ISSN: 2319-5967
ISO 9001:2008 Certified
International Journal of Engineering Science and Innovative Technology (IJESIT)
Volume 2, Issue 2, March 2013

Irrigation System Assessment- Farmer's and Manager's view

Binoy Aliyas Mattamana, Shiney Varghese, Kichu Paul
Professor, Civil Engineering, M.A. College of Engineering, Kothamanagalm, Kerala
Professor, Civil Engineering, M.A. College of Engineering, Kothamanagalm, Kerala
Assistant Professor, Civil Engineering, M.A. College of Engineering, Kothamanagalm, Kerala

Abstract— ***Irrigation is the key input in crop production. There are considerable numrs of techniques addressing the performance assessment of irrigation systems. Most of them give the performance index which is highly complicated. A system is said to be performing acceptable only if the supplier as well as beneficiary are satisfied. Here the supplier is irrigation system manager and beneficiary is farmer. From the point of view of farmer, he is satisfied when the irrigation water available is dependable and also to meet his requirement and the supplier is satisfied when he is able to supply water in a socially acceptable manner. To have a comprehensive view from both the sides different parameters are used. From the farmer's side adequacy, dependability and deficiency can be taken where as the indicators like efficiency, equity and wastage can be taken from the point of view of an irrigation system manager. In this study the above performance parameters has been selected to study the overall effectiveness of an irrigation system. It was found out that all these parameters are simple in calculation and it is easy for farmers and suppliers to assess the performance of an irrigation system***

Index Terms— **Irrigation, Irrigation System Assessment, Adequacy, Dependability, Deficiency, Efficiency, Equity, Wastage.**

I. INTRODUCTION

Irrigation is the key input in crop production. Faulty irrigation will cause wasting of valuable water and it will also affect the crop production. The success of an irrigation water delivery system can be measured by how well it meets the requirement of users served by them. From the farmer's point of view, the system is effective only when the water supply is adequate and dependant. Where as the manager achieves satisfaction when the system is able to conserve water and distribute the water in an equitable manner. A measure of wastage and deficiency at various points will help the manager to govern the system more effectively. Keeping the user's and manager's view, six parameters has been selected. Adequacy, dependability and deficiency are the parameters which are the farmer's interest and efficiency, equity and wastage are the indexes which are useful for the irrigation system manager. Hence the objective of this paper is to assess the performance of an irrigation system based on all the above parameters, adequacy, dependability, deficiency, efficiency, equity and wastage. Madathikudy lift irrigation scheme situated in the Kothamangalam Taluk is the irrigation system selected for the demonstration. The performance of the irrigation system is assessed both from the point of view of farmer and the irrigation system manager.

II. METHODOLOGY

Consider an irrigation system which supplies water to different crops through canals and field channels. Let Q refer the discharge. Let x and t represent the spatial and temporal co-ordinates. QD(x,t) represent the amount of actual water delivered at a point x at time t and QR(x,t) is the net irrigation requirement.

FARMER'S VIEW

1) Adequacy: Delivery of Required Amount

The primary interest of the farmer is to get adequate water for irrigation. The amount of water required depends upon type of crop, cropped area, period of cropping, application losses, and cultural practices, such as land preparation and salt leaching. For a region and for a period T, the adequacy attained by a system can be measured by

$$P_A = \frac{1}{T}\sum_T\left(\frac{1}{R}\sum_R p_A\right) \qquad \text{-(1)}$$

where $$p_A = \frac{Q_D}{Q_R}, \qquad \text{if } Q_D \le Q_R$$

$$p_A = 1, \qquad \text{Otherwise}$$

P_A is the spatial and temporal average of the ratio of amount delivered to amount required.

2) Dependability: Uniform Delivery over Time

The second concern of the farmer is the dependability. The farmer should not only get the required amount but also should get it in time. If water is not available at the right time it may lead to total crop failure. Dependability is defined as temporal uniformity of the ratio of the delivered amount of water to be required or scheduled amount. A system that dependably delivers an inadequate amount of water may be more desirable than one that delivers on the average an adequate yet unpredictable supply. A farmer can plan for a dependable delivery of an inadequate supply of water by planting less or growing different crops or adjusting other farming inputs. The dependability of water delivery can be taken as the temporal variability of the ratio of amount of water required that occurs over a region. This is measured by

$$P_D = \frac{1}{R}\sum_R CV_T\left(\frac{Q_D}{Q_R}\right) \qquad \text{-(2)}$$

Where $CV_T\left(\frac{Q_D}{Q_R}\right)$ = temporal coefficient of variation of the ratio $\frac{Q_D}{Q_R}$ over the time period *T*. As the value of P_D approaches zero, the relative water delivery is becoming more uniform over time, indicating a more dependable delivery.

3) Deficiency: Shortage of Water

If water does not arrive at farms in an adequate and timely amount, crop yields may suffer and farm net returns may decrease. The degree of deficiency is another parameter that the farmer is more concerned, so that he can take precaution measures to meet it. Knowledge of the amount of deficiency is quantitative measure of the unsatisfaction of the farmer. Assessment of deficiency is given as the ratio of water deficiency to the required amount .A measure of deficiency is considered as the temporal and spatial average of the ratio of $(Q_R - Q_D)$ and Q_R

$$\text{Deficiency, } P_{DF} = \frac{Q_R - Q_D}{Q_R} \quad (\text{if } Q_R > Q_D) \qquad (3)$$

$$= 0 \qquad (\text{otherwise})$$

$$P_{DF} = \frac{1}{T}\sum_T\left(\frac{1}{R}\sum_R \frac{Q_R - Q_D}{Q_R}\right)$$

The expression gives water deficiency over the system in each period and overall deficiency over the period.

SYSTEM MANAGER'S VIEW

1) Efficiency: Conservation of Water Resources

Resource conservation plays an important role in water delivery. System manager should always be cautious that the water delivered should not be greater than the requirement. If the system is supplying more than the requirement, it indicates the non conservation of the resources. A measure of this would be the spatial and temporal average of the ratio of Q_R to Q_D

$$P_F = \frac{1}{T}\sum_T\left(\frac{1}{R}\sum_R p_F\right) \qquad \text{-(4)}$$

Where $p_F = \frac{Q_R}{Q_D}$, (if $Q_R \le Q_D$)

$p_F = 1$, (otherwise)

2) Equity: Delivery of Fair Amount

It is always fair for the manager to see that he is giving a fair share of water to users throughout the system. Equity can be taken as an index on this regard. Here equity is defined as spatial uniformity of the ratio of the delivered amount of water to the required. A measure of equity would be the average relative spatial variability of the ratio of the amount delivered to the amount required over the time period of interest. It is given as

$$P_E = \frac{1}{T}\sum_T CV_R\left(\frac{Q_D}{Q_R}\right) \qquad \text{-(5)}$$

Where $CV_R\left(\frac{Q_D}{Q_R}\right) =$ spatial coefficient of variation of the ratio $\frac{Q_D}{Q_R}$ over the region *R*. This measure describes the degree of variability in relative water delivery from point to point over the region. The closer the value of P_E is to zero, the greater the degree of equity in delivery.

3) Wastage: Excess Water

Delivery of more than adequate supply of water to delivery points within the system results in wastage. Additionally excess water deliveries to farms promote conditions of water logging and salinity. Knowledge of the amount of excess supply and the respective delivery points is highly helpful for the manager to have over all control on the system. Wastage is defined as ratio of water delivered excess to the required amount. A measure of wastage would be the spatial and temporal average of the ratio of $(Q_D – Q_R)$ and Q_R

$$\text{Wastage, } P_W = \frac{Q_D - Q_R}{Q_R} \qquad (6)$$

$$= 1 \ (\text{if } Q_R = 0 \text{ or } \frac{Q_D - Q_R}{Q_R} \ge 1 \ )$$

$$= 0 \quad (\text{if } Q_D \le Q_R)$$

$$P_W = \frac{1}{T}\sum_T\left(\frac{1}{R}\sum_R \frac{Q_D - Q_R}{Q_R}\right)$$

The expression gives water wastage over the system in each period and overall wastage over the period.

III. APPLICATION

Madathikudy lift Irrigation scheme in Kothamangalam was selected for the study. The scheme is situated in Varappetty Panchayat in the Kothamangalam Taluk (Lat- 76 ° 40’, Long-10° 7’), Ernakulam district, Kerala. The layout of the site is shown in Figure 1. The command area is nearly 46.54 hectors. The pump house consists of a pump of 60 HP. The length of the canal is nearly 2 Km. Main canal is about 1000 m and the branch in one direction is 450 m and that in the other direction is 500 m. The source of water for the scheme is the Kothamangalam River. Nine measuring points were selected at different locations on delivery system for the study, 3 each at head, middle and tail. At each measuring points a well defined cross section was constructed for measuring velocity. Each measuring points serves different command area.

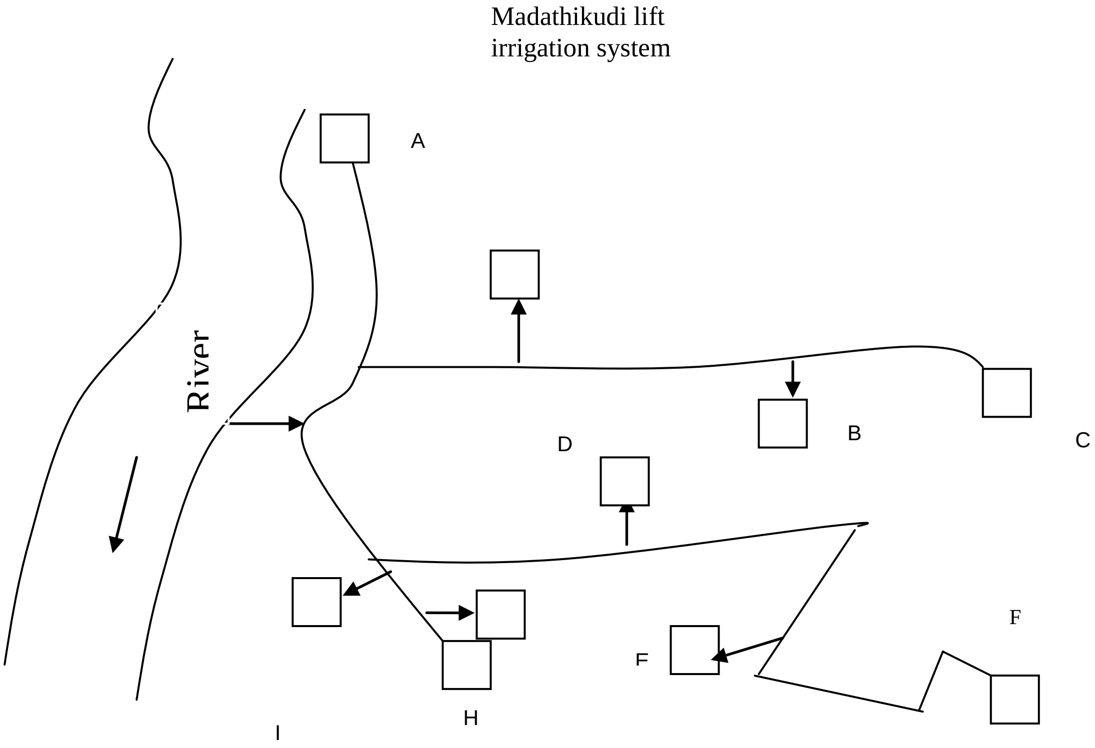


Fig 1. Layout of Madathikudi Lift Irrigation System

The second crop season spanning from October to February has been chosen for the study. The details of command area and cropping pattern were as shown in Table 1.The number of pumping days per week were six. Of this, on the first two days water was pumped to the head reach, the next two days to the middle reach and for the last two days pumping was to the tail reach. A set of field measurements were taken for a period of 15 weeks. The effectiveness of the system is measured from the farmer’s point of view and manager’s point of view as explained above.

Table 1 Details of Command Area and Crop Pattern

Sites	Command Area(ha)	Crop Pattern
A	0.45	Pineapple
B	0.20	Paddy
C	0.61	Paddy
D	0.36	Coconut
E	0.40	Plantain
F	0.14	Plantain

G	0.178	Paddy
H	0.202	Paddy
I	0.071	Paddy

WATER REQUIRED AND WATER DELIVERED

Water delivered and water required at 9 delivery points for a period of 15 weeks were worked out. Water delivered were determined from the stable known cross sections of the delivery channel and the mean velocity of flow

i.e. Discharge = Cross sectional area × Mean velocity - (7)

As per the equation 7, the water delivered at 9 delivery points for 15 weeks are given in Table 2. Water requirement of the plants depends on growth stage of plant and temperature. Pan evaporation method combining growth stage and temperature through evaporation, suggested by Michael, A. M (2006) is used to estimate the crop water requirement. The crop water requirement is estimated as follows.

$$CWR = Pe \times CF \times N \qquad - (8)$$

Where CWR = Weekly crop water requirement in mm.

Pe = Pan evaporation in mm,day.

Sites/ Weeks	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
A	189.0	198.0	207.0	162.0	0.0	69.4	131.1	138.8	61.7	48.0	168.0	36.0	168.0	241.5	81.0
B	177.8	34.0	25.7	205.9	425.6	80.1	176.2	184.2	168.2	183.2	0.0	391.3	191.5	159.1	224.6
C	77.4	77.4	162.5	255.4	93.4	172.3	148.8	172.3	211.4	146.5	0.0	138.8	208.3	220.2	14.9
D	143.6	143.6	90.7	113.4	113.4	91.8	113.4	135.0	135.0	135.0	69.4	69.4	69.4	145.8	64.8
E	96.9	96.9	46.8	93.5	210.2	112.0	133.3	133.3	122.6	62.8	51.7	45.8	51.7	40.1	79.5
F	17.6	85.8	52.8	96.8	140.8	91.6	91.6	100.4	0.0	55.5	13.7	205.7	34.3	85.8	48.2
G	116.2	79.2	68.6	47.5	103.5	76.5	112.5	103.5	13.8	12.0	26.4	0.0	7.2	18.0	10.9
H	215.9	200.0	176.0	184.0	220.3	204.0	195.8	204.0	15.8	21.6	138.2	0.0	21.6	70.2	62.4
I	133.2	126.0	79.2	79.2	76.6	73.1	59.2	38.3	9.8	6.5	7.5	0.0	10.1	0.0	23.9

CF = Crop factor.

N = Number of days.

Water requirement for each site was obtained by multiplying the crop water requirement for each crop with the area of sites. Calculated values of crop water requirement for each crop at 9 measuring points for the 15 weeks were given in Table 3. But there will be considerable reduction in the crop water requirement due to rainfall. Data corresponding to rainfall were collected from different measuring stations and given in Table 4. Therefore the net irrigation requirement is obtained by deducting rainfall for one week from the corresponding water requirement and given in Table 5.

Table 3 Crop Water Requirement in mm

Sites/Weeks	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
A	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
B	27	27	27	27	27	25	25	26	27	29	29	30	34	33	33
C	27	27	27	27	27	25	25	26	27	29	29	30	34	33	33
D	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
E	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20
F	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20
G	27	27	27	27	27	25	25	26	27	29	29	30	34	33	33
H	27	27	27	27	27	25	25	26	27	29	29	30	34	33	33
I	27	27	27	27	27	25	25	26	27	29	29	30	34	33	33

Table 4 Rainfall in cm

Sites/Weeks	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
A	4.0	14.2	7.0	5.7	1.0	9.2	6.1	1.7	0.0	1.3	0.0	0.0	0.0	0.0	0.7
B	4.0	14.4	7.1	5.8	1.0	9.3	6.2	1.7	0.0	1.3	0.0	0.0	0.0	0.0	0.7
C	4.0	14.1	7.0	5.7	1.0	9.2	6.1	1.7	0.0	1.3	0.0	0.0	0.0	0.0	0.7
D	4.0	14.4	7.1	5.8	1.0	9.3	6.2	1.7	0.0	1.3	0.0	0.0	0.0	0.0	0.7
E	4.0	14.4	7.1	5.8	1.0	9.3	6.2	1.7	0.0	1.3	0.0	0.0	0.0	0.0	0.7
F	4.0	14.4	7.1	5.8	1.0	9.3	6.2	1.7	0.0	1.3	0.0	0.0	0.0	0.0	0.7
G	4.0	14.2	7.0	5.7	1.0	9.2	6.1	1.7	0.0	1.3	0.0	0.0	0.0	0.0	0.7
H	4.0	14.2	7.0	5.7	1.0	9.2	6.1	1.7	0.0	1.3	0.0	0.0	0.0	0.0	0.7
I	4.0	14.2	7.0	5.0	1.0	9.2	6.1	1.7	0.0	1.0	0.0	0.0	0.0	0.0	0.7

Table 5 Net Water Requirement (Q_R) in Cubic Meter

Sites/Weeks	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
A	270.0	0.0	135.0	193.5	405.0	36.0	175.5	373.5	450.0	391.5	450.0	450.0	450.0	450.0	418.5
B	0.0	0.0	0.0	0.0	34.0	0.0	0.0	18.0	54.0	32.0	58.0	60.0	68.0	66.0	52.0
C	0.0	0.0	0.0	0.0	103.7	0.0	0.0	54.9	164.7	97.6	176.9	183.0	207.4	201.3	158.6
D	0.0	0.0	0.0	0.0	7.2	0.0	0.0	0.0	43.2	0.0	43.2	43.2	43.2	43.2	18.0
E	0.0	0.0	0.0	0.0	40.0	0.0	0.0	12.0	80.0	28.0	80.0	80.0	80.0	80.0	52.0
F	0.0	0.0	0.0	0.0	14.0	0.0	0.0	4.2	28.0	9.8	28.0	28.0	28.0	28.0	18.2
G	0.0	0.0	0.0	0.0	30.3	0.0	0.0	16.0	48.1	28.5	51.6	53.4	60.5	58.7	46.3

H	0.0	0.0	0.0	0.0	34.3	0.0	0.0	18.2	54.5	32.3	58.6	60.6	68.7	66.7	52.5
I	0.0	0.0	0.0	0.0	12.1	0.0	0.0	6.4	19.2	13.5	20.6	21.3	24.1	23.4	18.5

PERFORMANCE INDICATORS

FARMER'S VIEW

1) ADEQUACY

The adequacy has been calculated using the Equation (1). Spatial and temporal mean values of Q_D/Q_R are given in Table 6. The overall adequacy of the system is found to be 80%. However, weekly adequacy has been analyzed for critical evaluation. The spatial average of adequacy is given in Figure 2. Among 15 weeks, 11 & 12 th weeks shows very less adequacy. Figure 3 shows temporal average of adequacy versus sites. Site A shows very less adequacy whereas Site D shows very high adequacy.

Table 6 Adequacy

		Periods															
Sites	Area(ha)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	Temporal Average
A	0.45	0.7	1.0	1.0	0.8	0.0	1.0	0.8	0.4	0.1	0.1	0.4	0.1	0.4	0.5	0.2	0.5
B	0.2	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.0	1.0	1.0	1.0	1.0	0.9
C	0.61	1.0	1.0	1.0	1.0	0.9	1.0	1.0	1.0	1.0	1.0	0.0	0.8	1.0	1.0	0.1	0.9
D	0.36	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
E	0.4	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.7	0.6	0.7	0.5	1.0	0.9
F	0.14	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.0	1.0	0.5	1.0	1.0	1.0	1.0	0.9
G	0.18	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.3	0.4	0.5	0.0	0.1	0.3	0.2	0.7
H	0.2	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.3	0.7	1.0	0.0	0.3	1.0	1.0	0.8
I	0.07	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.5	0.5	0.4	0.0	0.4	0.0	1.0	0.7
Spatial Average		1.0	1.0	1.0	1.0	0.9	1.0	1.0	0.9	0.6	0.7	0.5	0.5	0.7	0.7	0.7	0.8

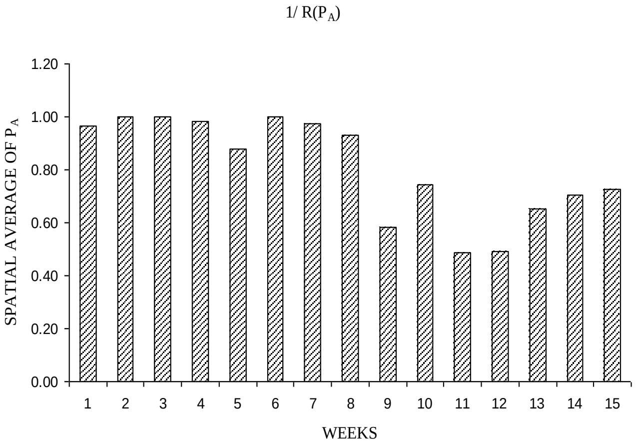


Fig 2. Plot of Spatial Average of PA over Weeks

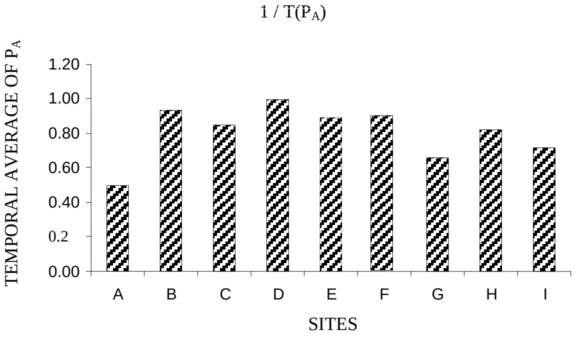


Fig 3. Plot of Temporal Average of PA over Sites

1) DEPENDABILITY

Table 7 shows dependability calculated. Dependability was given by Equation (2). The overall dependability of the system is found to be 0.38. Spatial average of coefficient of variation is graphically shown in Figure 4. Figure

4 show that at site D the coefficient of variation is zero. But at site A it is high. It shows that Site D is highly dependable.

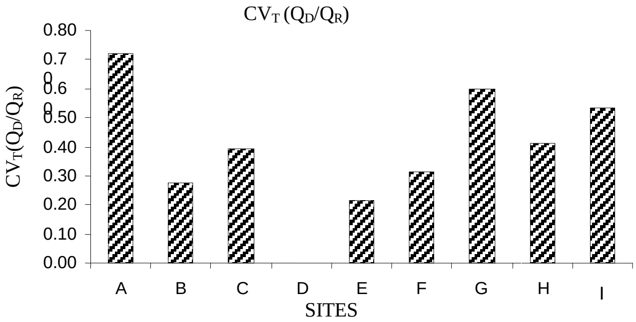


Fig 4 Plot of Temporal Average of CV_T over Sites

Table 7 Dependability & Equity

		Periods																	
Sites	Area (ha)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	Average	Std	CV
A	0.45	0.70	1.00	1.00	0.84	0.00	1.00	0.75	0.37	0.14	0.12	0.37	0.08	0.37	0.54	0.19	0.50	0.36	0.72
B	0.20	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.00	1.00	1.00	1.00	1.00	0.93	0.26	0.28
C	0.61	1.00	1.00	1.00	1.00	0.90	1.00	1.00	1.00	1.00	1.00	0.00	0.76	1.00	1.00	0.09	0.85	0.33	0.39
D	0.36	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.00	0.00
E	0.40	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.65	0.57	0.65	0.50	1.00	0.89	0.19	0.21
F	0.14	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.00	1.00	0.49	1.00	1.00	1.00	1.00	0.90	0.28	0.31
G	0.18	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.29	0.42	0.51	0.00	0.12	0.31	0.24	0.66	0.39	0.60
H	0.20	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.29	0.67	1.00	0.00	0.31	1.00	1.00	0.82	0.34	0.41
I	0.07	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.51	0.48	0.36	0.00	0.42	0.00	1.00	0.72	0.38	0.53
Average		0.97	1.00	1.00	0.98	0.88	1.00	0.97	0.93	0.58	0.74	0.49	0.49	0.65	0.70	0.72			0.38
Std		0.10	0.00	0.00	0.05	0.33	0.00	0.08	0.21	0.42	0.33	0.36	0.47	0.36	0.38	0.41			Dependability
CV		0.10	0.00	0.00	0.06	0.38	0.00	0.09	0.23	0.72	0.45	0.75	0.95	0.55	0.54	0.57	0.36		

Equity

3) ***DEFICIENCY***

Amount of deficit was obtained by using Equation (3). The temporal and spatial average of deficit is given in Table 8. The overall deficiency of the system is found to be 19%. Figure 5 shows the variation of deficiency over weeks. Spatial average is zero at second, third and sixth weeks. Deficiency is high at the end of the period. Graphical representation of temporal average is given in Figure 6. It shows that deficiency is zero at site D. At the same time Site A is affected by high deficiency. Shortage of water is less for other sites

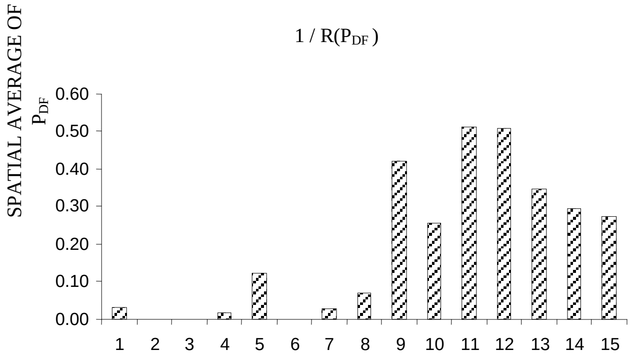


Fig 5 Plot of Spatial Average of P_{DF} over Weeks

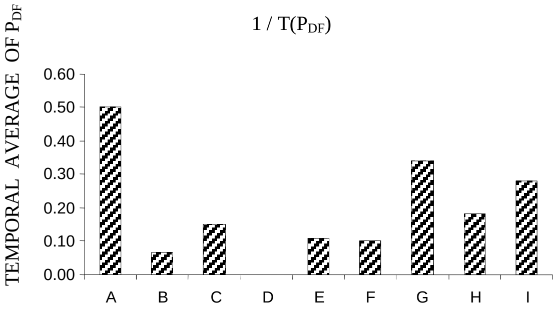


Fig 6 Plot of Temporal Average of P_{DF} over Sites

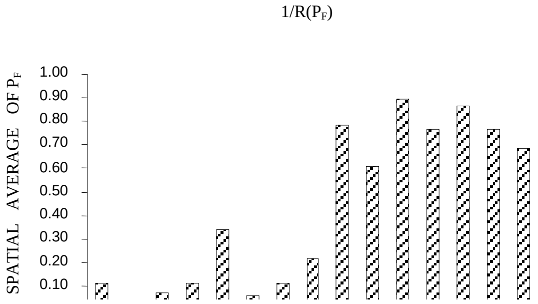
Table 8 Deficiency

		Periods															
Sites	Area(ha)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	Temporal Average
A	0.45	0.30	0.00	0.00	0.16	1.00	0.00	0.25	0.63	0.86	0.88	0.63	0.92	0.63	0.46	0.81	0.50
B	0.20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.07
C	0.61	0.00	0.00	0.00	0.00	0.10	0.00	0.00	0.00	0.00	0.00	1.00	0.24	0.00	0.00	0.91	0.15
D	0.36	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
E	0.40	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.35	0.43	0.35	0.50	0.00	0.11
F	0.14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.51	0.00	0.00	0.00	0.00	0.10
G	0.18	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.71	0.58	0.49	1.00	0.88	0.69	0.76	0.34
H	0.20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.71	0.33	0.00	1.00	0.69	0.00	0.00	0.18
I	0.07	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.49	0.52	0.64	1.00	0.58	1.00	0.00	0.28
Spatial Average		0.03	0.00	0.00	0.02	0.12	0.00	0.03	0.07	0.42	0.26	0.51	0.51	0.35	0.30	0.28	0.19

MANAGER'S VIEW

1*) EFFICIENCY*

Efficiency has been calculated by using the Equation (4). Spatial and temporal mean values of Q_R/Q_D are given in Table 9. The overall efficiency of the system is found to be 43%. Spatial average of efficiency was graphically shown in Figure 7. Efficiency was very less up to 8th week. From 9 -15 weeks efficiency was very high. Figure 8 shows temporal averages of efficiency. Efficiency shows very much change in each site. Site A having high efficiency while others have less efficiency.



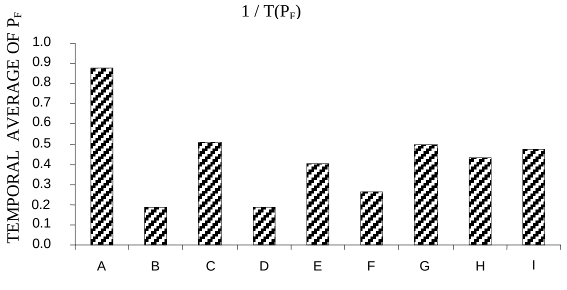


Fig 7 Plot of Spatial Average of P_F over Weeks **Figure 8 Plot of Temporal Average of P_F over Sites**

Table 9: Efficiency

		Periods															
Sites	Area (ha)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	Temporal Average
A	0.45	1.00	0.00	0.65	1.00	1.00	0.52	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.88
B	0.20	0.00	0.00	0.00	0.00	0.08	0.00	0.00	0.10	0.32	0.17	1.00	0.15	0.36	0.41	0.23	0.19
C	0.61	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.32	0.78	0.67	1.00	1.00	1.00	0.91	1.00	0.51
D	0.36	0.00	0.00	0.00	0.00	0.06	0.00	0.00	0.00	0.32	0.00	0.62	0.62	0.62	0.30	0.28	0.19
E	0.40	0.00	0.00	0.00	0.00	0.19	0.00	0.00	0.09	0.65	0.45	1.00	1.00	1.00	1.00	0.65	0.40
F	0.14	0.00	0.00	0.00	0.00	0.10	0.00	0.00	0.04	1.00	0.18	1.00	0.14	0.82	0.33	0.38	0.26
G	0.18	0.00	0.00	0.00	0.00	0.29	0.00	0.00	0.15	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.50
H	0.20	0.00	0.00	0.00	0.00	0.16	0.00	0.00	0.09	1.00	1.00	0.42	1.00	1.00	0.95	0.84	0.43
I	0.07	0.00	0.00	0.00	0.00	0.16	0.00	0.00	0.17	1.00	1.00	1.00	1.00	1.00	1.00	0.77	0.47
Spatial Average		0.11	0.00	0.07	0.11	0.34	0.06	0.11	0.22	0.79	0.61	0.89	0.77	0.87	0.77	0.68	0.43

2) EQUITY

Equity was calculated using Equation (5). Table 7 shows equity calculated. The overall equity of the system is found to be 0.36. Graphical representation of coefficient of variation versus weeks is given in Figure 9. Figure 9 shows that during the period 2, 3 and 6 the coefficient of variation seems to be zero. But at the 12th week it is very high and near to 1. So greater the degree of equity during 2nd, 3rd and 6th weeks.

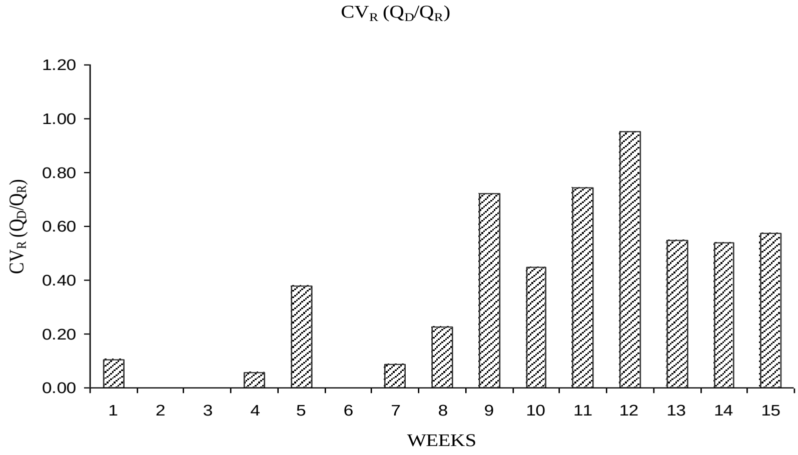
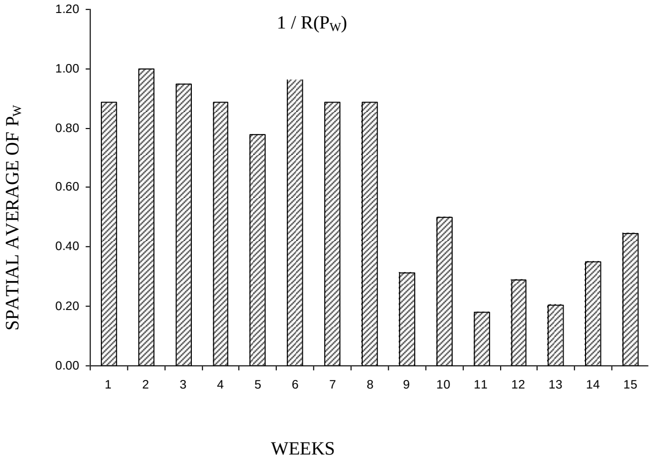


Fig 9 Plot of CV_R over Weeks

ISSN: 2319-5967
ISO 9001:2008 Certified
International Journal of Engineering Science and Innovative Technology (IJESIT)
Volume 2, Issue 2, March 2013

3) WASTAGE

Wastage was calculated using Equation (6). Spatial and temporal mean values of wastage are given in Table 10.



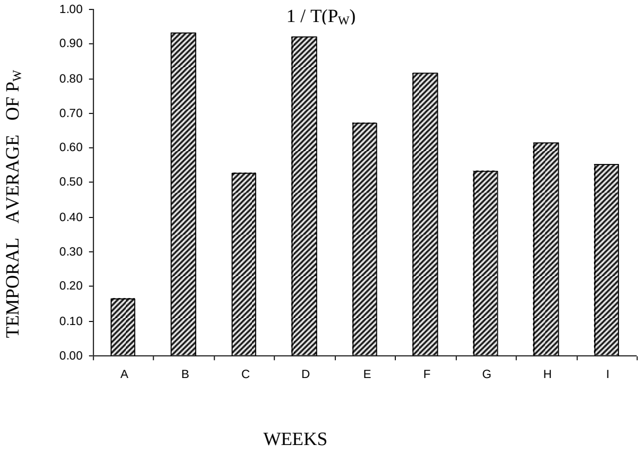


Fig 10 Plot of Spatial Average of PW over Weeks **Fig 11 Plot of Temporal Average of P_W**

The overall wastage of the system is found to be 64%. Figure 10 shows spatial average of wastage over weeks. At 2nd & 6th weeks wastage seems to be very high. Wastage is considerably less in 11th & 13th weeks. Temporal average of wastage over site is shown in figure 11. At sites A wastage is very less. Site B & D shows large amount of wastage.

Table 10 Wastage

		Periods															
Sites	Area(ha)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	Temporal Average
A	0.45	0.00	1.00	0.53	0.00	0.00	0.93	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.16
B	0.20	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.00	1.00	1.00	1.00	1.00	0.93
C	0.61	1.00	1.00	1.00	1.00	0.00	1.00	1.00	1.00	0.28	0.50	0.00	0.00	0.00	0.09	0.00	0.53
D	0.36	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.61	0.61	0.61	1.00	1.00	0.92
E	0.40	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.53	1.00	0.00	0.00	0.00	0.00	0.53	0.67
F	0.14	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.00	1.00	0.00	1.00	0.23	1.00	1.00	0.82
G	0.18	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.53
H	0.20	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.00	0.00	1.00	0.00	0.00	0.05	0.19	0.62
I	0.07	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.29	0.55
Spatial Average		0.89	1.00	0.95	0.89	0.78	0.99	0.89	0.89	0.31	0.50	0.18	0.29	0.20	0.35	0.45	0.64

V. CONCLUSION

Parameters for performance have been worked out. From the results it can be observed that the system manager is able to control the wastage at the sites B and D as the wastage is more than 80% upto 8th week where as a care should be taken to deliver water at site A as the deficiency of water is nearly 50% during end of the weeks. Performance indicators used are very simple in understanding and computation .The parameters used in farmer's point of view will helps the farmer to identify whether water does not arrive at farms in an adequate and timely amount. It also gives a quantitative measure of unavailability of water at farms. The parameters like efficiency, equity and wastage will help the irrigation system manager to control the water delivery system economically. This method is very transparent and easy for farmers and suppliers to assess the performance of an irrigation system.

REFERENCES

[1] Akkuzu, E., Unal, H.B., Karatas, B.S., Musa Avci., and Serafettin Asik., "General Irrigation Planning Performance of Water User Associations in the Gediz Basin in Turkey", Journal of Irrigation. and Drainage. Engg. 133(1), pp. 17-26, 2007.

[2] "General Irrigation Planning Performance of Water User Associations in theGediz Basin in Turkey", Journal of Irrigation. and Drainage. Engg. 133(1), pp. 17-26.

[3] Bos, M.G., Murry Rust, D.H., Merry, D.J., Johnson, H.G., and Snellen, W.B., 1993, "Methodologies for assessing performance of irrigation and drainage management, Irrigation and Drainage systems "., Vol. 7(4),pp. 231- 261 , 1993.

[4] Chari, S.T., Jonna, S., Raju, P.V., Murthy, C.S., and Hakeem, K.A., "System Performance Evaluation and Diagnostic Analysis of Canal Irrigation Projects", 1994.

[5] Clemmens, A.J., and Bos, M.G., "Statistical methods for irrigation system water delivery performance evaluation", Irrigation and Drainage systems. Vol. 4(4), pp. 345- 365, 1990.

[6] Fuard Marikar, John Wilkin-Wells, Susan Smolnik, and Sampath,R.K., 1992, " Irrigation system performance and its impact on crop productivity in SriLanka", International Journal of Water Resources Development., Vol. 8(4), pp. 226 – 234.

[7] Gorantiwar, S.D., and Smout, I.K., "Performance assessment of irrigation water management of heterogeneous irrigation schemes: 1.A frame work for evaluation", Irrigation and Drainage systems. 19(1), pp. 1-36, 2005.

[8] Javan, M., Sanaee-Jahromi, S., and Fiuzat, A.A., 2002, Quantifying Management of Irrigation and Drainage Systems, Journal of Irrigation. and Drainage. Engg. 128(1), 19- 25.

[9] Molden, D.J., and Gates, T.K., "Performance Measures for Evaluation of Irrigation-Water-Delivery Systems, Journal of Irrigation and Drainage Engineering"., 116(6), pp. 804-823,1990.

[10] Onta, P.R., and Madhab Banskota., "Performance based irrigation planning under water shortage, Irrigation and Drainage systems", 9 (2), Vol. 143-162, 1995.

[11] Ramchand Oad, and Sampath, R.K., 1995, "Performance measure for improving irrigation management, Irrigation and Drainage systems".,9 (4),pp. 357-370,1995.

[12] Samad Sanaee-Jahromi., Herman Depeweg., and Jan Feyen., "Water Delivery Performance in the Doroodzan Irrigation Scheme, Iran, Irrigation and Drainage Systems", 14(3), pp. 207-222, 2000.

[13] Small, L.E., and Arbindra Rimal., 1996, "Effects of alternative water distribution.

AUTHOR BIOGRAPHY

Binoy Aliyas Mattamana B.Tech (Civil). Kerala University, M.E. College of Engineering, Guindy,Anna University Chennai, Ph.D., Indian Institute of Science, Bangalore. Teaching since 1986. 2 year field experience in water management and 5 year research experience, Professor, Professor in Civil Engineering Department in Mar Athanasius college of Engineering, Kothamangalam.

Shiney Varghese B.Tech (Civil). Kerala University, M.E. College of Engineering, Guindy, Anna University Chennai. Professor in Civil Engineering Department in Mar Athanasius college of Engineering, Kothamangalam.

Kichu Paul took B.Tech M.G. University and joined as Asst. Professor in Civil Engineering Department in Mar Athanasius college of Engineering, Kothamangalam.