

## Studies on the Quality of Irrigation Waters in Kalawewa Area

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**Abstract :** The knowledge of the quality of irrigation water is important in judging its suitability for irrigation. Suitability of an irrigation water depends upon several factors such as characteristics of the water, soil, plant and climate. It is difficult to suggest a single water quality criterion because of the interaction of several factors, but however, the study of the seasonal variation of the quality of irrigation waters is helpful to prevent any adverse effect of the irrigation waters on the soil-plant system.

A study of the seasonal variation of total salt concentration, relative proportion of sodium to other cations and bicarbonate content of the water samples collected from certain selected spots in the Kalawewa area reveals that the irrigation waters are suitable. However, a remarkable increase of total salt concentration, SAR and RSC values of irrigation waters were observed in April (Maha harvesting season) and to a certain extent in November (Yala harvesting season). The maximum value of RSC of the irrigation waters so far did not exceed 1.5 meq. dm<sup>-3</sup>.

The quality of the drainage water which flows into Kala Oya also deteriorates during Maha and Yala harvesting periods. It is emphasised that the study of the quality of irrigation waters in Kala Oya and Rajangana area is absolutely essential. Monitoring of essential nutrients indicates an excessive drainage of the fertilizers.

### 1. Introduction

The Mahaweli irrigation project involves utilization of the water of the Mahaweli Ganga to irrigate an extensive area of dry zone. When complete, the Mahaweli Development project is expected to supply water for the irrigation needs of 900,000 acres<sup>7</sup> for two crops a year. The master plan also envisages the generation of 2,037 million kilowatt hours of hydroelectric energy. The phase 1 of the project, (Kala Oya, Ambanganga) covers 132,000 acres of existing lands and 91,000 acres of new lands.

The irrigation water flows through a system of tunnels, reservoirs, canals, etc., before it reaches the field where crop is grown. During this flow some soluble salts are always dissolved in, and the water becomes 'saline'. In the field the water will undergo 'evapotranspiration'<sup>13</sup> resulting in the accumulation of dissolved salts, which will affect the soil properties and subsequently the crop growth. It has been reported<sup>6</sup> that, in countries such as Afghanistan, Pakistan, Egypt, etc., irrigated areas have been abandoned due to the development of salinity and waterlogging. Several subsequent programmes have been implemented in these countries in order to overcome the problems of salinity and waterlogging. Therefore, it is essential to take adequate precautionary measures, especially in the areas irrigated by Mahaweli waters, in order to prevent any such salt danger caused by the increased utilization of irrigation water resources.

The knowledge of the quality of irrigation water is important in judging its suitability for irrigation. Suitability of an irrigation water depends upon several factors associated with characteristic of water, soil, plant and climate, and it can be expressed by the following relationship.<sup>9</sup>

$$SI = f(QSPDC)$$

Where,

SI = Suitability of irrigation water,

Q = quality of water i.e. the total salt concentration, cationic and anionic composition,

S = Physico-chemical properties of the soil profile,

P = salt tolerance characteristics of the crop plant at different stages of growth,

D = Drainage conditions,

C = climatic parameter.

It is difficult to suggest a single water quality criterion because of the interaction of several factors. The degree of adverse effects on soil properties is mainly related to the chemical composition of irrigated water.

The adverse effect of a particular quality water on soil-plant system depends upon the total salt concentration, relative proportion of sodium to other cations, boron concentration and bicarbonate content.<sup>8</sup> Waters of low electrical conductivity are generally composed of higher proportion of calcium, magnesium and bicarbonate ions whereas those of high electrical conductivity contain mostly of sodium and chloride ions. The relative proportion of sodium to other cations is determined by the sodium adsorption ratio (SAR).

$$SAR = Na^+ / \sqrt{Ca^{2+} + Mg^{2+}}$$

Where ionic concentration of each is in  $m \text{ mol dm}^{-3}$ . Any increase in the SAR of irrigation water increases the SAR of the soil solution, which ultimately increases the exchangeable sodium by the soil. Paliwal and Gandhi<sup>10</sup> have reported that salinity has little effect while SAR has more of an effect on the exchangeable sodium.

Various classifications have been proposed for irrigation waters of India.<sup>8</sup> One of these is the salt index, which is negative for all good quality waters and positive for those unsuitable for irrigation.

$$\text{Salt Index} = (\text{Total Na} - 24.5) - [\text{Total Ca} - \text{Ca in } \{ \text{CaCO}_3 + \text{Ca}(\text{HCO}_3)_2 \}] \times 4.85.$$

All quantities are expressed as ppm.  $[Mg] \equiv [Ca]$ .

This index may be applicable only under the limits prescribed by Ashgur, Puri and Taylor<sup>2</sup> in 1936. This emphasises a need for a water quality criterion in Sri Lanka especially in the areas irrigated by Mahaweli waters. The knowledge of potassium, nitrogen and phosphorous contents of the irrigation and drainage water is helpful to check the actual consumption of fertilizer by the crop.

## 2. Methods and Experimental Techniques

Analytical grade chemicals were used wherever possible. PH measurements were carried out using Corning Model 3 portable pH meter equipped with combined saturated calomel reference electrode and glass electrode.

Spectrophotometric determinations were carried out using Unicam SP 500 Series II UV/Visible spectrophotometer. Eel filter type flame photometer was used for the determination of sodium and potassium. Standard addition method<sup>14</sup> was adopted to overcome the spectral interference from calcium in the determination of sodium.

Carbonate and bicarbonate contents were determined potentiometrically under the thermostatic condition, in an atmosphere of nitrogen. Potentiometric titrations were carried out using Radiometer-pH meter 4, with a saturated calomel reference electrode and a glass electrode.

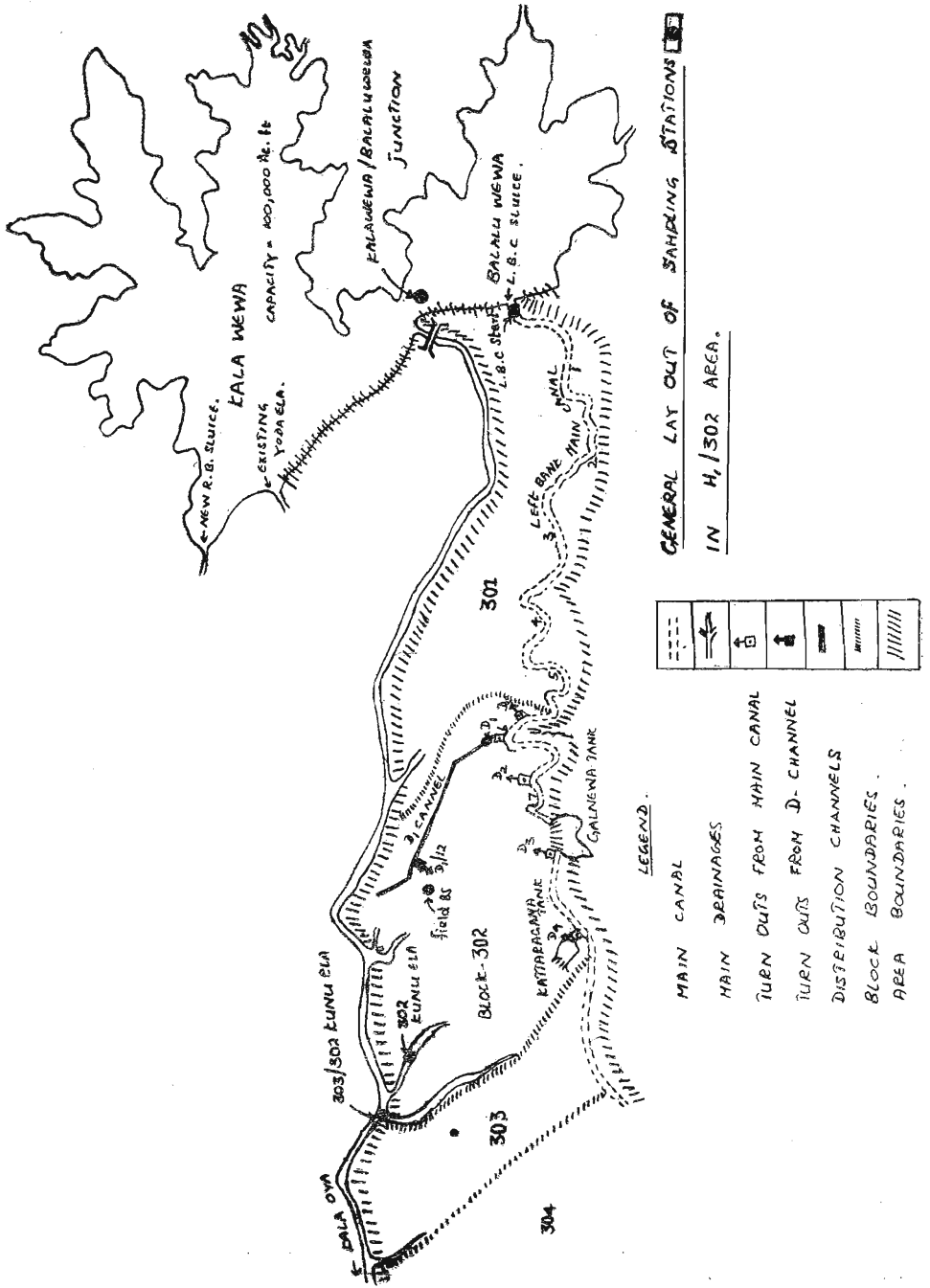
Calcium and magnesium were determined using EDTA titration. EDTA titration at pH=10.0 using Eriochrome Black T as the indicator gave the total concentration of calcium and magnesium whereas the titration in more alkaline medium (~ pH = 12.0) using Pattern-Reeder's indicator gave the concentration of calcium only.

Pre-concentrations of trace metals were performed using Amberlite IR 120 resins. Anions were concentrated using Amberlite IR 400 and Dowex I resins. Standard analytical methods<sup>5,11,12</sup> were adopted for determination of cations and anions. Modifications of some of standard analytical methods were done in order to achieve the simplicity and reproducibility.

Mercuric nitration titration<sup>3</sup> was used to determine the concentration of chloride ions. Sulphate ion concentration was determined gravimetrically as barium sulphate.

## 3. Results and Discussion

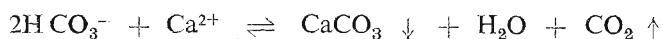
The area covered by this study involves an irrigation tank (reservoir), an irrigation canal, an irrigation channel, a few selected fields and two drainage canals in the Elceck 302 of the H - area of the Mahaweli development scheme. The seasonal variation of the quality of surface waters was studied by sampling at selected spots. The sampling frequency is slightly irregular mainly due to the non-availability of vehicles at required times.



Balalu Wewa is the reservoir which supplies irrigation water to Block 302 through the left Bank Canal (LBC). Seasonal variation of the filterable residue and total residual contents of waters from Balalu Wewa, Left Bank Canal and at the beginning of D1 Channel of Block 302 shows similar trends. (Figs. 1, 2 and 3). It is seen that there is an increase in the filterable residue as well as the total residue of the irrigation waters in April 1978 and 1979. The Maha harvest starts in March and ends in April. During this period the water supply to the field being completely cut off and consequently, as a result of rapid evaporation of existing water, the filterable residual content increases. With the increase in water supply after April the situation is improved. It has been reported<sup>1</sup> that the total solid concentration in Dam-bulu Oya reached 1,000 ppm. in August 1970 and an average value of about 500 ppm. in April 1970 whereas, the values reported in Kala Oya were average during the other times of the year except in April i.e. 900 ppm. It is fruitful to compare the available results prior to the Mahaweli diversion scheme with our results.

Figs. 1 and 2 indicate that after the diversion the total solid content in Balalu Wewa and L.B.C. did not exceed 300 ppm. This could be attributed to the dilution effect brought about by the diverted water from the Mahaweli ganga.

Figs. 4, 5 and 6 indicate the seasonal variation of sodium, calcium, magnesium contents and the SAR values. Even though there is very rapid increase of the sodium content in April 1978 and 1979, the sodium hazard is partially reduced due to the corresponding increase in calcium and magnesium contents. However, the increase in bicarbonate contents in April (Figs. 7, 8 and 9) can bring about an adverse effect due to the precipitation of calcium carbonate<sup>4</sup> with a resultant increase in sodium hazard. The increase in SAR values in April could also be attributed to increase in bicarbonate content. Irrigation waters rich in bicarbonate tend to precipitate soluble calcium and magnesium in soils as their carbonates.



This increases the sodium content in proportion to calcium and magnesium and this increases the SAR of the soil solution. The relative proportion of calcium and magnesium in bicarbonate rich waters is given by the concept of residual sodium carbonate(RSC).

$$\text{RSC} = (\text{HCO}_3^- + \text{CO}_3^{2-}) - (\text{Ca}^{2+} + \text{Mg}^{2+})$$

ionic concentration in m.eq. dm<sup>-3</sup>. According to Eaton's concept<sup>9</sup> if the RSC value is greater than 5 m.eq. dm<sup>-3</sup>, the irrigation waters in general, are harmful for soil properties and crop growth. Fortunately, the maximum value of RSC of those irrigation waters so far did not exceed 0.1 m.eq. dm<sup>-3</sup>. It is obvious that continuous monitoring of these values are essential to check the deterioration of the irrigation waters.

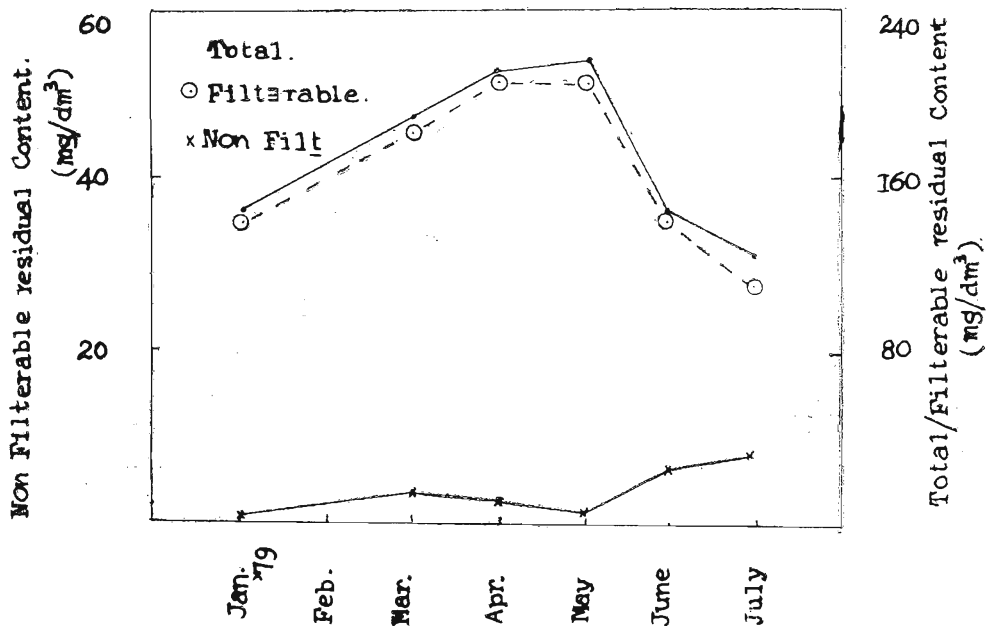


Fig. I. Variation in residual Content of the water samples collected from KALANEWA-BALALUWENA JUNCTION, in relation to time.

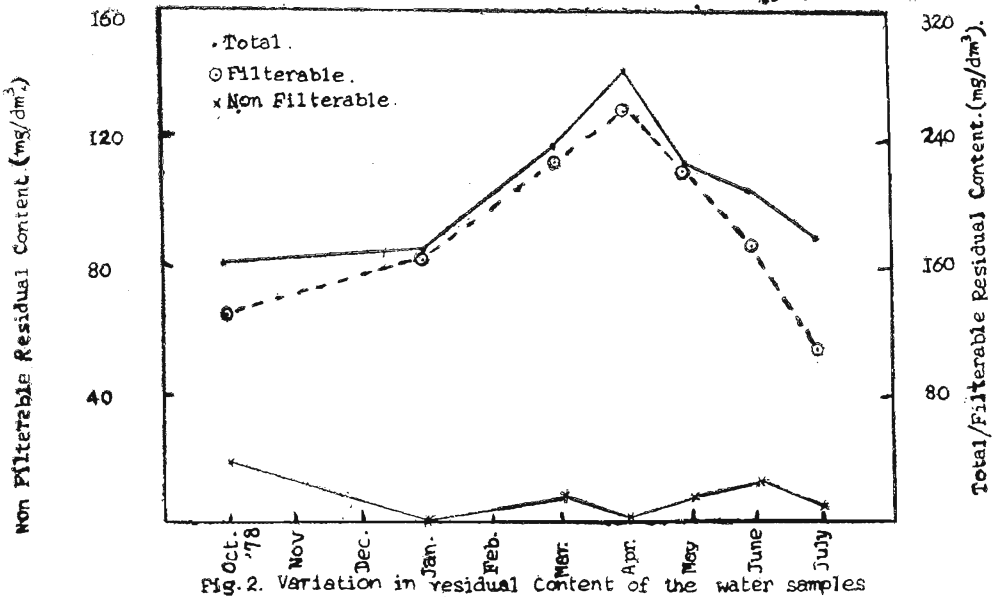


Fig. 2. Variation in residual Content of the water samples collected from LEFT BANK CANAL, in relation to time.

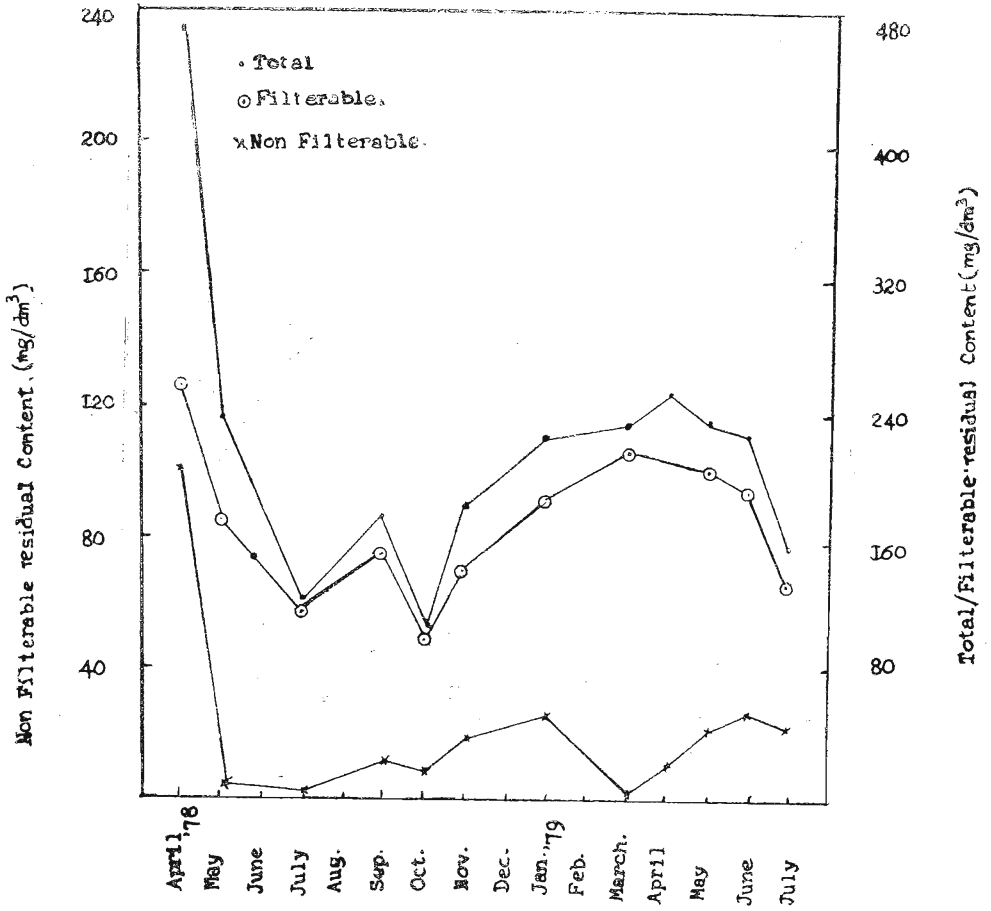


Fig.3. Variation in residual Contents of the water samples collected from D<sub>1</sub> start, in relation to time.

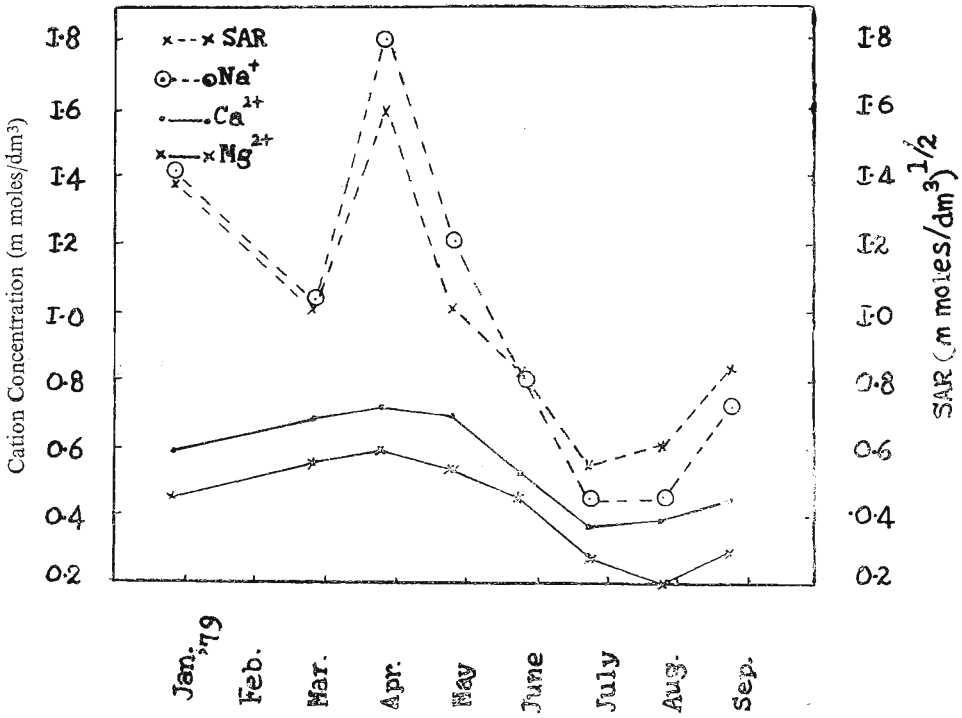


Figure 4. Variation in Ca<sup>2+</sup>, Mg<sup>2+</sup>, Na<sup>+</sup> and SAR values of the water samples collected from KALAWEWA-BALALUWEWA JUNCTION, in relation to time.

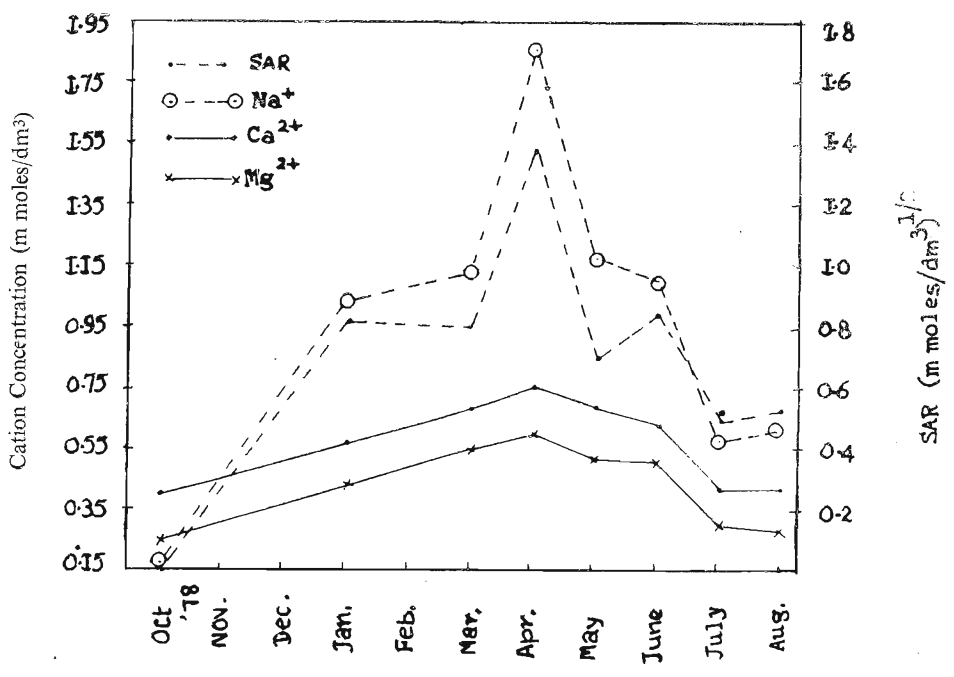


Figure 5. Variation in Ca<sup>2+</sup>, Mg<sup>2+</sup>, Na<sup>+</sup> and SAR values of the water samples collected from LEFT BANK CANAL, in relation to time.

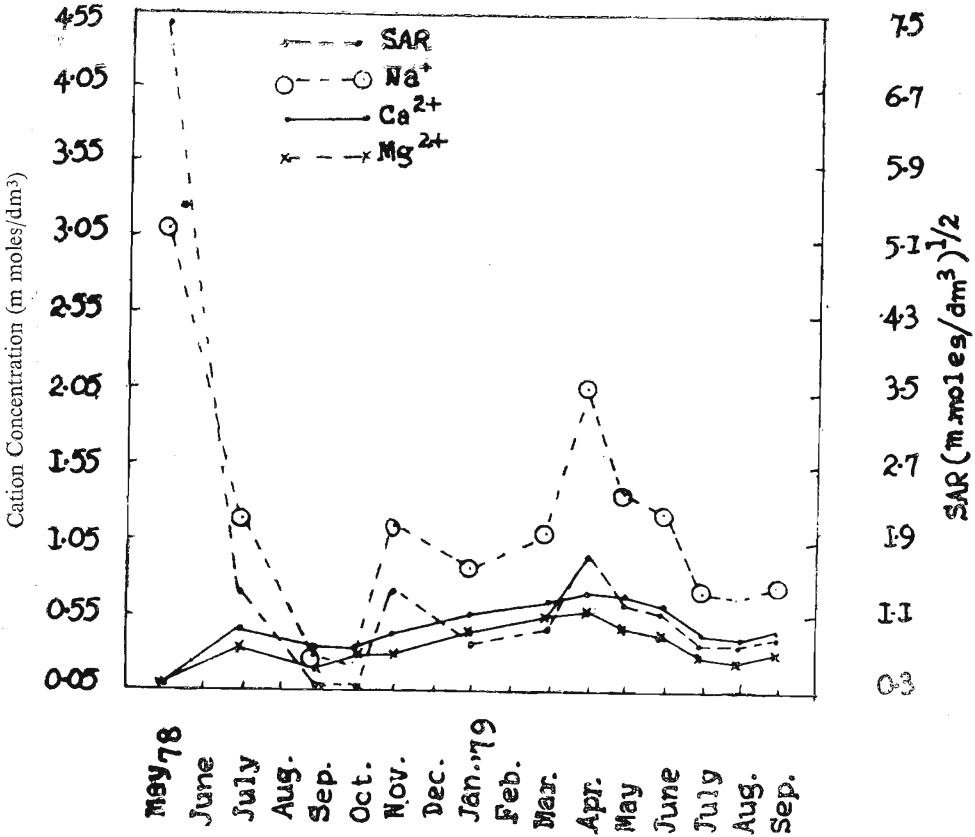


Figure 6. Variation in Ca<sup>2+</sup>, Mg<sup>2+</sup>, Na<sup>+</sup> and SAR values of the water samples collected from D<sub>1</sub> start, in relation to time.

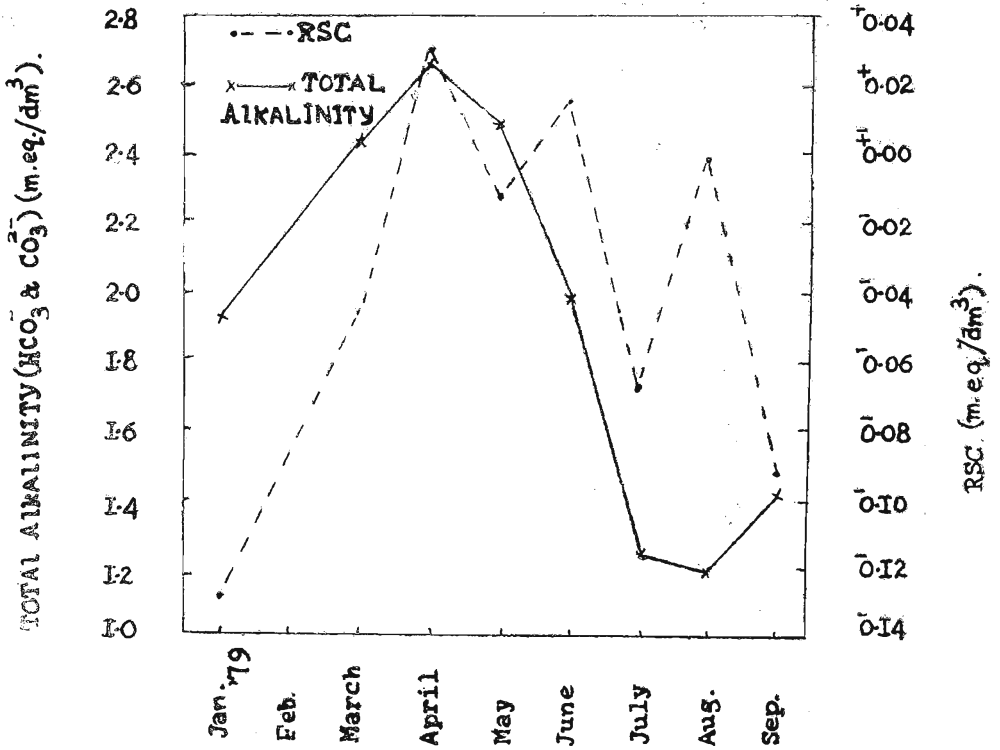


Fig.7 Variation in TOTAL AIKALINITY ( $\text{HCO}_3^-$  &  $\text{CO}_3^{2-}$ ) of the water samples collected from KALAWENA-BALALUWENA-JUNCTION, in relation to time.

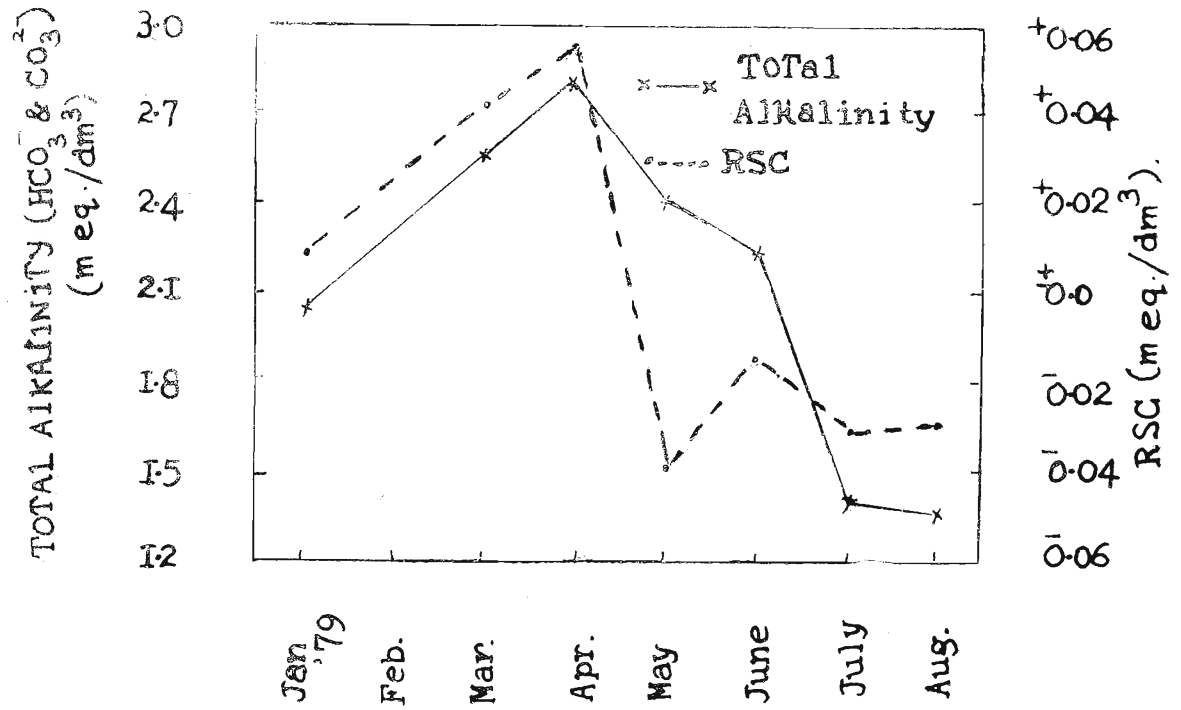


Fig.8 Variation in TOTAL Alkalinity ( $\text{HCO}_3^-$  &  $\text{CO}_3^{2-}$ ) of the water samples collected from LEFT BANK CANAL, in relation to time.

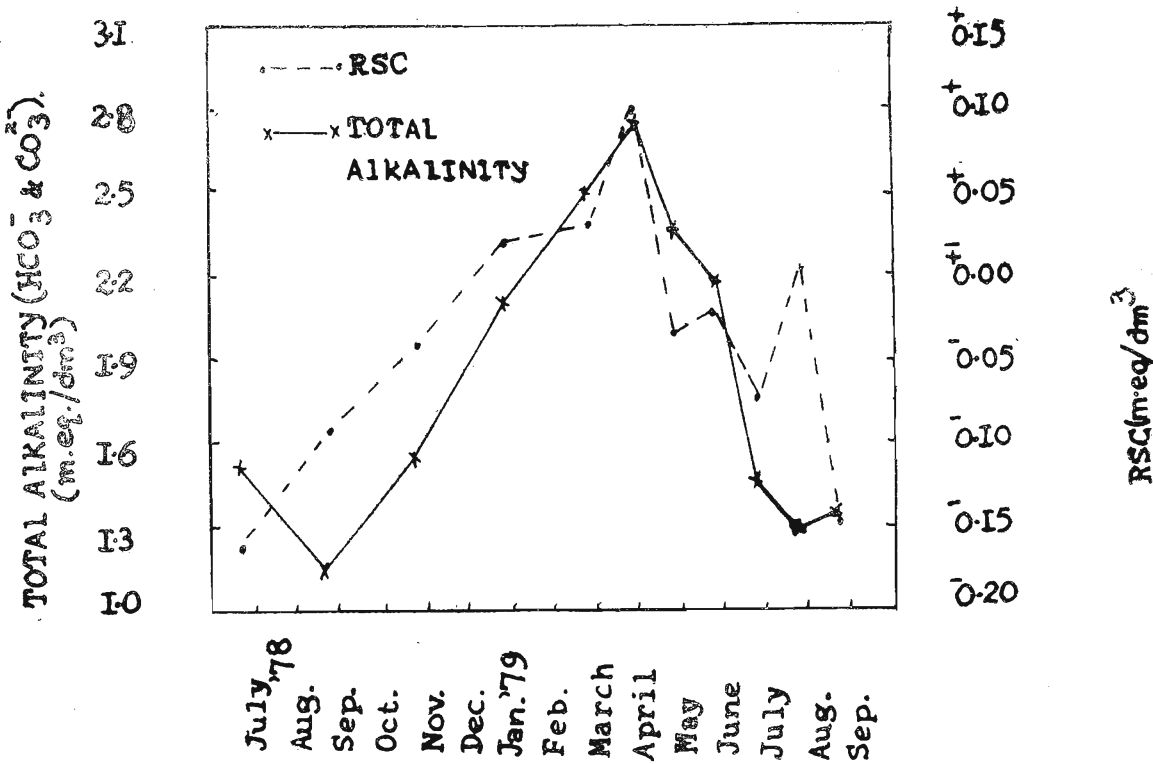


Fig. 9- Variation in total Alkalinity ( $HCO_3^-$  &  $CO_3^{2-}$ ) of one water samples collected from  $D_1$  start, in relation to time .

Somewhat similar results on seasonal variation were obtained from the field No. 85 of Block 302. (Figs. 10, 11 and 12 ). The value of dissolved solid content in D<sub>1</sub> channel and in field 85 remains unaltered revealing that no salts being dissolved in, during the path of the irrigation water from the channel to the field. In addition to the usual increase in the above values in April, 1979, a limited increase is observed in November 1978.

Even though we expect a similar increase in the Yala harvesting season, (October and November) it could be seen that this is observed only in the field 85 and in the drainage canals (Kunu Ela) 302 and 302/303. (Figs. 13, 14, 15, 16, 17 and 18). The fact that the irrigation waters are virtually unaffected during Yala harvesting season in comparison with the drainage waters, could be attributed to the monsoon rains which bring about a dilution effect.

The drainage canals (Kunu Ela) flow into Kala Oya and the water is used again to irrigate the Rajangana Area. The drainage canals differ from the other parts of the irrigation system by having the highest values of SAR and sodium content in May and not in April. (Figs. 14 and 17 ). However, the same waters reveal high values of RSC and bicarbonate contents in April and not in May. (Figs. 15 and 18). The increase in bicarbonate content in April influences the precipitation of calcium and magnesium in the water as carbonates with the resulting increase of SAR which is reflected in the following month. Fig. 18 shows that the RSC value of the drainage water in 302/303 Kunu Ela reaches the value of 1.3 m. eq. dm<sup>-3</sup> in April 1979. This value is well within limit of the water quality criterion which determines the sodium hazard. Therefore, the drainage waters are not harmful for soil properties and crop growth even if they are used for further irrigation. The data on the quality of irrigation waters in Rajangana tank and in its canal system are not available, but one can recommend that the study on the quality of irrigation waters in Rajangana area may be fruitful.

Table I shows the seasonal variation of potassium content in irrigation and drainage waters. Potassium present in irrigation waters releases excessive sodium from the exchange surface of the soil thus improving the soil physical condition. Further, being an essential nutrient, potassium acts favourably in reducing harmful effect of sodium by way of providing potassium regularly to the plant. A fairly high concentration of potassium is observed in the drainage waters, especially in the sowing season. The potassium concentration in drainage waters is higher than in the corresponding irrigation waters indicating that there is a loss of potassium applied as a fertilizer to the fields.

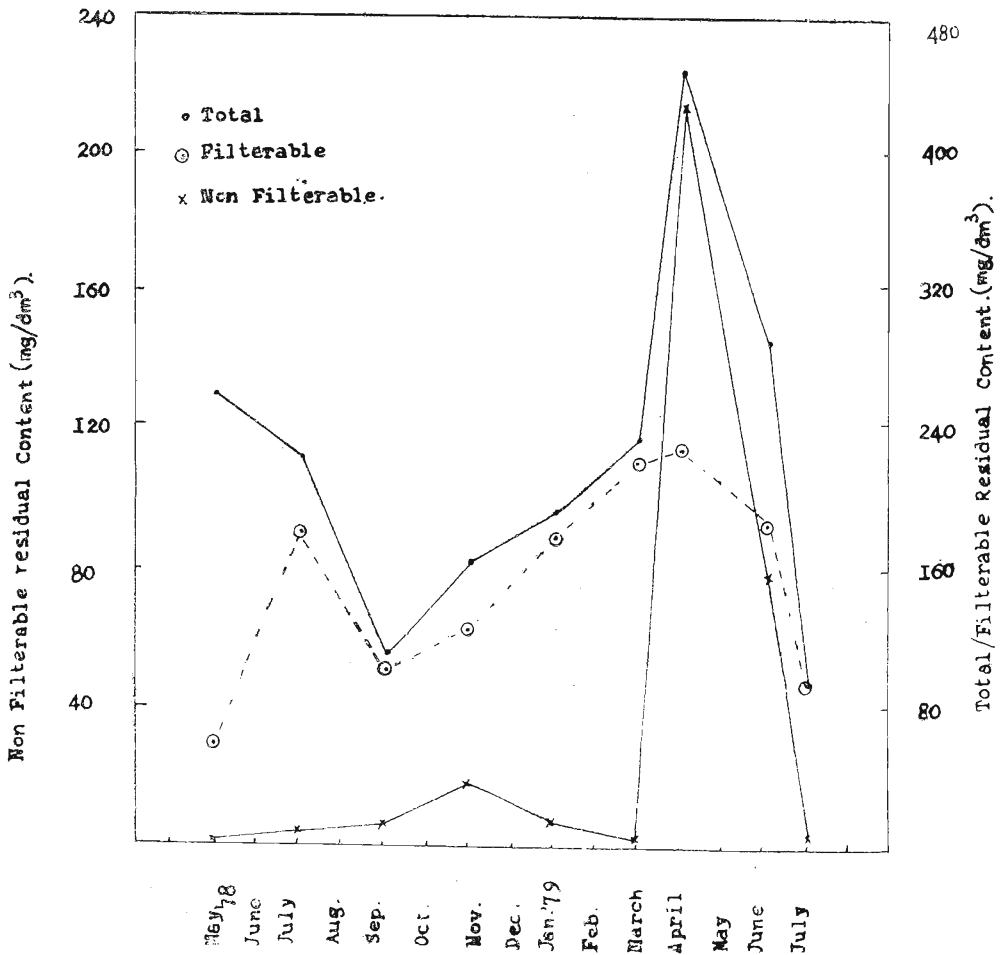


Fig 10 Variation in residual Content of the water samples collected from Field 85, in relation to time.

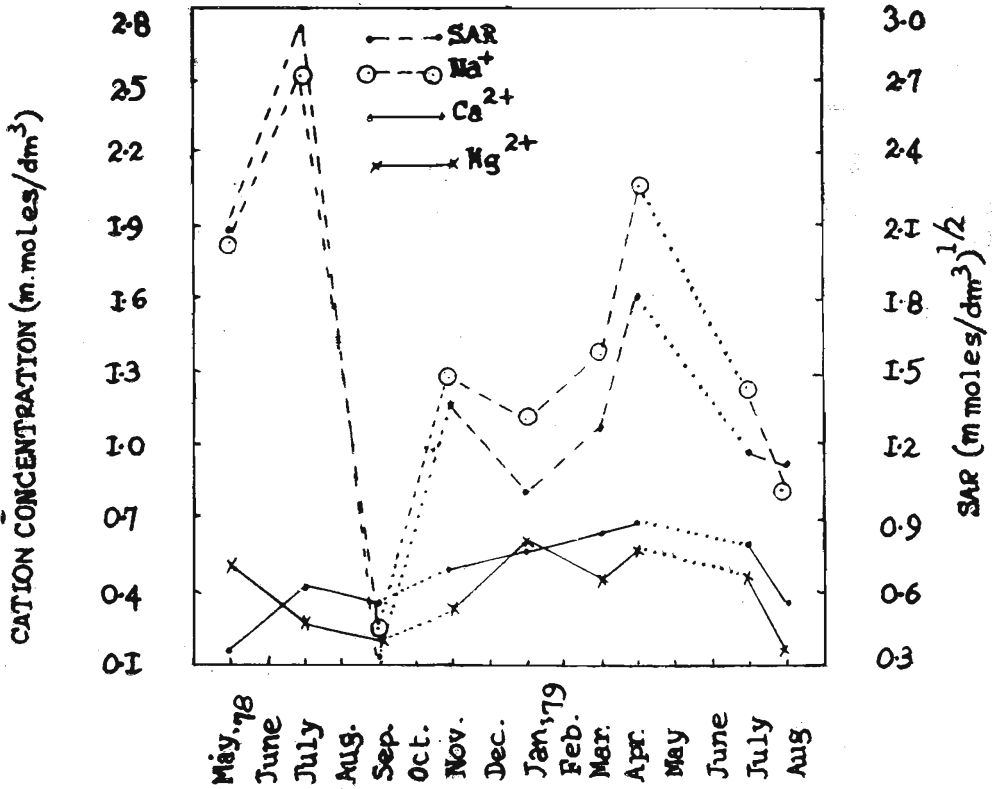


Figure 11. Variation in Ca<sup>2+</sup>, Mg<sup>2+</sup>, Na<sup>+</sup> and SAR values of the water samples collected from Field 85, in relation to time. (Dotted line indicates non-availability of water for sampling).

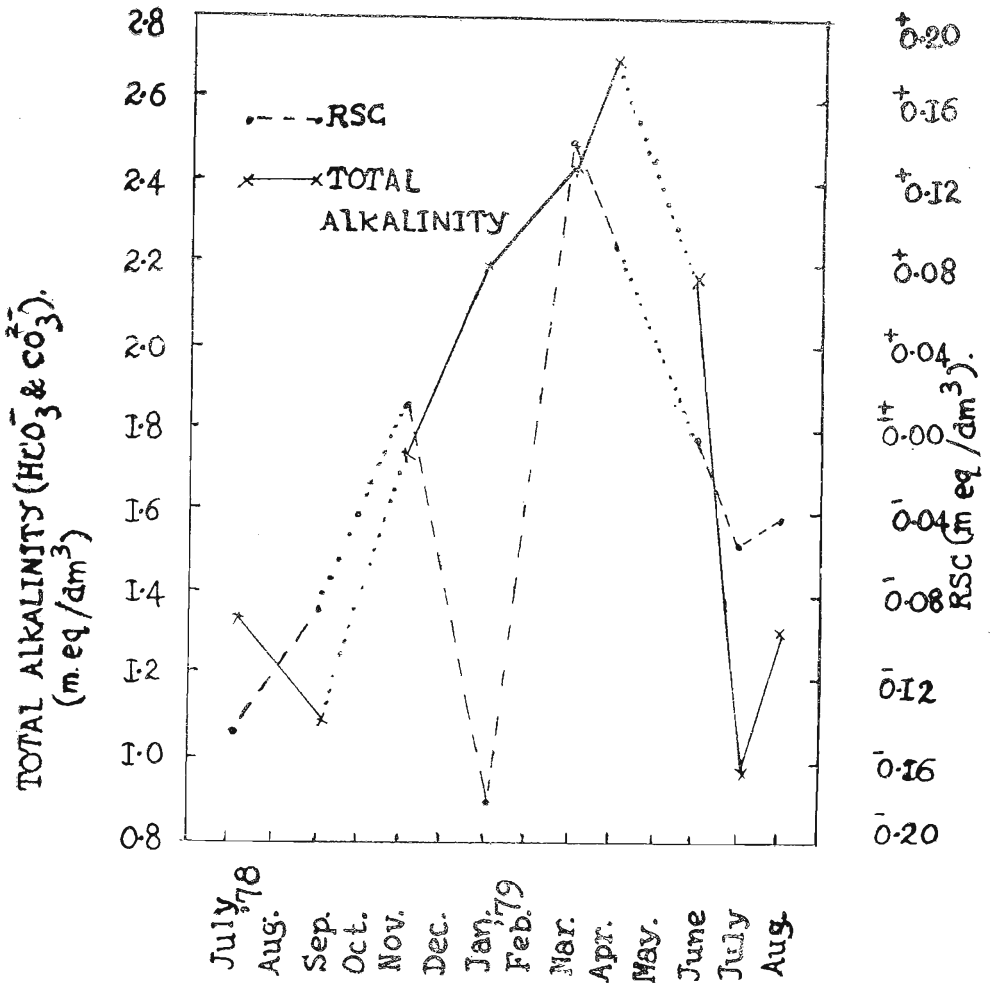


FIG-12 Variation in TOTAL Alkalinity ( $\text{HCO}_3^-$  &  $\text{CO}_3^{2-}$ ) of the water samples collected from Field 85 in relation to time. (Dotted line indicates, non-availability of water for sampling.)

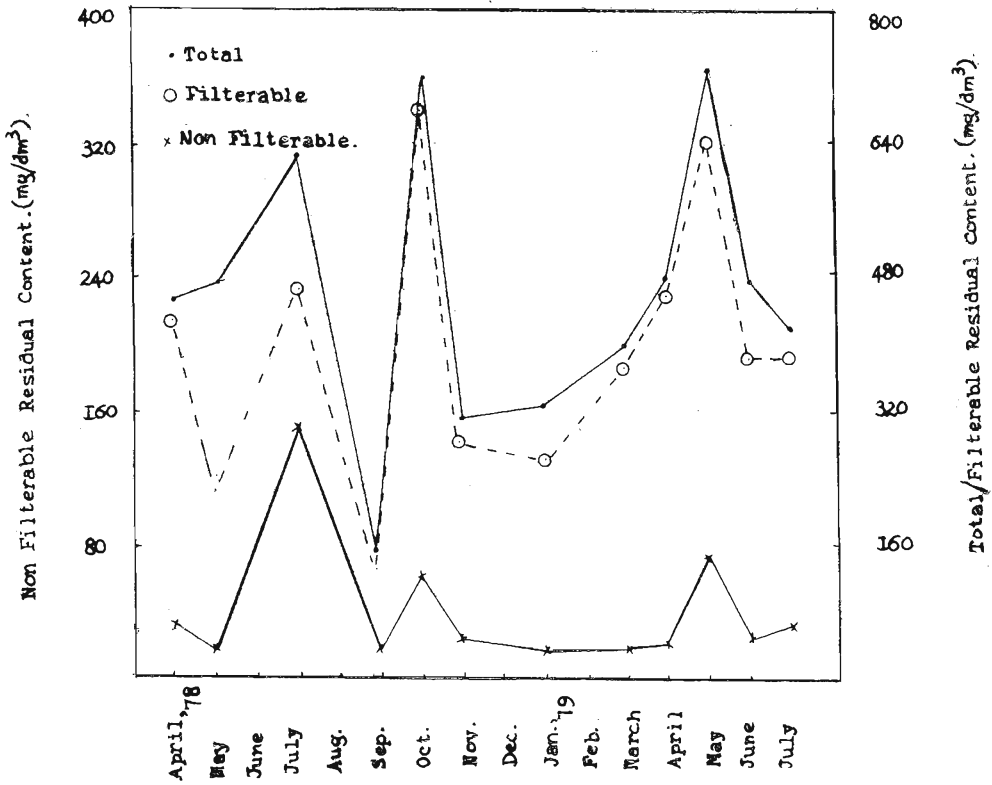


Fig.13 Variation in residual Contents of the water samples collected from 302 KUNU-BLA, in relation to time.

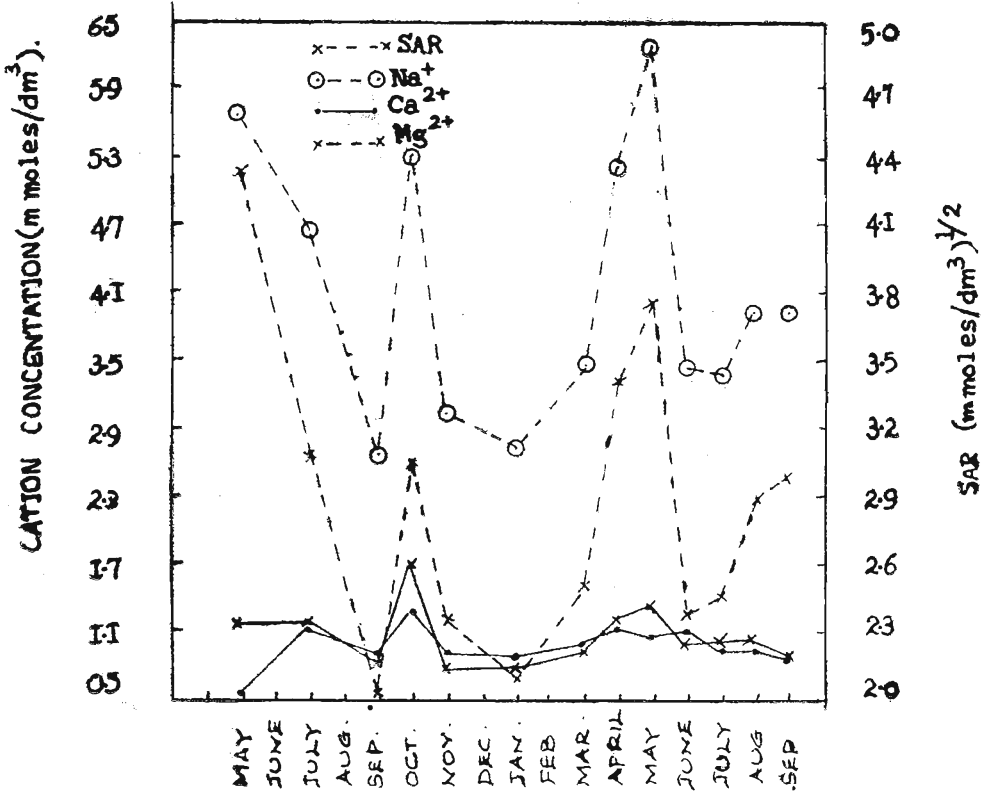


Figure 14. Variation in Ca<sup>2+</sup>, Mg<sup>2+</sup>, Na<sup>+</sup> and SAR values of the water samples collected from D<sub>1</sub> D<sub>2</sub> D<sub>3</sub> KUNU-ELA in relation to time.

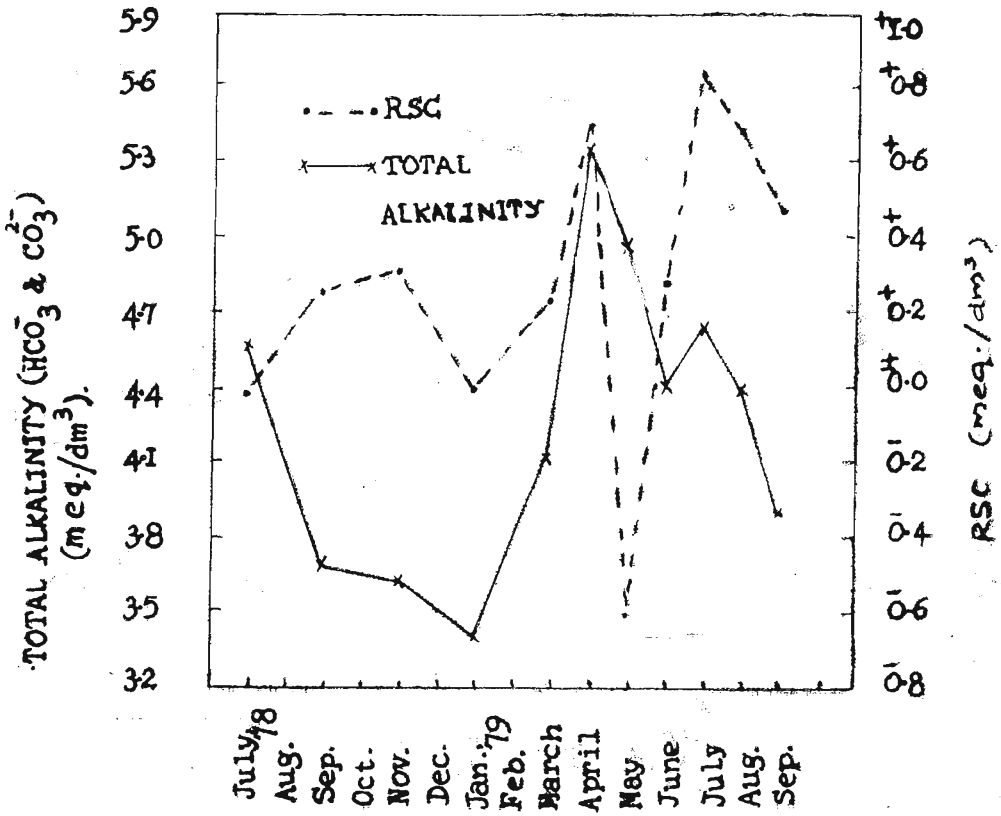


Fig.15 Variation in TOTAL ALKALINITY ( $\text{HCO}_3^-$  &  $\text{CO}_3^{2-}$ ) of the water samples collected from D<sub>1</sub>D<sub>2</sub>D<sub>3</sub> KUNU-ELA in relation to time.

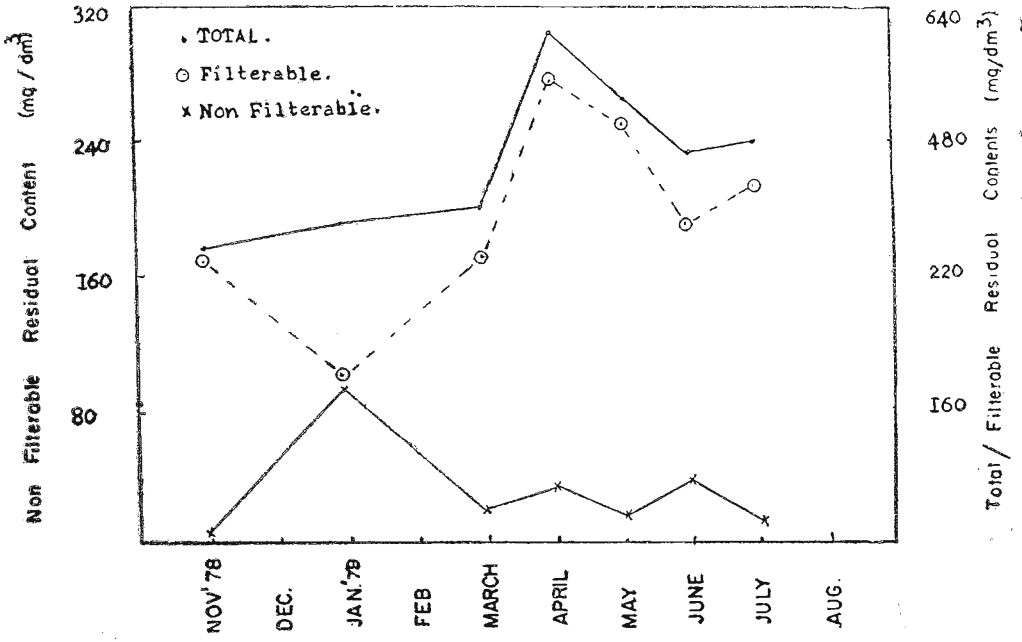


FIG.16, Variation in residual Content of the water samples collected from 302/303 Kuru-Ela in relation to time.

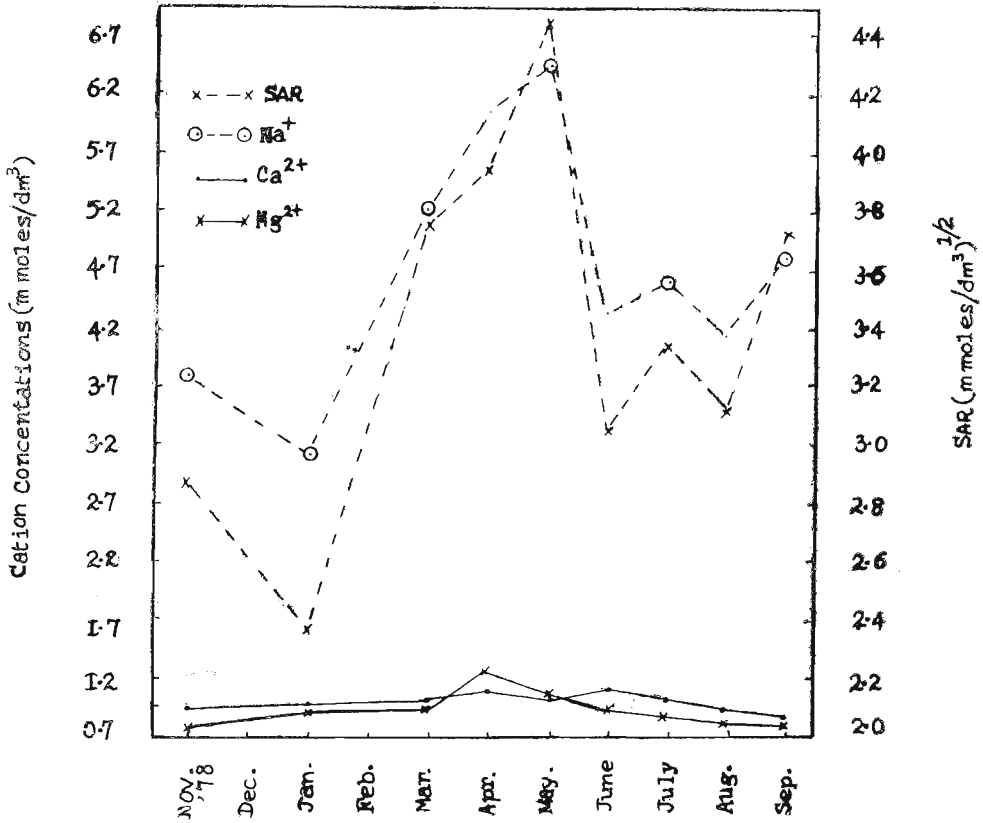


Figure 17. Variation in Ca<sup>2+</sup>, Mg<sup>2+</sup>, Na<sup>+</sup> and SAR values of the water samples collected from 302/303 KUNU-ELA, in relation to time.

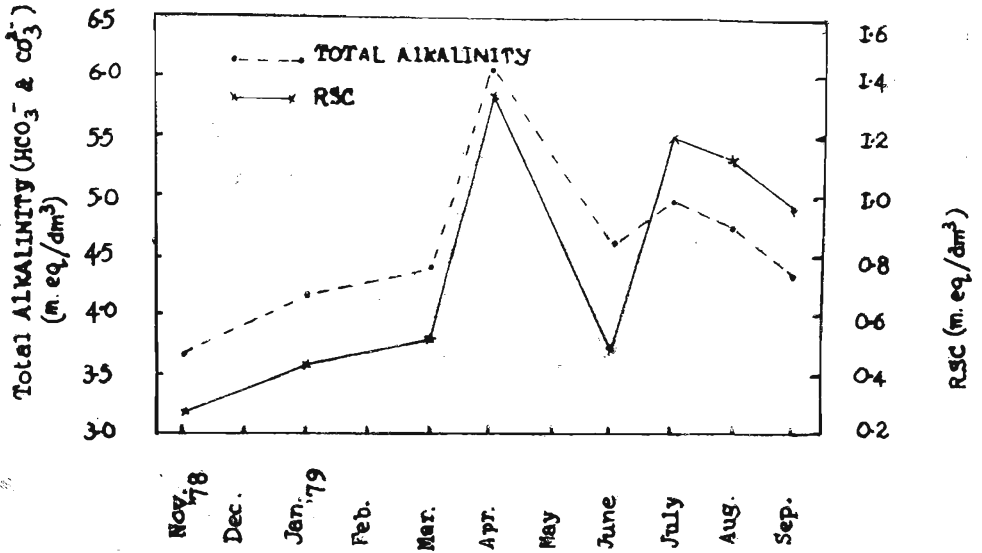


Fig.18. Variation in TOTAL ALKALINITY ( $\text{HCO}_3^-$  &  $\text{CO}_3^{2-}$ ) of the water samples collected from 302/303 KUNU-ELA in relation to time.

TABLE 1. Seasonal Variation of Potassium Content in Irrigation Waters. ( $K_2O$  ppm.)

	D <sub>1</sub> Start	Field 85	302 Kunu-Ela	302/303 Kunu-Ela	Kalawewa	Left bank Canal (start)
1978 April	6.02	—	8.69	—	—	—
May	4.34	11.21	6.66	—	—	—
July	2.17	2.65	5.90	—	—	—
Sept.	1.72	1.88	1.88	—	—	—
Oct.	1.88	—	5.06	—	—	2.11
Nov.	3.92	5.20	5.91	7.05	—	—
1979 Jan.	5.36	5.66	6.08	6.32	4.22	5.08
March	3.01	3.61	3.19	4.22	2.65	2.68
April	4.69	5.90	3.79	3.97	4.15	4.57
May	4.12	—	7.34	7.10	4.12	4.09

Table 2 shows that the phosphate content of the irrigation water has an average value of 10 ppm of  $P_2O_5$ , which could be attributed partially to the dissolution of the apatite mineral found in that area. However, the high values of phosphate content in the drainage waters in April and May are due to the application of fertilizers. It seems that even though the phosphate fertilizers are applied after sowing, the major part being drained off into Kala Oya. Reasonably high concentrations of soluble phosphate may be obtained in the Rajangana Reservoir during this period.

TABLE 2. Seasonal Variation of the total Phosphate Content of Irrigation Waters (ppm of  $P_2O_5$ )

	D <sub>1</sub> Start	Field 85	302 Kunu-Ela	Kalawewa	L.B.C. (start)	302/303 Kunu-Ela
1978 April	19.73	35.62	11.74	—	—	—
May	11.66	—	25.71	—	—	—
July	7.29	8.79	15.54	—	—	—
Sept.	9.67	9.67	17.79	—	—	—
Oct.	5.16	—	28.55	—	—	—
Nov.	9.67	12.30	18.24	—	—	21.42
1979 Jan.	1.92	0.52	9.08	8.25	4.89	13.45
March	9.36	9.43	13.55	11.39	9.92	15.72
April	15.72	16.07	23.58	15.72	16.77	31.62
May	13.27	—	27.25	13.80	13.45	34.24
June	9.43	8.21	16.07	8.38	9.78	18.34

TABLE 3. Seasonal Variation of total ion Contents in Kalawewa/Balaluwewa Water Samples.

Month	Cations meq. dm <sup>-3</sup>				Anions meq. dm <sup>-3</sup>				
	Ca <sup>2+</sup>	Mg <sup>2+</sup>	Na <sup>+</sup>	K <sup>+</sup>	HCO <sub>3</sub> <sup>-</sup>	CO <sub>3</sub> <sup>2-</sup>	PO <sub>4</sub> <sup>3-</sup>	Cl <sup>-</sup>	SO <sub>4</sub> <sup>2-</sup>
Jan. '79	0.29	0.22	1.39	0.09	1.66	0.27	0.04	0.59	—
March '79	0.34	0.27	1.13	0.06	1.98	0.44	0.05	0.97	0.03
April '79	0.36	0.29	1.83	0.09	2.35	0.31	0.07	1.13	0.39
May '79	0.35	0.27	1.21	0.09	2.49	0.00	0.06	1.44	0.03
June '79	0.26	0.23	0.8	0.06	1.99	0.00	0.03	0.67	0.03
July '79	0.19	0.14	0.48	0.04	1.24	0.00	0.03	0.41	0.08
Aug '79	0.20	0.10	0.48	0.04	1.19	0.00	0.04	0.38	0.01
Sep. '79	0.23	0.15	0.74	0.08	1.42	0.00	0.04	0.72	0.10

TABLE 4. Seasonal Variation of total ion contents in left bank canal water samples.

Month	Cations meq. dm <sup>-3</sup>				Anions meq. dm <sup>-3</sup>				
	Ca <sup>2+</sup>	Mg <sup>2+</sup>	Na <sup>+</sup>	K <sup>+</sup>	HCO <sub>3</sub> <sup>-</sup>	CO <sub>3</sub> <sup>2-</sup>	PO <sub>3-4</sub>	Cl <sup>-</sup>	SO <sub>4</sub> <sup>2-</sup>
Oct '78	0.21	0.23	0.17	0.04	—	—	—	—	—
Jan. '79	0.29	0.22	1.04	0.10	1.79	0.27	0.02	0.65	—
March '79	0.35	0.28	1.13	0.06	2.24	0.31	0.05	1.02	0.03
April '79	0.38	0.31	1.87	0.09	2.53	0.30	0.08	1.18	0.03
May '79	0.35	0.26	1.17	0.08	2.41	0.00	0.06	0.99	0.04
June '79	0.32	0.25	1.11	0.07	2.26	0.00	0.04	0.83	0.03
July '79	0.21	0.15	0.59	0.05	1.40	0.00	0.03	0.53	0.01
Aug. '79	0.21	0.14	0.61	0.04	1.36	0.00	0.04	0.46	—

TABLE 5. Seasonal Variation of total ion contents in D<sub>1</sub> Channel water samples

Month	Cations meq. dm <sup>-3</sup>				Anions meq. dm <sup>-3</sup>				
	Ca <sup>2+</sup>	Mg <sup>2+</sup>	Na <sup>+</sup>	K <sup>+</sup>	HCO <sub>3</sub> <sup>-</sup>	CO <sub>3</sub> <sup>2-</sup>	PO <sub>2-4</sub>	Cl <sup>-</sup>	SO <sub>4</sub> <sup>2-</sup>
April '78	—	—	3.49	0.13	—	—	0.09	—	—
May '78	0.48	0.04	3.14	0.09	—	—	0.05	—	—
July '78	0.23	0.18	1.20	0.05	1.31	0.19	0.03	—	—
Sep. '78	0.18	0.12	0.30	0.04	1.03	0.09	0.04	—	—
Oct. '78	0.18	0.16	0.26	0.04	—	—	0.02	—	—
Nov. '78	0.23	0.16	1.27	0.08	1.34	0.19	0.04	0.69	—
Jan. '79	0.29	0.23	0.88	0.11	1.85	0.27	0.01	0.65	—
March '79	0.34	0.28	1.13	0.06	2.10	0.40	0.04	1.06	0.03
April '79	0.37	0.31	2.08	0.09	2.49	0.32	0.07	1.18	0.04
May '79	0.35	0.26	1.39	0.09	2.39	0.00	0.06	1.00	0.03
June '79	0.32	0.24	1.30	0.08	2.20	0.00	0.04	0.83	0.04
July '79	0.23	0.15	0.74	0.05	1.48	0.00	0.03	0.59	0.03

TABLE 6. Seasonal Variation of total ion content in field 85 water samples

Month	Cations meq. dm <sup>-3</sup>				Anions meq. dm <sup>-3</sup>				
	Ca <sup>2+</sup>	Mg <sup>2+</sup>	Na <sup>+</sup>	K <sup>+</sup>	HCO <sub>3</sub> <sup>-</sup>	CO <sub>3</sub> <sup>2-</sup>	PO <sub>3-4</sub>	Cl <sup>-</sup>	SO <sub>4</sub> <sup>2-</sup>
May '78	0.79	0.27	1.85	0.23	—	—	0.16	—	—
July '78	0.23	0.15	2.55	0.05	1.16	0.19	0.04	—	—
Sep. '78	0.18	0.11	0.26	0.39	1.09	0.0	0.04	—	—
Oct. '78	—	—	—	—	—	—	—	—	—
Nov. '78	0.25	0.18	1.30	0.11	1.44	0.29	0.06	0.74	—
Jan. '79	0.29	0.31	1.13	0.12	2.11	0.09	0.002	0.75	—
March '79	0.33	0.23	1.39	0.07	2.33	0.09	0.43	1.03	1.04
April '79	0.35	0.29	2.09	0.13	2.43	0.26	0.07	1.22	0.03
May '79	—	—	—	—	—	—	—	—	—
June '79	0.30	0.24	1.30	0.08	2.17	0.00	0.04	0.86	0.06
July '79	0.18	0.08	0.83	0.05	0.98	0.00	—	0.63	0.01

TABLE 7. Seasonal Variation of total ion Contents in 302 Kunu-Ela Water Samples

Month	Cations meq. dm <sup>-3</sup>				Anions meq. dm <sup>-3</sup>				
	Ca <sup>2+</sup>	Mg <sup>2+</sup>	Na <sup>+</sup>	K <sup>+</sup>	HCO <sub>3</sub> <sup>-</sup>	CO <sub>3</sub> <sup>2-</sup>	Cl <sup>-</sup>	PO <sub>4</sub> <sup>3-</sup>	SO <sub>4</sub> <sup>2-</sup>
April '78	—	—	4.88	0.17	—	—	—	0.05	—
May '78	0.26	0.58	5.65	0.14	—	—	—	0.12	—
July '78	0.56	0.58	4.67	0.12	3.88	0.69	—	0.07	—
Sep. '78	0.44	0.41	2.65	0.03	2.80	0.88	—	0.08	—
Oct. '78	0.65	0.85	5.30	0.10	—	—	—	0.13	—
Nov. '78	0.46	0.37	3.04	0.12	2.56	1.08	1.40	0.08	—
Jan. '79	0.44	0.41	2.73	0.12	2.86	0.54	1.27	0.04	—
March '79	0.50	0.46	3.47	0.06	3.30	0.80	1.79	0.06	—
April '79	0.56	0.60	5.21	0.08	5.14	0.24	2.46	0.11	0.10
May '79	0.68	0.70	6.25	0.15	4.97	0.00	3.83	0.13	0.40
June '79	0.55	0.48	3.43	0.12	4.03	0.00	2.11	0.07	0.05
July '79	0.46	0.49	3.40	0.06	4.66	0.00	1.88	0.09	0.09

TABLE 8. Seasonal Variation of total ion Contents in 302/303 Kunu-Ela Water Samples.

Month	Cations meq. dm <sup>3-</sup>				Anions meq. dm <sup>3-</sup>				
	Ca <sup>2+</sup>	Mg <sup>2+</sup>	Na <sup>+</sup>	K <sup>+</sup>	HCO <sub>3</sub> <sup>-</sup>	CO <sub>3</sub> <sup>2-</sup>	PO <sub>4</sub> <sup>3-</sup>	Cl <sup>-</sup>	SO <sub>4</sub> <sup>2-</sup>
Nov. '78	0.47	0.39	3.78	0.14	3.12	0.59	0.09	1.62	—
Jan. '79	0.48	0.45	3.12	0.13	3.45	0.72	0.06	1.50	—
March '79	0.50	0.46	5.21	0.08	3.78	0.60	0.07	1.91	0.08
April '79	0.56	0.63	6.08	0.08	5.43	0.67	0.15	2.88	0.17
May '79	0.50	0.54	6.47	0.15	5.10	0.20	0.15	2.58	0.26
June '79	0.56	0.47	4.37	0.15	4.60	0.00	0.08	2.11	0.06
July '79	0.51	0.44	4.61	0.07	4.99	0.00	0.12	1.90	0.10

#### 4. Conclusion

These studies indicate that the irrigation waters in Kala Wewa and in the canal system are suitable. Regular monitoring of the quality of irrigation water is essential to develop water quality criteria for this area. In order to evaluate the limits in the quality of irrigation waters, it is necessary to know the extent to which various soil properties are affected by the continued use of a given quality irrigation water. Therefore, the need for the investigation of the interaction of the observed quality waters on different types of soils obtained from Kalawewa area is emphasised. This will enable one to study the cause for the current development of salinity in certain newly irrigated areas in this region.

It is rather difficult to come to a conclusion on the results of the monitoring of essential nutrients, within a period of one year. But the excessive drainage of these essential nutrients will lead to a type of water pollution by human activities.

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