Catchment Water balance Studies

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Abstract

In the dry zone of Sri Lanka Catchment water balance has shown a contribution to water table by rain only in wet months (positive values in the last row of table 3) of the year. In dry months continuous depletion of soil moisture is clearly evident (negative values in the last row of table 47 except during first few weeks).

It could be generalised stating that the recharging of the Ground Water table in the Dry zone of Sri Lanka takes place in the wet season by rain and by heavy irrigations in the Dry season.

Introduction

This paper report on a hydrologic study undertaken in the Catchment "C" project, in the dry zone research agricultural station at Mahailluppallama. This catchment bears well drained Reddish Brown Earth soils, Imperfectly drained Reddish Brown earth soils, and their drainage associate the Low Humic Gley soils. Full catchment (12.2 Ha) was cropped on both graded and bench terraces. The catchment has an average slope of 2% and was developed to practice Surface Irrigation. Runoff from the well drained and Imperfectly drained area were monitored separately from that of the poorly drained area.

Materials and Methods

Water budget or storage equation was used in this study.

$E_T = P + I \pm U - O \pm S$ (Wilson, 1975)

Where E_T = Evapotranspiration
P = Total precipitation
I = Surface Inflow (ie. Irrigation if any)
U = Underground outflow
O = Surface outflow
S = Change in Storage (Both surface and sub-surface)

This study was done with a full catchment bearing crops. During Maha 1978/79 the poorly drained member was restricted only for paddy whilst the imperfectly drained and well drained members were cropped with Maize, Soybean, Chillies and Paddy.

In Yala 1979 the whole catchment was cropped with Cowpea and Soybeans. The surface outflow from the well drained and Imperfectly drained area was measured using a Parshallmeasuring flume (0.92 meters wide) filled with an automatic water level recorder. The subsurface inflow and outflow in the catchment was not taken into consideration.

Four nonrecording rain gauges were installed at different points according to Theissen polygon method to obtain mean rainfall in the catchment. All the environmental weather parameters were obtained from Mahailluppallama Agromet Station. These data were used in modified Penmann formula (FAO, 1977) to estimate E_t grass. The stage by stage crop factors were used to obtain E_T crop. Irrigation schedule was based on soil and crop data for Maha 1978/79 (Table 1), and for Yala 1979 (Table 2).

Table 1 Soil and Crop data for Maha 1978/79

Crop	Growth Stages			
	1	2	3	4
Paddy (Variety - 75 - 150)	20 days	30 days	30 days	20 days
Assumed root depth	0.31 m	0.46 m	0.46 m	0.46 m
Depletion level	25%	25%	25%	25%
CSMD (m)	0.0102	0.0153	0.0153	0.0153
Soybean (Variety - Pb-1)	15 days	20 days	30 days	20 days
Assumed root depth	0.31 m	0.61 m	0.92 m	0.92 m
Depletion level	50%	75%	75%	75%
CSMD (m)	0.0203	0.0610	0.0910	0.0910
Maize (Variety Thai - Compositae	20 days	35 days	45 days	30 days
Assumed root depth	0.31 m	0.61 m	0.61 m	0.61 m
Depletion level	50%	50%	50%	50%
CSMD (m)	0.0203	0.0406	0.0406	0.0406
Chllies (Variety - MI-1)	20 days	35 days	45 days	30 days
Assumed root depth	0.31 m	0.61 m	0.61 m	0.61 m
Depletion level	50%	50%	50%	50%
CSMD (m)	0.0203	0.0406	0.0406	0.0406

CSMD = Cumulative Soil moisture depletion.

Table 2 Soil and Crop data for Yala 1979

Crop	Growth Stages			
	1	2	3	4
Soybean (Variety Pb-1) and} Cowpea (MI-35) }-	15 days	20 days	35 days	20 days
Assumed rooting depth	0.31 m	0.61 m	0.92 m	0.92 m
Depletion level	75%	75%	75%	75%
Irrigation depth	0.0305 m	0.0610 m	0.0914 m	0.0914 m
Assumed pan factor required (to account for variation in Crop E_T with growth stages)	0.65	0.85	1.05	0.75
Cumulative pan evaporation value for irrigation timing	0.047 m	0.0716 m	0.0871 m	0.122 m

Table 3 Catchment "C" Water Balance Data - 1978/79 Maha

Standard week number	42	43	44	45	46	47	48	49	50	51	52	01	02	03	04	05	06	07	08	Total
Rainfall Ha. m	1.0	1.67	1.99	0.17	0	3.17	0.03	0.31	0.35	0.1	1.27	0	0	0	0.09	0	0	0	0.21	10.36
Irrigation Ha. m	0	0	0	0	0.1	0.2	0	0	0	0.1	0	0	0.04	0.09	0	0.07	0.03	0.02	0	0.65
E_T loss Ha.m	0.33	0.22	0.18	0.28	0.31	0.27	0.39	0.31	0.27	0.28	0.28	0.33	0.34	0.36	0.32	0.39	0.34	0.38	0.34	5.92
Runoff Ha.m	0.15	0.84	0.89	0.01	0	2.52	0	0	0	0	0.84	0	0	0	0	0	0	0	0	5.25
Surface Balance	+ 0.52	+ 0.61	+ 0.92	- 0.12	- 0.21	+ 0.58	- 0.36	0	+ 0.08	- 0.08	+ 0.15	- 0.33	- 0.30	- 0.27	- 0.23	- 0.32	- 0.31	- 0.36	- 0.13	- 0.16

- 11.01
- 11.17

Note: **Of the total inputs 53.6% was as E_T**

Of the total inputs 47.6% was Runoff
Of the total rainfall 50.73% was as Runoff

The change in soil moisture storage before and after the begining of the season has resulted in an overall negative balance.

For all crops except paddy the ridge and furrow system of irrigation was used. Streams were cut back ten feet before the end of the furrow to achieve high application efficiencies. A furrow length of 46 meters at 0.5 percent slope was used in both well and imperfectly drained soils.

In the case of paddy for operational easiness 31 meters long 0.92m wide borders were used. In Maha 1978/79 only a few irrigations were required.

Results and Discussions

Water balance for Maha 1978/79 are reported (Table 3). A positive balance indicates replenishment of the water table which was seen in rainy weeks.

The overall negative balance could probably be due to the changes in soil moisture content of the profile over the season, Evapotrnspiration and runoff losses were nearly equal. Applicability of this data for runoff prediction in the dryland areas is limited due to high antecedent moisture contents in the soil caused by irrigation.

1979 Yala water balance results are also reported (Table 4). Overall positive balance in the season confirms the accuracy in scheduling practice adopted.

Conclusions

Of the total inputs 53.6% was lost as Evapotranspiration by crops whilst 47.6% was lost as surface runoff. As shown in the overall balance, irrigation caused no runoff. Thus 50.73% of the total rainfall was yielded as surface outflow from the catchment.

Unlike in the Maha 1978/79, Yala 1979 yielded no surface runoff. In Maha 78/79 with a crop combination of Maize, Soybean, Chillies and Paddy (2:2 1/2:1:2 1/2), 0.2 Ha. were managed with 0.1233 Ha.m of water whilest with a crop combination of Cowpea and Soybean (1:1) 0.17 Ha. were managed with 0.1233 Ha. m of water. Thus for the above cropping pattern duty of water in Maha is 1.23 time greater than that of yala season.

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References

1. Wilson, E.M. (1975). Engineering Hydrology, pp 36 - 37.
2. Doorenbos, J. (1977). Cropwater requirements, FAO Irrigation and drainage paper No. 24

Table 4 Catchment "C" Water Balance Data 1979 Yala

Standard week number	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	Total
Rainfall Ha. m	0.01	0	0	0	0.02	0	0.01	0	0	0.01	0.13	0	0	0	0	0.18
Irrigation Ha. m	0.74	0.41	0.74	0.49	0.31	0.36	0.43	0.35	0.34	0.35	0.38	0.15	0.39	0.23	0.14	5.81
E_T loss Ha. m	0.4	0.15	0.15	0.3	0.27	0.27	. 0.45	. 0.46	0.48	0.43	0.41	0.2	0.2	0.21	0.2	4.58
Runoff Ha. m	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
Balance	+ 0.35	+ 0.26	+ 0.59	+ 0.19	+ 0.06	+ 0.09	- 0.01	- 0.11	- 0.14	- 0.07	+ 0.10	-0.05	+ 0.19	+ 0.02	- 0.06	+ 1.41