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ASSESSMENT OF TEMPORAL VARIATION OF SOIL SALINITY IN PADDY FIELDS IN PUTTALAM DISTRICT

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ABSTRACT

A study was conducted in Puttlam district to assess temporal variation of soil salinity in paddy fields. A paddy track belongs to one grid of 2.5 km by 2.5 km was selected from Arachchikattuwa District Secretariat Division (DSD) and two soil samples from the upper and lower positions of the catena from 0 to 15 cm were gathered in monthly intervals throughout the year. Fifty four soil samples were collected from entire study area per one month and sampling points were demarcated by Global Positioning System (GPS). Samples were analyzed for Electrical Conductivity (EC) and thematic maps were developed for EC categories of < 2 dS/m, 2-4 dS/m, 4-8 dS/m and > 8 dS/m. Land extents were then calculated for each legend (< 2 dS/m, 2-4 dS/m, 4-8 dS/m and > 8 dS/m). Suitable months for establishment of paddy crop were determined by the percentage extent of degree of salinity above 4 dS/m. It is learned from the results of this experiment that electrical conductivity values were varying with time within Arachchikattuwa DSD. The maximum EC values were reported in February, July and August while low mean EC values (1.9, 1.8 and 1.7 dS/m) were recorded in April, September, October and November. Percentage land extent having electrical conductivity above 4 dS/m was 10% in September and April where high rainfall received. As such April for *Yala* season and September for *Maha* season are the suitable months to establish paddy crop in Arachchikattuwa in Puttalam district. Since EC levels are at minimum during the whole cropping season of *Maha* it is the most suitable season to grow rice in the Puttalam district.

Key words: Electrical conductivity, Soil Salinity, Temporal variation

INTRODUCTION

As many other Asian countries, Sri Lanka is an agricultural country where rice is the staple food. At present, the country produces 3.8 million mt of rice to feed 20.3 million population. In five years, estimated population will be 23.6 million and rice requirement is expected to be 4.2 million mt. Therefore, it is necessary to increase rice production in the country to feed the growing population. Increasing yield potential, expanding cultivated extent and increasing yield per unit area are the possible measures to increase rice production. Increment of yield potential and expansion of cultivated extent have been already achieved and improvement of management practices through controlling biotic and abiotic stresses are the possible alternatives left which is the most applicable approach of productivity improvement of paddy fields. At present, required inputs including seed paddy, fertilizer are adequately supplied and the most of recommended rice varieties are resistant to major biotic stresses. Therefore, main barriers of increasing rice yield per unit area today are abiotic stresses identified as salinity, drought, floods, temperature and iron toxicity. At present, salinization has become the second most widespread soil problem in rice growing countries next to drought. It is considered to be a serious constraint on rice production in Sri Lanka as well (Sirisena, 2013). According to Szabolcs (1994), more than 10% of irrigated lands worldwide are affected by salinity. Soil degradation by salinity is expected to be intensified by the imminent climate change and the increase in irrigation demand.

In Puttalam district alone, 18.8% and 4% of land area have been identified as marginally suitable or unsuitable for rice production, respectively (Sirisena *et al.*, 2014). As such, average grain yield of the district is 3.7 t/ha in *Maha* season and 3.5 t/ha in *Yala* season (District Statistical Branch, 2011) which are far below the country average of 4.3 t/ha (CBSL, 2013). According to Sirisena *et al.* (2014), soil salinity is the major reason for reduction of average grain yield. Therefore, emphasis has been given to identify spatial variability of soil salinity in the Puttalam district to introduce technical package to alleviate issues associated with soil salinity. Since salinity is varying with the moisture content of the soil, same level of salinity cannot be expected though out the year due to variation of rainfall and irrigation in the area. Therefore, if periods dominating low salinity levels can be identified, time of planting can be adjusted to protect rice crop form high salinity. Therefore, the aim of this study was to investigate the changes of soil salinity during the year in Puttalam district by taking Archchikattuwa Divisional Secretariat Division (DSD) as a representative area.

MATERIALS AND METHODS

Arachchikattuwa DSD which has climatic and soil conditions similar to average climatic and soil conditions in the Puttalam district was selected for this study. Arachchikattuwa DSD occupies 10,400 ha of land area which is 3.4% of the land area of Puttalam district. Cultivable paddy extent of Arachchikattuwa is 1,735 ha including 686 ha, 562 ha and 485 ha of major irrigated, minor irrigated and rainfed, respectively (District Statistical Branch, 2011). Figure 1 shows the distribution pattern of paddy field in Arachchikattuwa DSD. Majority of the paddy fields in this DSD are affected by soil salinity (Sirisena *et al.*, 2014). Analogue and digital maps of 1:50,000 prepared by the Department of Survey in Sri Lanka (Department of Survey, 2000) were used as the base maps for the study. Two composite soil samples to a depth of 0-15 cm were periodically gathered from the upper and lower positions of one paddy track belonging to a grid of 2.5 km by 2.5 km. In total, 54 soil samples were collected per month and the points were demarcated by Global Positioning System (GPS).

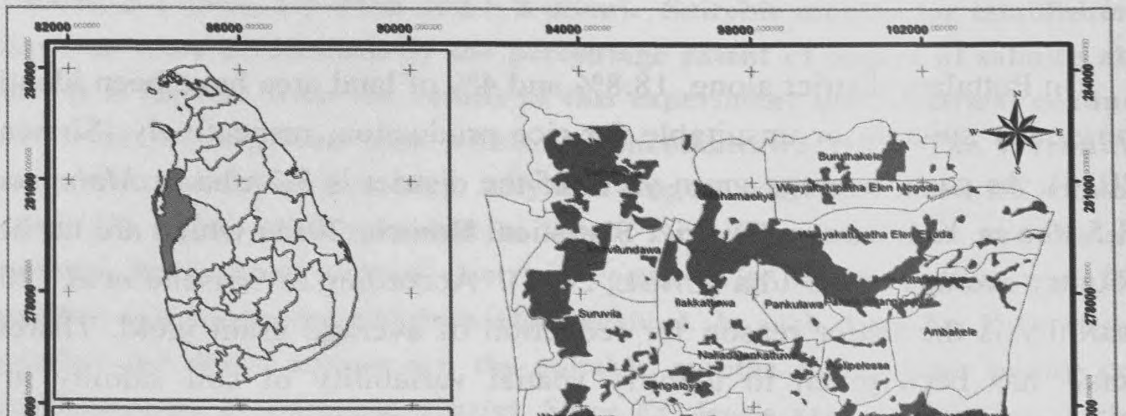

Figure 1. Distribution of paddy fields in Arachchikattuwa DSD in Puttalam District.

Soil sampling was done form October, 2013 to September, 2014. Collected soil samples were air dried at room temperature. Impurities like debris and stones were removed and soil samples were crushed by using clean mortar and pestle to break aggregates. Soil was then passed through 2 mm sieve. Samples were analyzed for Electric Conductivity (EC) by saturated extract method (Dharmakeerthi *et al.*, 2007) using electrical conductivity meter Model Orion, 145 A+. According to Ikehashi and Ponneperuma, (1978) rice plants are susceptible to salinity and yield reduction is started at 2 dS/m. A half of the yield is reduced at 4 dS/m and total reduction is occurred at 8 dS/m. Therefore, EC values used to prepare thematic maps on soil salinity relevance to rice growth for twelve months period classed as less than 2 dS/m (non saline), 2 – 4 dS/m (slightly saline), 4 – 8 dS/m (moderately saline), and greater than 8 dS m^{-1} (strongly saline) (Dharmakeerthi *et al.*, 2007) using Arc View 9.3 GIS software.

RESULTS AND DISCUSSION

Results presented in Table 1 shows the EC values of the area throughout the year. Accordingly, EC values varied with time within Arachchikattuwa DSD. Lowest EC value was 0.1 dS/m and the highest value was 38.3 dS/m. The maximum values were reported for February, July and August. Lower mean EC values (1.9, 1.8 and 1.7 dS/m) were recorded in September, October, November and April. The lowest standard deviations were recorded in September and April. This may be the reason of rainfall distribution pattern of the year. Therefore, to confirm the relationship between soil salinity and rainfall pattern, monthly rainfall from October 2013 to September 2014 of the Ambakele meteorological station located within Arachchikattuwa DSD was used (Table 2). Accordingly it is proven that soil salinity is closely related to rainfall and number of rainy days of the area.

The low rainfall and low number of rainy days in the months of January, February, March, June and July may be the reasons for higher salinity in February and August. On the other hand, high rainfall and higher number of rainy days in April and September may be the reasons for lower salinity in the months of April and September. However, monthly average rainfall data of the Puttalam district is not total agree with the above situation. Therefore, it is advisable to consider the rainfall which is the nearest to the experimental site. Maps prepared for spatial distribution of soil salinity throughout the year in Arachchikattuwa DSD and results appeared in Table 3 reveals the percentage land extent of each salinity classes.

Table 1. Minimum, maximum and mean EC values of the Arachchikattuwa DSD throughout the year.

Month	Minimum	Maximum	Mean	Std. Dev.
Oct-13	0.1	17.8	1.8	2.7
Nov-13	0.1	15.4	1.8	2.9
Dec-13	0.2	18.1	2.5	3.3
Jan-14	0.1	17.2	2.2	3.2
Feb-14	0.1	23.8	2.5	3.9
Mar-14	0.1	18.8	2.4	3.2
Apr-14	0.1	15.5	1.7	2.6
May-14	0.1	21.5	2.2	4.1
Jun-14	0.1	24.7	2.3	4.5
Jul-14	0.1	38.3	2.5	5.5
Aug-14	0.1	38.3	2.5	5.5
Sep-14	0.2	16.6	1.9	2.6

Table 2. Average monthly rainfall data of the Puttalam district and monthly rainfall data of Ambakele (from October 2013 to September 2014).

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
RF (mm) of Puttalam	20	14	18	55	70	40	50	104	119	188	145	51
Rainy Days of Puttalam	1	1	2	3	3	2	3	4	5	8	7	4
RF (mm) of Ambakele	13.2	35.5	13.5	414.7	112.2	33.2	6.8	174.1	98.6	129.5	214.8	101.1
Rainy Days of Ambakele	2	1	1	14	8	3	2	8	10	5	9	4

Ikehashi and Ponnaperuma (1978) observed that 50% of the rice yield of salt susceptible varieties is reduced at 4 dS/m and 100% reduction is occurred at 8 dS/m. According to the above results, the lowest percentage (10%) of paddy fields having 4-8 dS/m EC level is found in September and April (Figure 2 and 3). Rice plants are highly sensitive to soil salinity during the seedling stage (Ikehashi and Ponnaperuma, 1978). Therefore, soil salinity should be at minimum during the early seedling stage until one month. Considering the above, the most suitable months for planting rice in Puttalam district are September for *Maha* and April for *Yala*.

Since soil salinity is at lower levels during the period from September to January *Maha* is the best season to cultivate rice in saline paddy fields in the Puttalam district. According to Sirisena (2013), salinity effect on rice plants can be minimized by maintaining stagnate water in the paddy fields during seedling stage of the rice crop. Since rice seedlings are too small, maintaining stagnate water in the paddy fields during seedling which cannot be done. Therefore, crop establishment should be done at the low level of soil salinity. To further increase productivity in the saline paddy fields, salt tolerant rice varieties (Bg 369, Bg 310, At 354 and At 401) can be used. To validate the above, field trails should be conducted with planting time in April and September. These trials should be demonstrated in farmers' fields to educate farmers and extension officers.

Table 3. Percentage land extent having different salinity levels in Arachchikattuwa DSD throughout the year

Month	< 2 dS/m	2 - 4 dS/m	4 - 8 dS/m	> 8dS/m
Oct-13	60	23	16	1
Nov-13	63	12	24	1
Dec-13	40	34	21	4
Jan-14	52	20	27	1
Feb-14	52	17	27	4
Mar-14	39	35	24	1
Apr-14	61	29	9	1
May-14	51	29	14	5
Jun-14	56	22	15	7
Jul-14	49	26	21	4
Aug-14	48	28	21	4
Sep-14	55	36	9	1

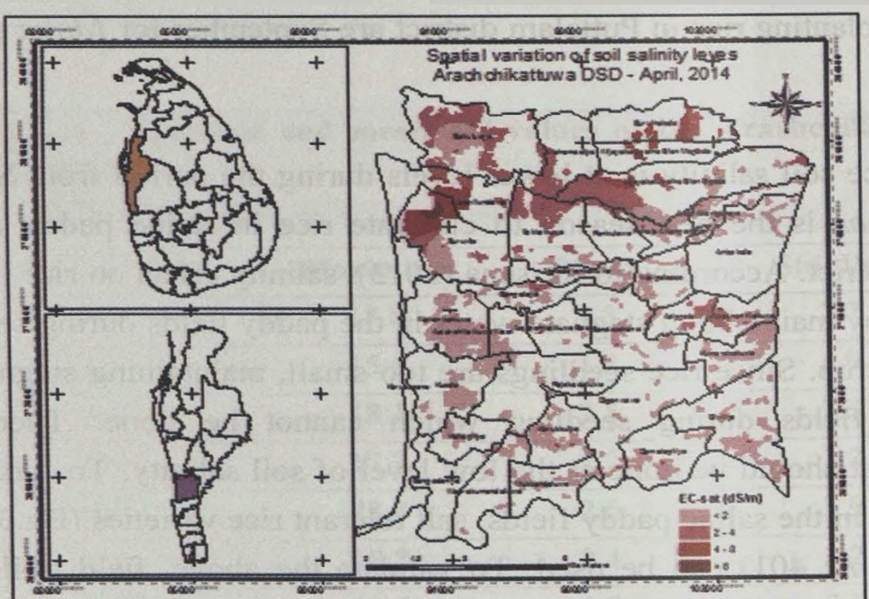

Figure 2. Distribution of soil salinity of paddy fields in Arachchikattuwa DSD in April, 2014.

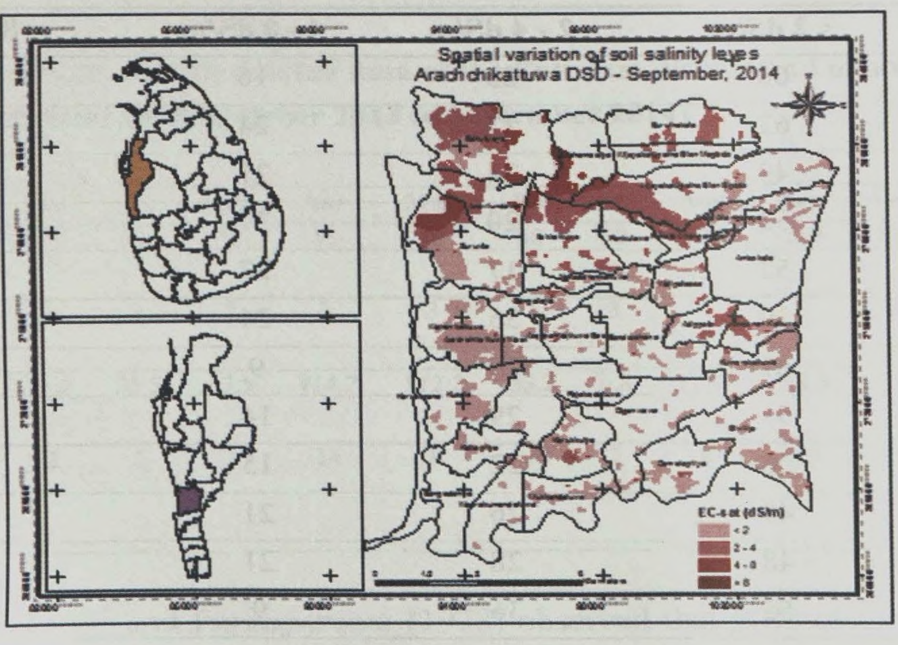

Figure 3. Distribution of soil salinity of paddy fields in Arachchikattuwa DSD in September, 2014.

CONCLUSIONS

Estimation of temporal variation in soil salinity is important to decide the cultivation time of rice. It is learned from the results of this experiment that EC values were varying with time within Arachchikattuwa DSD. The maximum EC values were reported in February, July and August. Low mean EC values (1.7, 1.9, 1.8 and 1.8 dS/m) were recorded in April, September, October and November. Percentage land extent having EC above 4 dS/m was lowest (10%) in September and April where high rainfall and number of rainy days are occurred. As such April for *Yala* season and September for *Maha* season were the suitable months to establish paddy crop in Arachchikattuwa in Puttalam district. Since EC levels were at minimum during the whole cropping season of *Maha,* it is the most suitable season to grow rice in the Puttalam district.

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