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Impact of Subsurface Drainage System on Ground Water Quality of Kalipatnam Pilot Area

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ABSTRACT

Reclamation of saline, saline-alkali and waterlogged soils formed due to the intrusion of sea water/ poor shallow ground water quality can effectively be done by the sub-surface drainage (SSD) technology. One year after installation of SSD system, ground water salinity in the pilot area (27.23 dS/m) has significantly reduced to 20.45 dS/m, where as control area ground water salinity has slightly increased from 36.66 dS/m (May,05) to 37.65 dS/m (May, 06). Two crop seasons after installation of SSD system, EC of the groundwater have been reduced considerably. At Kalipatnam pilot area, EC of groundwater has reduced by 25 percent due to installation of SSD system.

Key words : Drainage, Groundwater quality, Reclamation, Salinity,Salts.

In Andhra Pradesh, the command areas affected by water logging and salinity are estimated to be 2.74 lakh ha and 1.15 lakh ha respectively in canal commands alone (Anonymous, 1986). In many canal commands, there has been a rise in the water table and consequent degradation of soils through water logging and secondary salt build-up and the impact of irrigation over many years has caused the ground water table to rise into root zones in these command areas, which led to reduction in crop yields. This problem is found to be aggressive along the coastal line of Andhra Pradesh. The soils of Godavari Western delta nearer to sea are experiencing a problem of salinity and water logging due to seawater intrusion. The technology of sub-surface drainage system is the most appropriate under the salinity and water logging conditions to leach out the excess and harmful salts from the crop root zone, providing a better environment to the plants to grow. Therefore monitoring the ground water quality during the SSD system operation period serves as the key index for the performance assessment of Installed SSD system. Hence, in the present study ground water quality was monitored in both the pilot and control area for one year (May, 05 to May, 06) to assess the performance of installed subsurface drainage system in the Kalipatnam pilot area of Godavari Western Delta.

MATERIALS AND METHODS

General Characteristics of The Pilot Area

Kalipatnam drainage pilot area (16^{o}23'N, 81^{o}32'E) is located in Godavari Western Delta near east cost of Peninsular India. These soils are waterlogged and saline sodic. Soils are alluvial and adjacent to salt stream (Upputeru) which is joining sea at 9 km distance having influence on the ground water quality. Therefore, effective salinity control must include not only adequate drainage to control and stabilize the water table but also a net downward movement of water to prevent salinization by capillary rise.

The water table fluctuated between the soil surface in the monsoon season and 0.90 m from the ground level in summer season (Anonymous-2000a). Rainfall is very high in the month of October. The mean annual, summer and winter temperatures are 26.9^{0}C, 30.1^{0}C and 23.8^{0}C respectively and the mean annual rainfall is 853 mm. The soils of the pilot area are saline sodic with ECe 4.03 to 16.00 dS/m, pH 6.86 and ESP 15 to 60 %. EC of the groundwater of the pilot area varied from 4.80 to 43.10 dS/m with an average of 23.9 dS/m. The main crop at the pilot area is paddy followed by paddy with a fallow period of two months. The pilot area receives irrigation water from Kalipatnam Extension channel of Godavari Western Delta with an average EC of 0.4 dS/m. Flooding method of irrigation is adopted and Water is allowed to flow from field to field. The water from the fields is drained to Upputeru through a separate drain called Magaleru drain.

Sub-surface drainage system with a pumped outlet is installed in Summer 2005, in a pilot area of 18 ha at Kalipatnam where the identified problems are Water logging, Salinity and Sodicity. Based on the drainage investigations, SSD system was installed with a 50m lateral spacing and Nylon mesh was used as filter material. On the Western side of the collector line, 7 lateral drains named as W1, W2 …..W7 and on the Eastern side of the collector line, 7 lateral drains named as E1, E2 …..E7 are installed (Fig 1). SSD was operated for 788 hours for the year 2005-06 (May, 05 to May, 06). Observation wells have been installed at the pilot area for monitoring ground water quality. Twelve observation wells and 5 deep piezometers were installed in drainage pilot area and 12 Observation Wells installed in Control area at 150 m X 150 m spacing for monitoring the ground water quality. Water samples collected at fortnight intervals from 24 observation wells at the pilot area and control were analysed for EC. Data were tabulated and graphs were prepared.

RESULTS AND DISCUSSION

The EC of the groundwater varied from 4.80 to 43.10 dS/m with an average of 23.9 dSm^{-1} (Anonymous, 2000 b). The chloride content was very high (60 – 590 meq/l), whereas SAR (2.00 – 7.28) was in safe limits and Mg/Ca ratio (1.67 – 11.55) was in unsafe range (Table 1).

Influence of SSD system on groundwater salinity

The Water samples collected from the 24 Observation wells (12 in pilot & 12 in control) at fortnightly intervals were analysed for Electrical Conductivity and contour maps were prepared (Fig. 2 & 3). High EC values were observed during summer months because of seepage from seawater through Upputeru into the pilot area and during monsoon seasons with adequate supply of irrigation water, salinity of the ground water was reduced to lower levels (Table 2). To compare the trend of salinity reduction, data on ground water salinity levels before and after installation of Sub surface drainage system from the twelve observation wells have been analysed. It is observed from the Figure 4 showed that the salinity level of the groundwater is decreased in pilot area compared to control because of installation of subsurface drainage system.

There was considerable reduction in ground water salinity in the pilot area after SSD installation. Maps were prepared to observe the changes in EC before and one year after the installation of the system (Fig 2&3). One year after installation of SSD system ground water salinity in the pilot area has significantly reduced by 25 per cent (From 27.23 dS/m to 20.45 dS/m), where as control area ground water salinity has slightly increased from 36.66 dS/m (May,05) to 37.65 dS/m (May, 06). (Table 2).

Monthly Monitoring of Ground Water Quality:

Monthly mean ground water salinity under study period (May, 05 to May, 06) indicated that during May, 05 mean ground water salinity difference between the pilot and control area was 25.72% (Table 2) which was widened to 45.68 % during May, 06. This increase in difference between the pilot and control area from May, 05 to May, 06 can be attributed to operation of SSD system for 778 hours (Figure 4).

During the months of January and February, *rabi* crop suffers from irrigation water scarcity as the Kalipatnam pilot area is located in the tail end area. During this period pilot area maintained lower salinity than control area (January 06, 57.34 %, February 06, 54.79%)

The reduction in salinity of ground water at pilot area within two seasons after installation of subsurface drainage system was effective thus proving that sub surface drainage technology can also be effectively used in the saline and sodic soils to remove the salts in huge quantities from the profile in shortest possible time. The reason for the reduction in groundwater salinity and increase in rice yield was due to the removal of salts through the sub – surface drainage system installed in the pilot area. Establishment of paddy crop was good after installation of drains and general yield increase was 1.4 t/ha. The relation between yield and salinity will be approached by a straight line for the important range of yield decrease (van Hoorn and van Alphen, 1994).

Sub surface drainage technology can also be effectively used in the saline and sodic soils to remove the salts in huge quantities from the profile in shortest possible time. After two crop seasons, EC of groundwater was reduced by 25 per cent. It was estimated that 12.75 tones/ha of salts were leached through the system for two seasons. One year after the installation of SSD system, yield was increased 1.4 t/ha over control.

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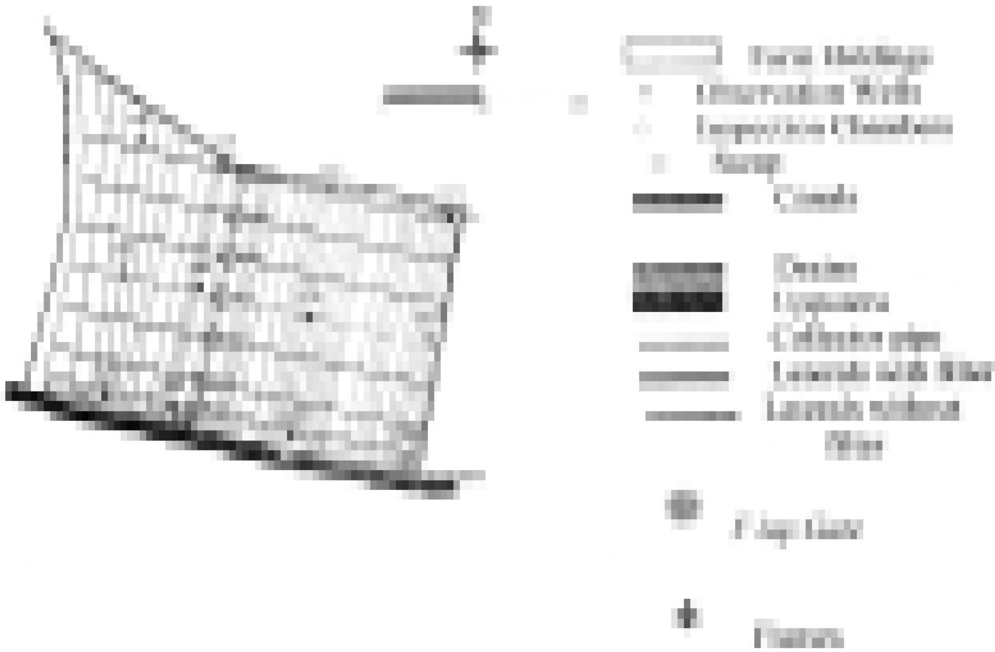

Figure: 1 Kalipatnam pilot area showing observation wells, drainage systems and farmers holdings

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Table 1.Ground water quality of Kalipatnam Drainage Pilot Area

S.No	Parameter	Range Minimum	Maximum	Average
1	EC (dS/m)	4.52	43.40	23.60
2	Ca^{++} (me/l)	4.5	15.00	10.92
3	Mg^{++} (me/l)	13.5	167.50	76.67
4	Na^{+} (me/l)	9.05	37.12	28.52
5	SAR	3.02	6.32	4.52
6	Cl (me/l)	60.0	590.00	306.00

Table 2 Changes in EC (dS/m) of Ground water in the pilot area, Kalipatnam

Month	EC (dS/m)			
	Pilot area		Control	
	Range	Mean	Range	Mean
May, 05	12.70-39.50	27.23	19.30-70.50	36.66
June, 05	13.47-35.97	24.91	17.63-70.40	39.13
July, 05	11.70-30.27	20.72	19.63-51.3	34.74
August, 05	4.66-19.45	13.37	12.06-39.85	26.34
September, 05	4.07-29.10	14.82	9.66-52.60	29.00
October, 05	5.43-23.27	14.09	10.86-46.23	27.67
November,05	2.93-37.15	14.11	6.59-54.00	27.38
December, 05	3.93-35.5	14.81	7.35-58.60	30.31
January,06	4.11-34.2	13.55	10.35-59.80	31.77
February, 06	2.67-33.4	14.38	5.12-61.80	31.81
March, 06	2.08-36.3	13.91	5.90-69.10	32.21
April, 06	1.31-35.80	16.63	13.00-68.80	35.68
May, 06	2.88-39.40	20.45	15.20-74.20	37.65

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