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Investigations for Installation of Drainage System to Control Salinity in Godavari Western Delta – A Case Study

P Sreedevi, R Ganesh Babu, M Ratnam and Ch Sreenivas
A.P.Water Management Project, Net work Centre, Undi-534 199 (AP)

ABSTRACT

The study on Pre drainage investigations carried out at Kalipatnam pilot area (18 ha) of Godavari Western Delta under Andhra Pradesh Water Management Project revealed that the pilot area is almost flat with a slope of 0.01 percent and a shallow water table of poor quality (EC 4.8 to 43.1 dS m^{-1}). The soils are highly saline with an EC 4.03 to 16.35 dSm^{-1} and ESP 15 to 60%. The piezometer study concluded that there is vertical ground water movement in the pilot area and hence natural drainage is not possible. The Staff guage studies at Upputeru, revealed that there is back flow of sea water to the fields during summer. The tidal range of Upputeru varies from 0.0 to 0.9 m above MSL where as the maximum land elevation is 0.4 m MSL. Hence, pumped subsurface drainage system is recommended in the pilot area instead of gravity flow.

Key words : Drainage system, Salinity, Waterlogging ,

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The sustainability of irrigated agriculture in India is under threat due to widespread occurrence of Waterlogging and salinity. According to an estimate, the extent of salinity-affected areas are 3.3 m ha in India and 0.8 m ha in Andhra Pradesh alone. The impact of continuous irrigation over the years has resulted in raise in Ground Water table which in turn resulted in development of salinity and water logging in the command areas reducing the crop yields (Anonymous 2002). This problem was found aggressive in Godavari western delta along the coast.

The technology of subsurface drainage system is the most appropriate under saline and water logging conditions to leach out the excess and harmful salts from the crop root zone, providing a better environment for the plants to grow and produce good yields. The design and construction of subsurface drainage system involves detailed study of topography of pilot area, ground water situations requiring a record of the depth and quality of water table and its variation during the year, the hydraulic conductivity, infiltration characteristics of the soils, depth to impervious layer, tidal range of the sea. The tail end of the Godavari Western Delta adjacent to Upputeru was selected to conduct operational research for drainage investigations under A.P. Water Management Project with technical collaboration from Alterra-ILRI, Wageningen University, The Netherlands.

MATERIAL AND METHODS

The study was conducted in Kalipatnam village of West Godavari district located at 16^0 23' N latitude and 81^0 32' E longitudes at a distance of 15 Km from Bay of Bengal. The pilot area spread over 18 ha and is bounded by irrigation canal in the North and West, drain in the East. Adjacent to pilot area there is salt stream called Upputeru through which excess rainwater, agricultural waste from upstream merges in to Bay of Bengal. Hence there is a problem of seawater intrusion into the pilot area during high tide. The mean annual, summer and winter temperatures are 26.9^0C, 30.1^0C and 23.8^0C respectively and the mean annual rainfall is 853 mm. The soils of the pilot area are saline with EC 4.03 to 16 dS/m, pH 6.86 and ESP is 15 to 60%, similar studies were conducted at Uppukonduru by Laxmi *et al*., 2003. The main crop of pilot area is rice followed by rice with a fallow period of two months during summer. The pilot area receives irrigation water from Kalipatnam Main Channel of Godavari Westerns delta system. The irrigation water quality was 0.4 dSm^{-1}. Flooding method of irrigation is adopted and water is allowed to flow from field to field. The excess water from the fields is drained into Upputeru through Magaleru drain.

About 12 observation wells have been installed in the pilot area at a depth of 4.0m for measuring groundwater depth and quality. The pilot

area has been experiencing a serious problem of water logging and salinity due to seawater intrusion from Upputeru (Raghu Babu *et al.*, 2005). Hence a Staff gauge is installed at Upputeru to study the tidal affect of the sea to the pilot area. The *insitu* measurement of hydraulic conductivity was done at 12 different locations selected at 150X150m grid using Auger hole method (Kumbhare and Rao 1991). The infiltration experiment has been conducted in the Kalipatnam pilot area using double ring infiltrometer at five different sections of pilot area. To study the movement of ground water at specific points, a battery of piezometers is installed at the pilot area at different locations at different depths i.e 7.5m, 5m and 2.5 m at different locations. Depth to water levels was measured in the piezometers at fortnight intervals.

RESULTS AND DISCUSSIONS

The detailed survey of the pilot area was carried out with a grid size of 50 X 50 m and land elevations were taken. The contour map was prepared for Kalipatnam pilot area with a contour interval of 0.01m (fig.1). The topography of the pilot area is even and flat with 0.01 percent slope towards southeast corner with a maximum land elevation of 0.40 m MSL.

Water table depth and Groundwater quality:

The water table depth and quality were monitored from 12 observation wells installed at a grid interval of 150 X 150m at fortnight interval. It was observed that water table is at the ground surface during crop season and declined up to 0.9m during summer (fig.2). The ground water quality was very poor with EC 4.8 to 43.1 dSm^{-1}, which is not suitable for irrigation. This indicates waterlogged conditions exits in the pilot area through out the year (Aheer *et al.*, 1996).

Depth to the impervious layer:

Deep borings were done in the pilot area at 3 different locations. The physical properties of the soil revealed that the impervious layer is at 7 m below the surface.

Saturated Hydraulic conductivity:

The hydraulic conductivity of the pilot area varied from 0.008 to 1.489 m day^{-1} with an average 0.33 m day^{-1} (Table 1). These values showed that the hydraulic conductivity was high in the middle of the pilot area indicating sandy textured soil. The hydraulic conductivity is calculated using equation developed by Ernst (Ritzema, 1994).

Infiltration:

To study the permeability of soils infiltration studies were conducted using double ring infiltrometer at 5 different sections. The Basic infiltration was calculated to be 0.13 m/day, which is low indicating clay loamy textured soil in the surface (Table 2).

It was observed that the water table was high in the piezometer installed at 7.5 m than that installed at 5m and 2.5m.This indicates that there is upward movement of groundwater and hence natural drainage is highly impossible in the pilot area (Fig. 3). The method for the same is reported else where (Anonymous 2002)

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Tidal influence of Upputeru stream:

The Electrical Conductivity of the Upputeru stream near by pilot area was very high (44.2 dS/m) during the summer and it was low (0.36 dS/m) during the monsoon season. The tidal range of Upputeru varies from 0 to 0.9m above MSL. It was observed that the lowest water level in Upputeru is almost above the minimum field elevation through out the year except during *Rabi* season (Fig. 4). From this it was clearly observed that gravity drainage is highly impossible and there is a possibility of sea water intrusion into the fields during high tide. Hence pumped sub-surface drainage system is recommended for the pilot area.

CONCLUSIONS

The pre drainage investigations revealed that the pilot area is almost flat with a slope of 0.01 percent. The water table is shallow with poor quality (EC 4.8 to 43.1 dS/m). The soils of the area are saline with an ECe 3.0 to 12.3 dS/m. The hydraulic conductivity of the pilot area is estimated to be 0.33 m/day. The studies on groundwater flow indicate upward seepage and hence there is no natural drainage through the layer.

The tidal range of Upputeru river varies from 0.0 to 0.9 m above MSL, which is above the field level. Hence, it was concluded that gravity drainage is not possible and a pumped drainage system has to be recommended for the pilot area.

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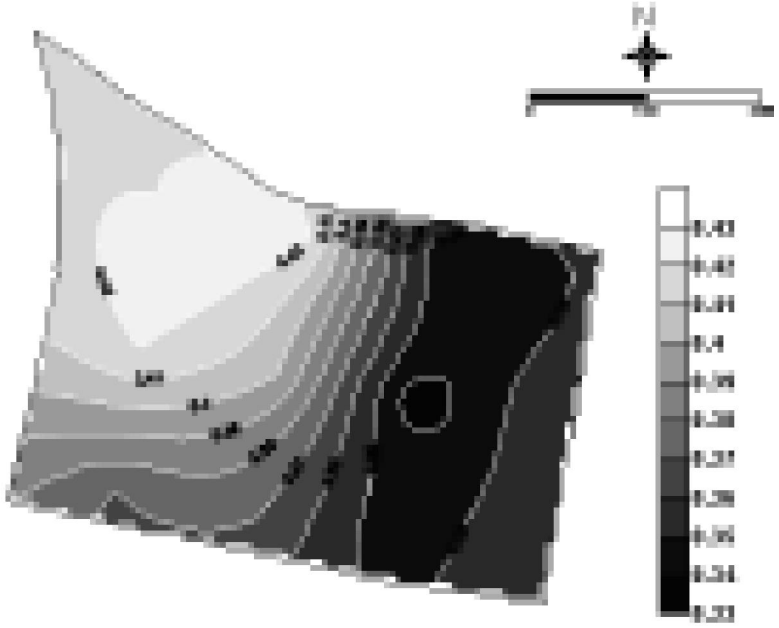

Fig. 1 Toposheet of the Kalipatnam pilot area

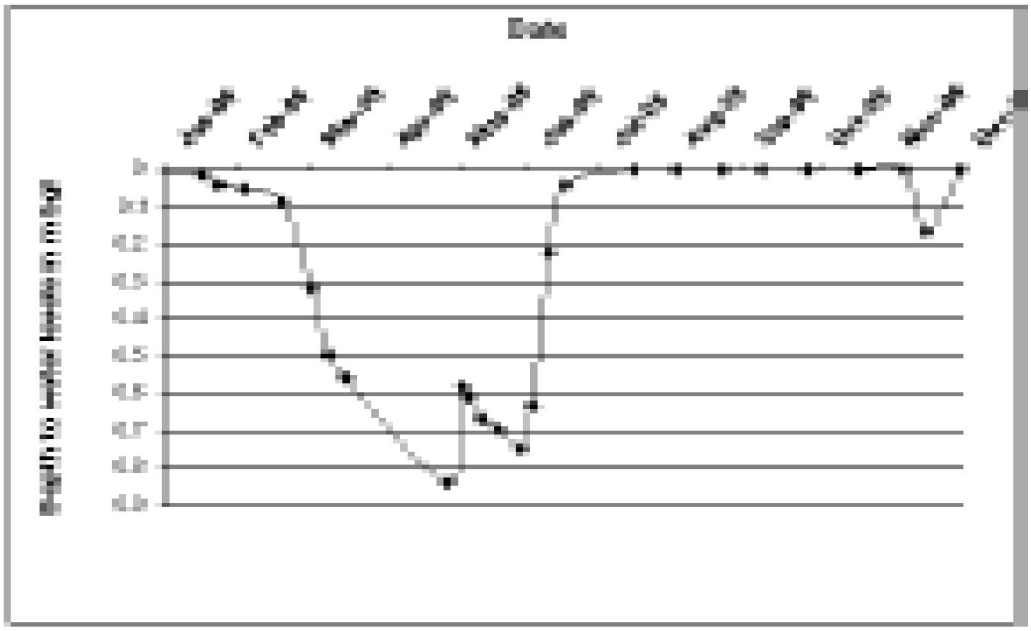

Fig. 2 Depth to water levels in Observation Wells at pilot area

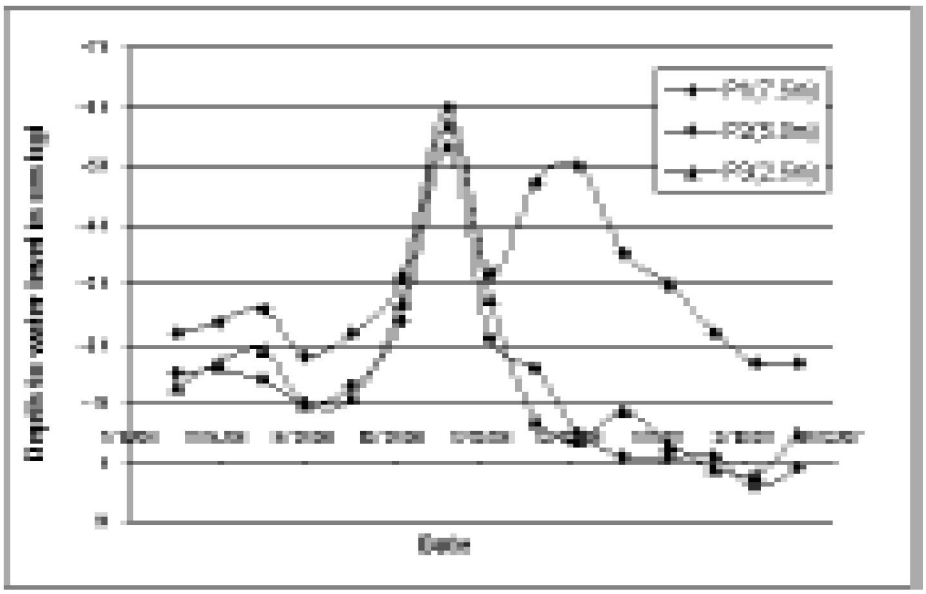

Fig. 3 Hydraulic heads in the piezometers at Kalipatnam pilot area

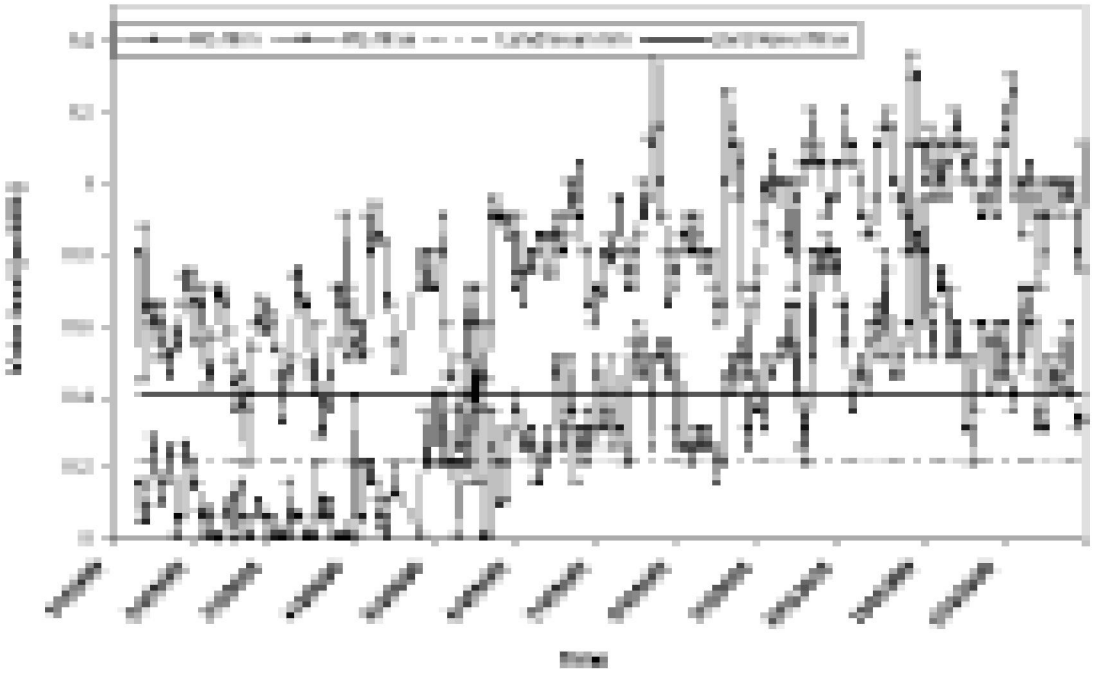

Fig. 4 Tidal fluctuations in Upputeru during the year 2005

Table 1 Hydraulic conductivity at different locations at Kalipatnam pilot area

S.No	Nearest Grid point	Hydraulic Conductivity (m d^{-1})
1	H1	0.008
2	H2	0.204
3	H3	0.292
4	H4	0.431
5	H5	1.318
6	H6	0.575
7	H7	0.343
8	H8	0.106
9	H9	0.731
10	H10	1.489
11	H11	0.393
12	H12	0.626
	Geometrical Mean	0.330

Table 2 Basic Infiltration of Soils at Kalipatnam pilot area

Section No.	Section	Basic infiltration (m d^{-1})
1	South Eastern	0.048
2	North Eastern	0.240
3	Central	0.144
4	North Western	0.072
5	South Western	0.144
	Average	0.130

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