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Evaluation of Agriculturally important water quality parameters of "Ketawala Anicut" located in Gampaha District.

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Abstract

This project was carried out to evaluate agriculturally important water quality parameters of Ketawala anicut located in Gampaha district over a period of four-months. The analysis was carried out to evaluate mainly Sodium Adsorption Ratio (SAR), salinity and ammonical nitrogen. Furthermore, total hardness of water, Phosphate and nitrate contents and chemical oxygen demand (COD) were also evaluated. The data gathered in this project, specially SAR and salinity provide an indication that the quality of irrigation water can be affected by poor water supply and evapotraspiration. This type of base line data are useful in monitoring the quality of irrigation water of this reservoir.

Introduction

It is reported that the percapta availability of water in Asia declined by 40-60% between 1965-1990. Under these circumstances it is very likely that Asia will have to face a water crisis by the year 2025 A.D (1). There are two adverse effects in this regard. If the surface water becomes unsuitable for irrigation and the ground water becomes unsuitable for drinking purposes, we really facing a water crisis. In order to prevent this, it is very important to prevent pollution of water regardless of the purpose. During the flow of irrigation water, before it reaches to the field of crop , soluble salts can be dissolved in it and resulting in salinity. Salinity can be increased with deforestation. Evapotranspiration of water in the field accumulates dissolved salts. Which has an impact on soil properties and crop growth . It has been reported that irrigated areas have to be abandant due to the increase in salinity, specially when the rain fall is low (2-5).

It is necessary to have an idea about chemical composition of irrigation water to check salt-build up during irrigation. Irrigation with bad quality water under poor drainage conditions lead to increase salinity. Diverted water for irrigation is lost through evapotranspiration in the field (evaporation and transpiration). This is due to the changes from liquid to gaseous state by energy of sunlight. When the water is lost due to evapotranspiration , any dissolved solids present in the water are left behind. The major constituents of irrigation waters are sodium, copper, Magnesium , chloride , sulphate and bicarbonate ions . In some cases it is possible to find potassium,nitrate, copper, cobol and phosphate are present as minor quantities. They usually do not affect irrigation water. Boron is also found in low concentration in irrigation waters, but it is harmful to crop growth above a concentration of a few ppm . The harmful effects of metal ions sometimes depend on the speciaion.

Suitability of irrigation waters depend on several factors such as total salt concentration , cation and anion composition , physico chemical properties of the soil profile , salt tolererance characteristics of the crop plant. Drainage conditions and climatic parameters etc. The degree of adverse effect on soil properties and crop growth is mainly related to the chemical composition of irrigated water. The quality of irrigation water is generally judged by total salt concentration, sodium adsorption ratio (SAR), boron concentration and bicarbonate content. High value of total salt concentration of irrigation water will increase the salinity of water. The relative proportion of sodium to other cations is determined by SAR.It has been observed that plant growth is affected with increase of total concentration of salt, SAR or both. Irrigation waters rich in bicarbonates tend to precipitate soluble calcium and magnesium their carbonates. This increases the sodium content in proportion to Calcium and magnesium there by increasing the SAR.

This project was carried out to evaluate agriculturally important water quality parameters of Ketawala Anicut located in Gampaha district. Gampaha is a suburb of Colombo . Ketawala anicut was build in 1943 by utilizing the water of Attanagalla oya and provide irrigation water for a vast area of paddy fields. It is also used for bathing purposes by the people in the vicinity. The project was carried out for a period of four months to monitor sodium adsorption ratio (SAR) , salinity , ammonical nitrogen , total hardness , phosphate and nitrate contents, and chemical oxygen demand (COD) . Preliminary water quality parameters of this field was carried out previously(6).

Experimental

Materials

All the chemicals used were analytical grade and distilled deionized water was used for the experiments. Water samples were collected from the Ketawala anicut once a month for the duration of four months. Water samples were collected in bottles which are cleaned with 10% HNO_3 followed by tap water and deionized water. In the case of measurements of dissolved O_2, the dissolved oxygen was fixed at the site by adding $MnSO_4$ and alkali with azide. After collection , the samples were kept at 4°C until used for analysis. The measurement of pH and temperature are done at the site.

Methods

Chemical oxygen demand (COD) was determined using dichromate reflux method. Determination of ammonical nitrogen was carried out with Nessler's reagent (Colorimetric method). Phosphate concentration of the water samples were evaluated with vandomolybdophosphoric acid colorimetric method. The determination of total hardness (Ca^{2+} and Mg^{2+} content) was accomplished by EDTA complexometric titration and determination of Ca^{2+} by it self was done by patton and Reedere's (HHSNNA) titrimetric method. Determination of sodium content was accomplished with flame photometry. From the values of calcium , magnesium and sodium , SAR values were calculated. Salinity was determined with Argentometric titration procedure and finally nitrate (NO^3) content was determined using nitrate ion selective electrode.

Results and discussion

Evaluation of water quality parameters of the field located at the Ketwala anicut (locations as indicated in the figure 1) was done from ploughing to harvesting for a duration of four months (02.10.1996 - 13.01.1997). During this period considerable variation of temperature and pH was not observed. However the conductivity measurement were fluctuated between 40.0 $uScm^{-1}$ and 58.0 $uScm^{-1}$ (Table 1,2,3).

It is noted that nitrate concentration in the water samples was reduced toward the last dates of sampling (Table 4). Significant variation of chemical oxygen demand (COD) was observed at the 2nd and 3rd sampling dates (Table 5). Ketawala anicut uses water of the Attanagalla oya which is not situated close to any industrial zone and therefore this water body has low COD values. Phosphate ion concentration was not varied significantly during this sampling period. Usually natural water contains less amount of phosphates. According to the WHO standards, average concentration of phosphate in surface water is 0.054 ppm. Calcium and magnesium contents also were not varied significantly during the sampling period (Table 6). However significant increase of ammonical nitrogen content was observed at the third sampling date as evident in the table 7. That is probably due to the fact that the use of urea fertilizer around this date in the field. Significant variation of salinity was not observed (table 8) during the period of sampling. The average value of salinity of this analysis is 0.155gkg^{-1}. This is very low compared the harmful levels of salinity for crop growth . Finally a considerable increase of SAR was reported at the 4th sampling date. This could be probably be attributed to evapotranspiration. Around this date supply of water to the field was stopped and field contained less water resulting in high evapotranspiration .

Conclusions and future directions

Evaluation of water quality parameters of irrigation water of Ketawala anicut was carried out through four months period. Considerable variation of water quality even under application of agrochemicals could not be observed during four months sampling period. At any rate, to arrive at a conclusion it is necessary to carry out this analysis for a longer time period.

The data gathered in this project specially SAR and salinity provide and an indication how the quality of irrigation water can be affected by poor water supply and evapotranspiration. Also it has been observed beyond a certain value of SAR and salinity that particular irrigation water becomes unsuitable for agricultural purposes. Therefore monitoring of the water quality with respect to these parameters are very important when the successful agricultural production is expected. Furthermore, this type of base line data are very important to this particular water resource as such data are not currently available. In addition the data of this type could be very useful in environment research.

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ROUGH SKETCH OF THE AGRICULTURAL LAND (STUDY SITE)

FIG. (1)

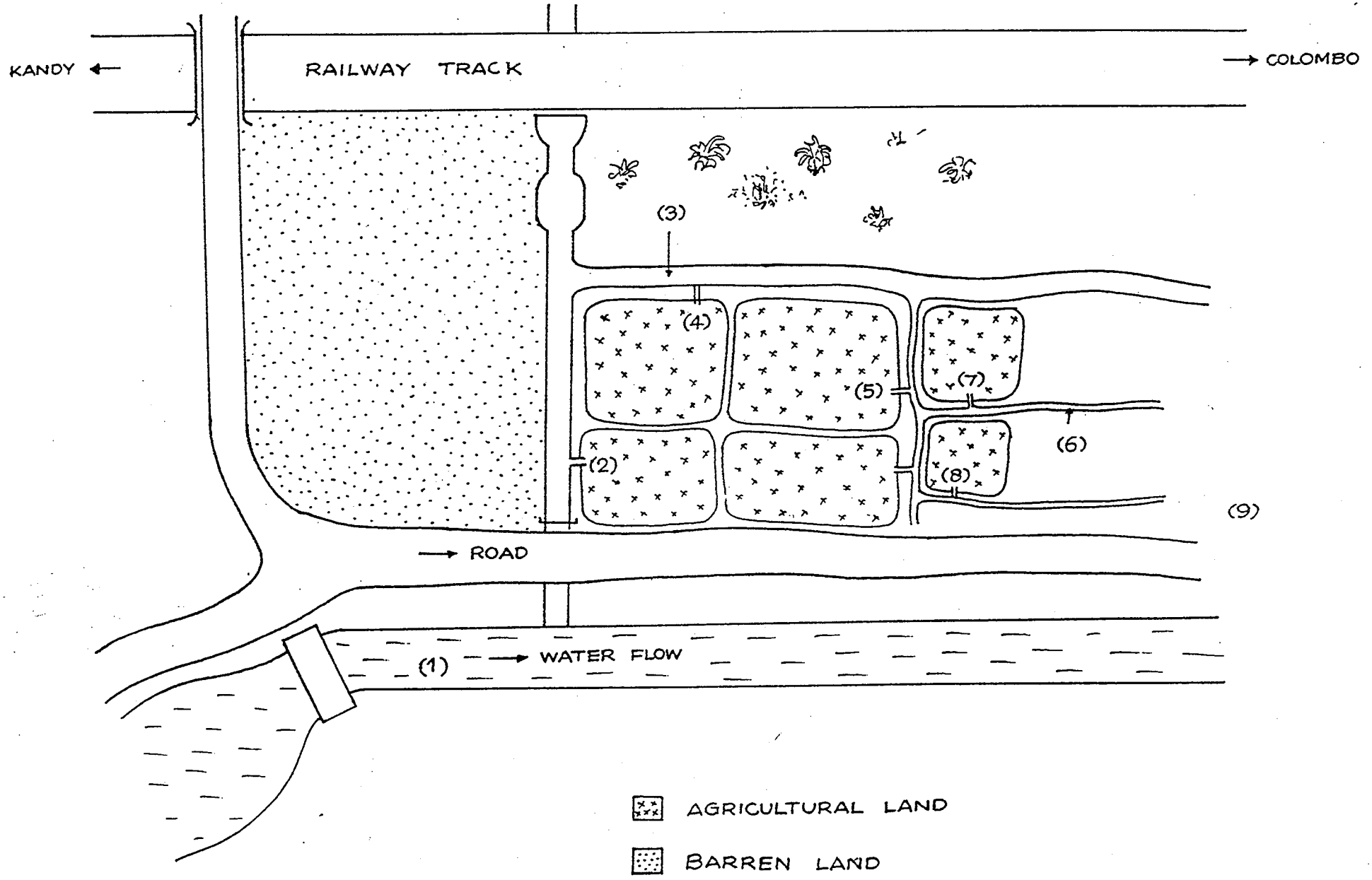


Figure 1

Location	Sampling date			
	02/10/96	13/11/96	07/12/96	13/01/97
1	29.0	29.0	28.0	29.0
2	29.0	29.0	28.0	29.0
3	29.0	29.0	28.0	29.0
4	28.0	33.0	29.0	30.0
5	31.0	33.0	29.0	---
6	31.0	32.0	29.0	---
7	31.0	32.0	29.0	30.0
8	31.0	31.0	29.0	---
9	30.0	33.0	29.0	---

Table 1. Variation of temperature (C°).

Location	Sampling date			
	02/10/96	13/11/96	07/12/96	13/01/97
1	5.67	6.00	6.71	6.81
2	6.84	6.00	6.80	6.70
3	5.95	6.01	6.97	6.75
4	6.09	7.03	6.96	7.19
5	6.08	7.00	6.90	-----
6	7.18	6.92	6.95	-----
7	6.24	7.20	7.12	7.41
8	6.53	6.37	6.95	-----
9	6.62	6.77	6.90	-----

Table 2. Variation of pH determined by pH electrode.

Location	Sampling date			
	02/10/96	13/11/96	07/12/96	13/01/97
1	43.0	54.0	37.0	56.0
2	42.0	54.0	38.0	55.0
3	43.0	54.0	40.0	55.0
4	48.0	47.0	39.0	57.0
5	46.0	47.0	36.0	-----
6	40.0	50.0	37.0	-----
7	50.0	43.0	36.0	58.0
8	43.0	55.0	38.0	-----
9	43.0	50.0	37.0	-----

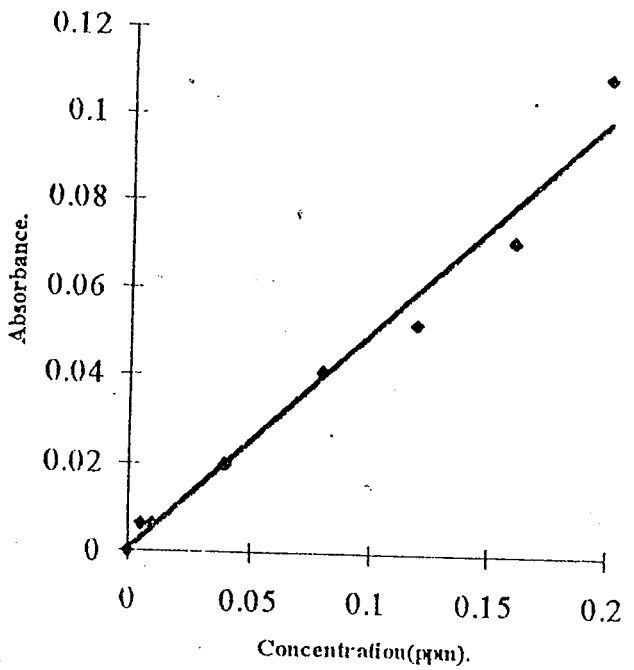
Table 3. Variation of conductivity determined by conductivity meter/ $\mu s\ cm^{-1}$.

Location	Sampling date			
	02/10/96	13/11/96	07/12/96	13/01/97
1	0.550	0.358	0.202	0.211
2	0.552	0.360	0.344	0.188
3	0.557	0.325	0.212	0.177
4	0.368	0.190	0.169	0.159
5	0.381	0.170	0.131	-------
6	0.240	0.178	0.296	-------
7	0.582	0.120	0.314	0.147
8	0.332	0.213	0.352	-------
9	0.346	0.163	0.286	-------

Table 4. Variation of $N\text{-}NO_3^-$ concentration determined by the ion selective electrode/ppm.

Location	Sampling date			
	02/10/96	13/11/96	07/12/96	13/01/97
1	15.80	4.80	1.70	8.70
2	17.00	5.60	1.50	7.00
3	14.60	3.80	1.50	7.20
4	8.00	5.80	3.10	12.40
5	11.00	5.60	4.70	-------
6	14.60	4.20	2.90	-------
7	14.60	4.60	4.50	11.10
8	10.00	3.80	5.10	-------
9	8.60	7.80	4.70	-------

Table 5. Variation of Chemical Oxygen Demand (COD) determined by dichromate titrimetric method/ ppm.



Calibration curve for the determination of PO_4^{3-}

Location	Sampling date			
	02/10/96	13/11/96	07/12/96	13/01/97
1	0.082	0.012	0.070	0.041
2	0.064	0.014	0.067	0.045
3	0.072	0.018	0.074	0.057
4	0.063	0.018	0.077	0.044
5	0.070	0.015	0.056	-------
6	0.162	0.013	0.068	-------
7	0.063	0.013	0.081	0.057
8	0.063	0.014	0.063	-------
9	0.069	0.015	0.079	-------

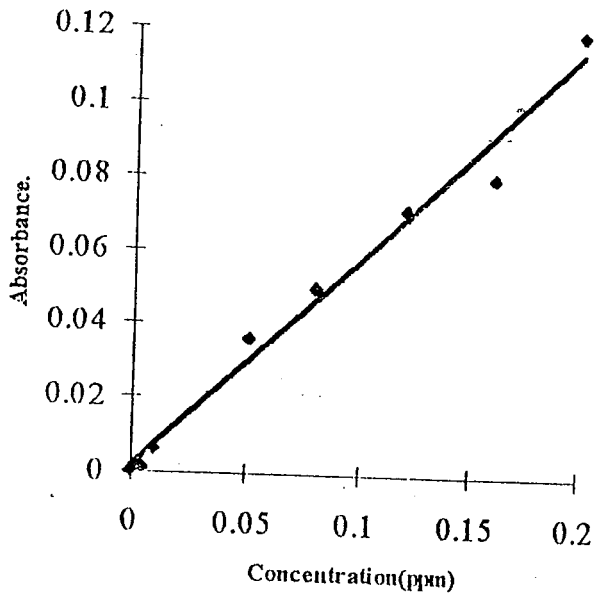
Table 6. Variation of PO_4^{3-} ion concentration determined by the vandomolybdophosphoric acid colourimetric method/ ppm.

Location	Sampling date			
	02/10/96	13/11/96	07/12/96	13/01/97
1	1.650	3.170	1.876	2.560
2	3.200	3.184	2.345	2.171
3	1.600	3.175	2.188	2.41
4	3.200	2.381	2.657	2.710
5	3.200	2.375	2.345	------
6	1.600	2.381	2.188	------
7	1.600	3.174	1.876	3.135
8	0.200	2.460	2.345	------
9	0.100	3.174	2.423	------

Table 7. Variation of Ca^{2+} ion concentration determined by the EDTA titrimetric method/ppm.

Location	Sampling date			
	02/10/96	13/11/96	07/12/96	13/01/97
1	0.980	0.963	0.854	0.973
2	------	0.963	1.138	1.101
3	0.973	0.971	1.043	0.816
4	0.978	0.479	0.854	1.215
5	1.958	0.482	0.854	------
6	1.946	0.482	0.614	------
7	0.973	------	0.854	1.117
8	------	1.446	0.617	------
9	1.946	------	0.522	------

Table 8. Variation of Mg^{2+} ion concentration determined by EDTA titrimetric method / ppm.



Calibration curve for the determination of NH_3.

Location	Sampling date			
	02/10/96	13/11/96	07/12/96	13/01/97
1	0.488	0.225	0.960	0.235
2	0.378	0.233	1.155	0.227
3	0.401	0.462	1.230	0.237
4	0.553	0.528	1.332	0.213
5	0.767	0.408	1.407	-------
6	0.823	0.373	1.398	--------
7	0.267	0.377	1.444	0.219
8	0.214	0.377	1.277	--------
9	0.112	0.318	1.277	--------

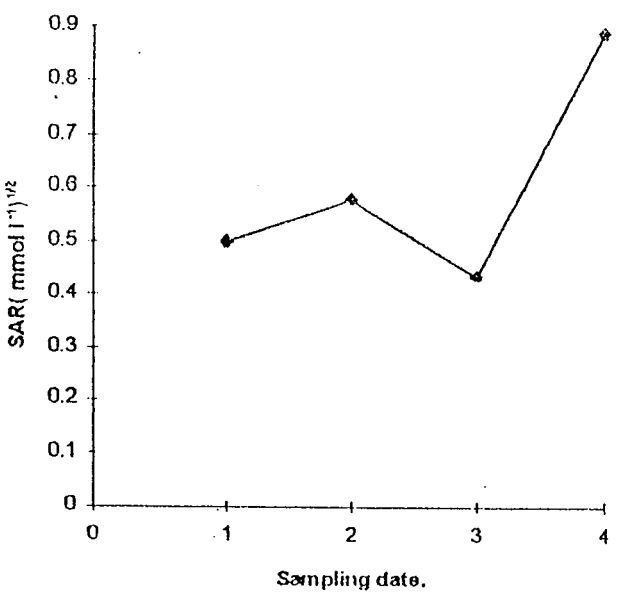
Table 9. Variation of NH_3 ion concentration determined by Nesslerization method/ ppm.

Location	Sampling date			
	02/10/96	13/11/96	07/12/96	13/01/97
1	0.096	0.129	0.131	0.210
2	0.083	0.129	0.135	0.207
3	0.105	0.157	0.144	0.194
4	0.105	0.135	0.153	0.211
5	0.118	0.129	0.180	--------
6	0.118	0.192	0.165	---------
7	0.118	0.284	0.126	0.207
8	0.096	0.183	0.153	---------
9	0.097	0.277	0.156	---------

Table 10. Variation of Salinity determined by the argentometric method gkg^{-1}.

Location	Sampling . date			
	02/10/96	13/11/96	07/12/96	13/01/97
1	0.594	0.545	0.477	0.913
2	0.594	0.545	0.413	0.990
3	0.573	0.540	0.427	0.987
4	0.491	0.494	0.421	0.831
5	0.426	0.434	0.413	--------
6	0.459	0.661	0.460	--------
7	0.569	0.444	0.468	0.947
8	0.580	0.545	0.423	--------
9	0.468	0.537	0.423	--------

Table 11. Variation of Sodium Adsorption Ratio (SAR)/ $(mmol\ l^{-1})^{1/2}$.



. Variation of average SAR of the field.