. Reference marks were placed at a distance of 4 times the crest level of weirs (Bos, 1976).

Irrigation Requirements
The irrigation demand data was used from Swabi SCARP (1991), which is based on a cropping intensity of 175%. Long term (25 years) data were used to determine the irrigation requirements using the Penman Monteith equation to compute the evapotranspiration through the CropWat (Clarke et al., 1998) computer software.

RESULTS AND DISCUSSION
The stage-discharge curves of the outlets of Dagai Distributary are presented in Figures 1, 2 and 3, respectively. The $C_{d_a}$ values of the outlets 3485/L, 10450/R and 15850/R were 2.5, 1.73 and 2.36 respectively. These variations were due to the field conditions such as error in head measurement. More importantly it is usual for weirs to trap some sediment and other material upstream of the weir crest causing an increase in the actual value. Restrictions to flow downstream of the crest and high crest resulted in a decrease in the value of the ($C_{d_a}$).

![Fig. 1. Stage-discharge relationship of outlet 3485/L of Dandoka Minor.](image-url)
**Supply and Demand**

In the period from April-July, the actual water supply to the sample outlets was in excess of the requirements (Fig. 4, 5 and 6). In August, there was a prolonged closure of the Distributary due to rainfall, resulting in water saving. Due to the rotations introduced in the system by the Irrigation Department under the Crop Based Irrigation Operations Khan et al (2004), in the period from August-December there was some water saving, although even then, there was excess water supply to all the outlets. Observations on irrigation patterns of water users indicated that most of the irrigation activities were taking place in the day time. Night irrigation practices in months such as from July-August and from November-December were not observed. In the months of June and August water users either closed the outlets of their watercourses or they simply let water flow to nearby drain at the downstream end of the watercourse.
Fig. 4. Supply and demand of outlet 3485/L.

Fig 5. Supply and demand of outlet 10450/L.
CONCLUSIONS
The following conclusions can be drawn from the study:

i. There was over supply to all the sample outlets of the distributary.

ii. Water saving measures should be introduced such as night supply reduction.

iii. Such an over supply could result in water logging in the command area of Dagai Distributary.

REFERENCES


