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# Spatial and Temporal Variability in Salinisation of Soil and Ground Water of Operational Drainage Pilot area, Kalipatnam, West Godavari district of Andhra Pradesh

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**ABSTRACT**

Changes in the salinity of soil and ground water were monitored in 18 ha study area of Kalipatnam drainage pilot area. Soil salinity is monitored at 24 grid points (100m x 100m) after each crop season. Ground water satinity is monitored from 12 grid points (150m x150m) at fortnight intervals from May, 2005 to May, 2006. Water salinity of adjoining Upputeru (salt stream) is also monitored during the period. Surface soils are having relatively lower EC values than subsurface indicate that ground water is contributing to the development of salinity. *Summer* soils are having higher salinity than post *Kharif* soils, indicate capillary rise of poor quality ground water during fallow period is the main source of salinity which inturn influenced by sea. Ground water salinity is following the pattern of salt stream and strong positive correlation (r=0.89**) was recorded between the ground water salinity and salt stream salinity. Temporal variability of ground water indicate during the monsoon months ground water salinity maintained at lower level and during the fallow period coinciding with no (very low) rainfall receipt resulting in the higher soil salinity. Negative correlation was observed between ground water salinity and pH (r=-0.615*). Spatial distribution of soil salinity indicates wide variability.

**Key words :** Drainage pilot area, Ground water, Spatial, Soil, Temporal variability.

Soil salinity, an inherent soil property in coastal region, mainly depends on the salinity of ground water, the potential source of salts, which gradually rises up and evaporates on the soil surface during dry period. Notably salinity and its allied characteristics in soil and ground water fluctuate with season (Madhumita Das & Maji, 2001).

In coastal regions of Andhra Pradesh , salinity and water logging are the common phenomena. In these soils rice is grown in two seasons *Kharif* (monsoon rice crop, July to December) and *Rabi* (non-monsoon rice crop, December to March) followed by three full months of fallow period (April to June). As these areas are nearer to sea, ground water is poor and major contributor of soil salinity. Rain fall is not well distributed and being lower than evaporation that to in dry periods capillary rise of salts is the common phenomenon. To deal with the threat of salinity it is very much essential to know the changes of salinity of soil and ground water with space and time over the calendar year. In the present study Kalipatnam drainage pilot area of Godavari Western Delta was selected for proper appraisal of salinization of soil and ground water and their spatial variability with time.

## MATERIAL AND METHODS

The Kalipatnam pilot area is located in West Godavari district of Andhra Pradesh and located at $16^0$ 23' Northern latitude and $81^0$ 32' Eastern longitude. The elevation ranges from 0.3 to 0.6 m above MSL. The mean annual rainfall of the pilot area is 1200 mm with high evaporation demand of 1400 mm. Paddy-Paddy-Fallow is the major cropping system followed by Aqua-Paddy-Fallow. The Kalipatnam pilot area is located adjoining the Upputeru (Salt stream) that carries the excess water coming from Kolleru Lake to the Bay of Bengal. Seepage from Upputeru, shallow ground water table and poor drainage are the main reasons in development of soil salinity in this area.

### Changes in soil salinity:

A 18 ha of land was selected as study area and 24 grid points were established with a spacing of 100 m x 100 m to observe the changes in soil salinity with season. Season wise (*Summer* - 05, after *Kharif* and *Summer*,06) soil samples were collected from grid points for two depths (0-15 cm&15-30 cm) and analysed the samples for soil reaction (pH) and electrical conductivity (ECe dS + m) in the saturated extract (Richards, 1968) and mapped using surfer 7.0 package to access the spatial variability.

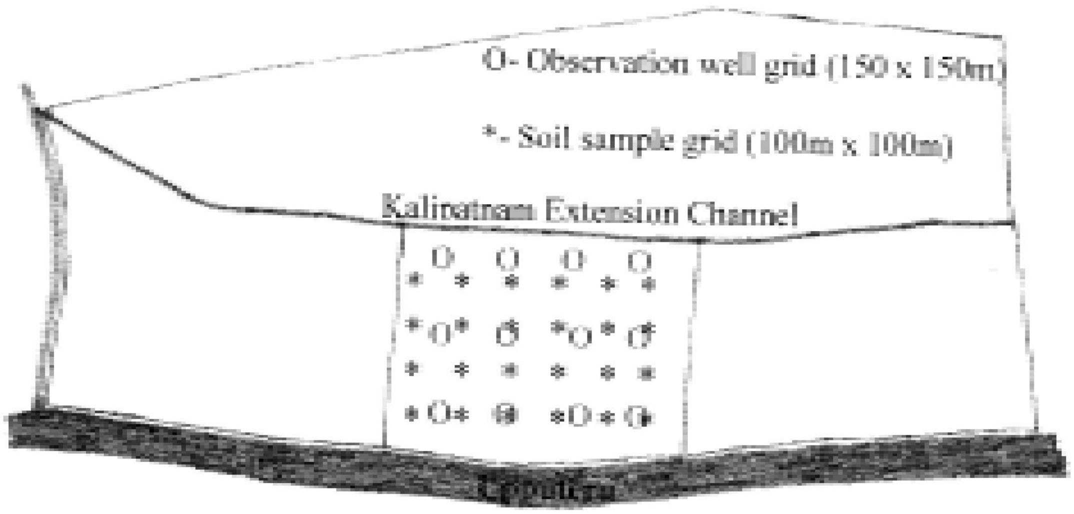


**Figure 1 Location map of Kalipatnam Drainage Study Area with Soil Sampling and Ground Water Grid Locations.**

**Figure 2. Salinity (d $Sm^{-1}$) Changes in ground water and Upputeru from May,05 to May,06**

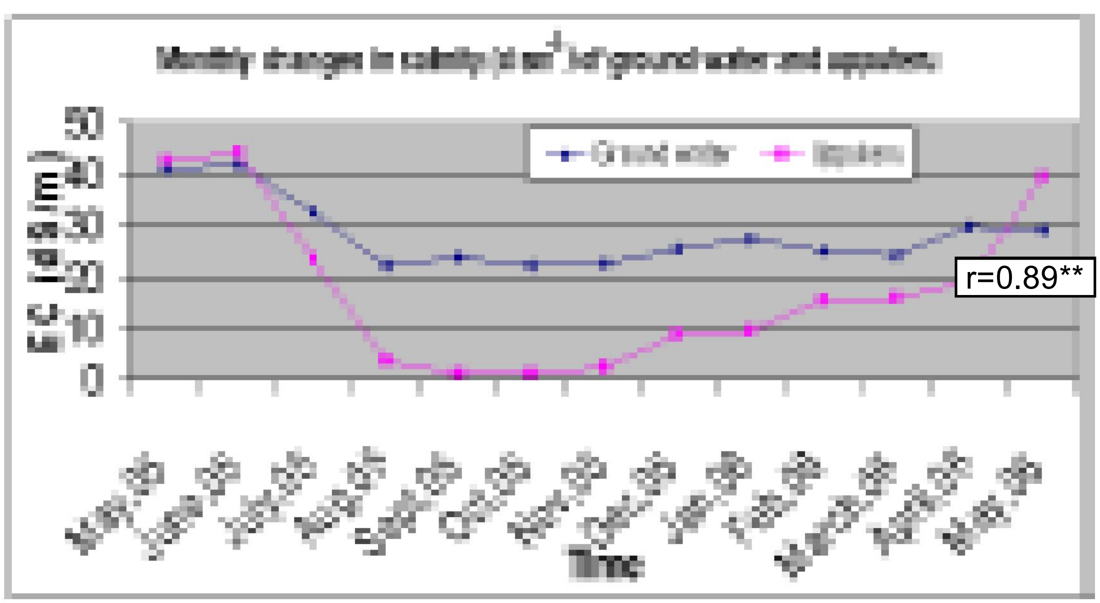

**Figure 3. Relation between ground water salinity (d sm$^{-1}$) and pH**

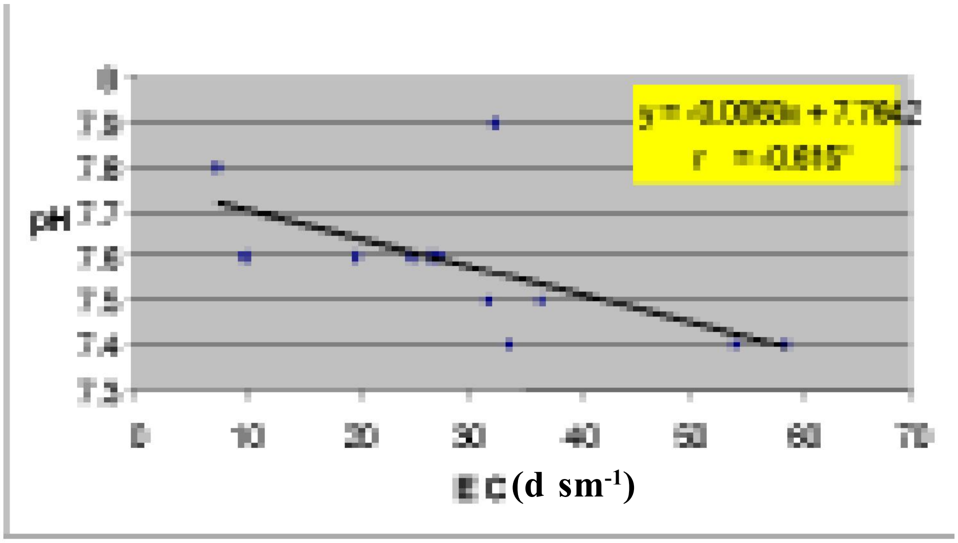


**Figure 4. Spatial distribution of surface soil (0-15cm) salinity ( ECe,** d sm$^{-1}$) **during *summer*,05**

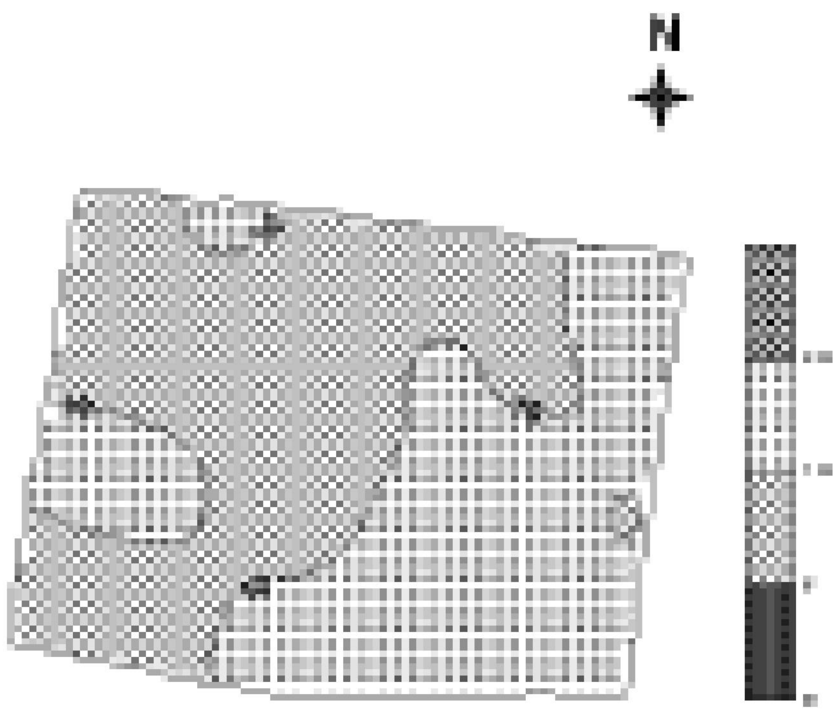

**Figure 5. Spatial distribution of subsurface soil (15-30cm) salinity ( ECe, d sm$^{-1}$) during *summer*,05**

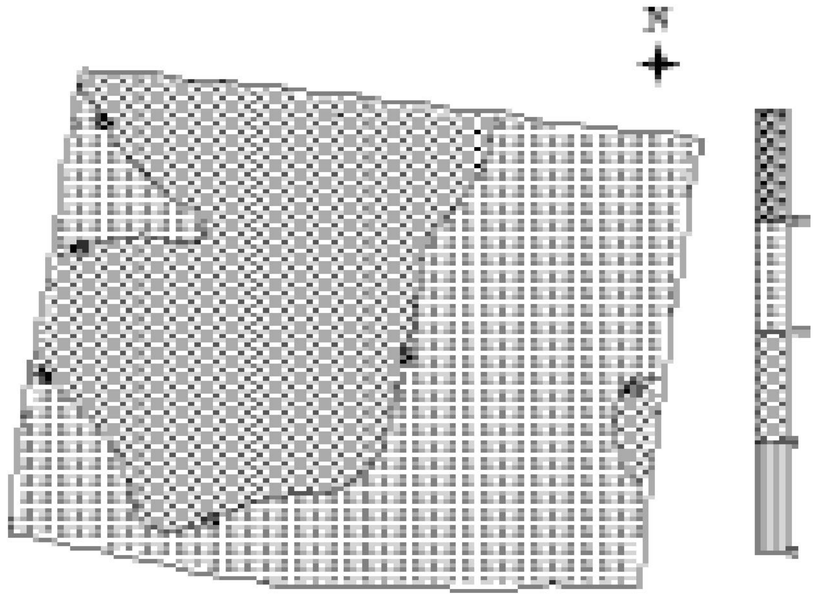


**Figure 6. Spatial distribution of surface soil (0-15cm) salinity ( ECe, d sm$^{-1}$) after *Kharif*,06**

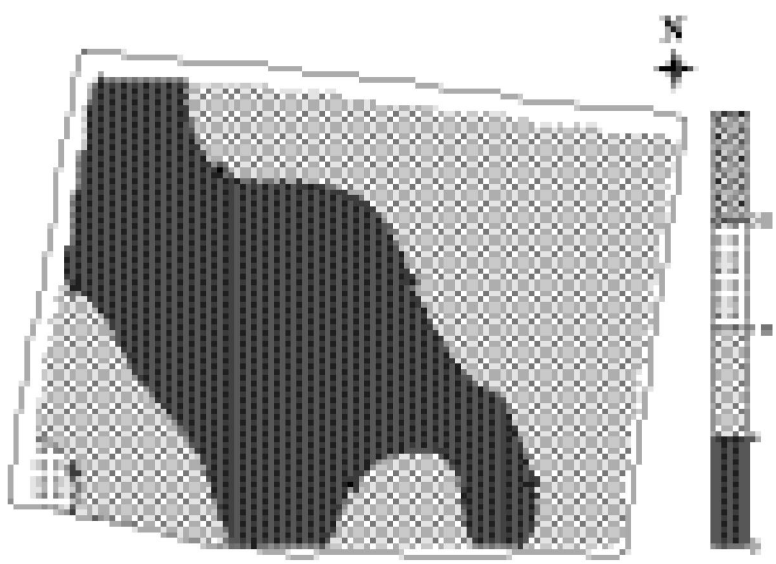

**Figure 7. Spatial distribution of subsurface soil (15-30cm) salinity ( ECe,** d $sm^{-1}$) **after** ***Kharif*****,06**

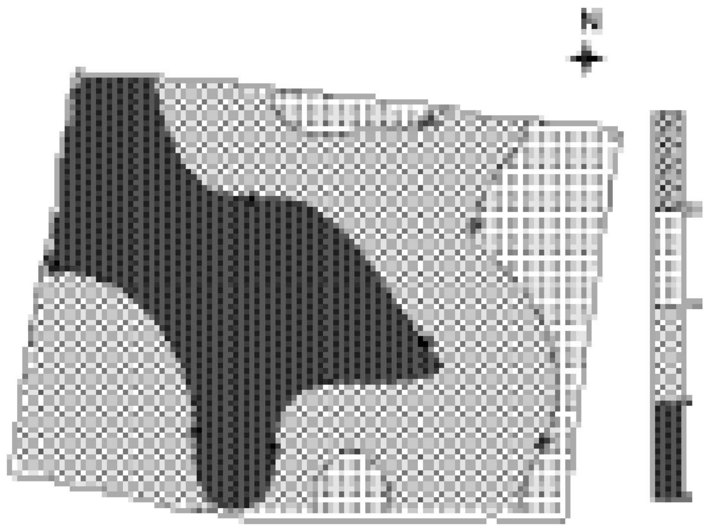

**Figure 8. Spatial distribution of surface soil (0-15cm) salinity ( ECe,** d $sm^{-1}$) **during** ***summer*****,06**

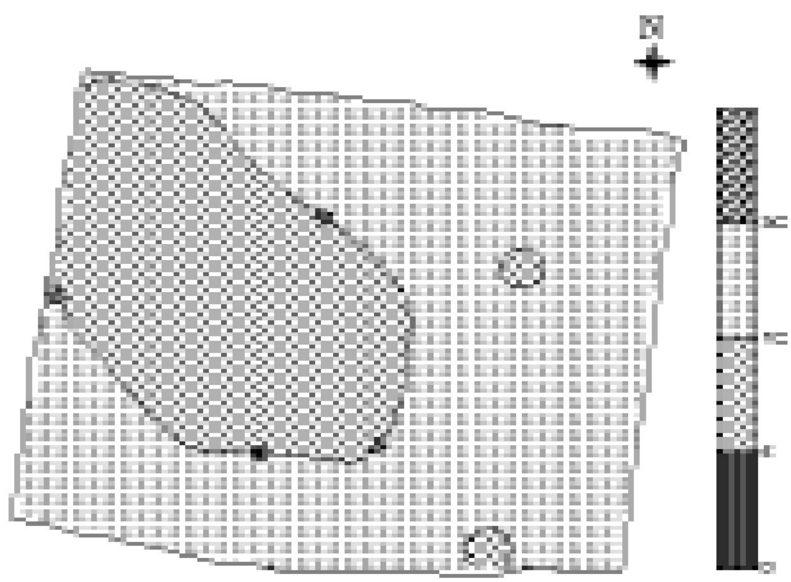

**Figure 9. Spatial distribution of subsurface soil (15-30cm) salinity ( ECe, d $sm^{-1}$) during *summer*,06**

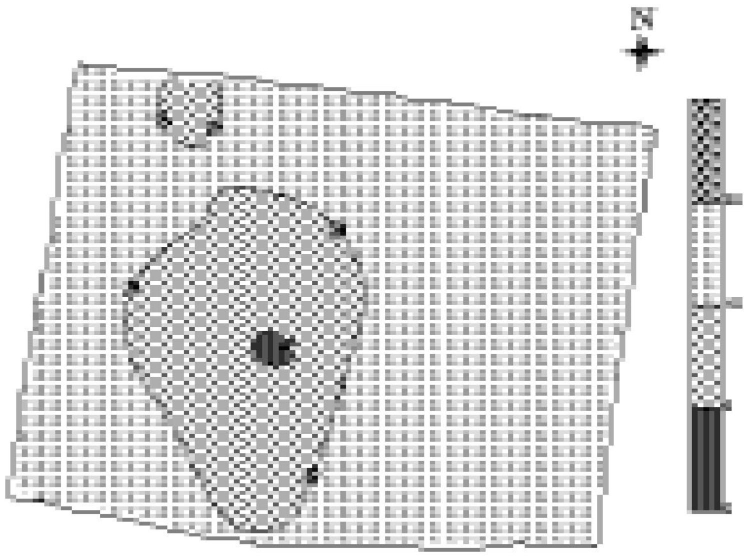


**Figure 10. Changes in ground water table during *summer*,05 to *summer*,06**

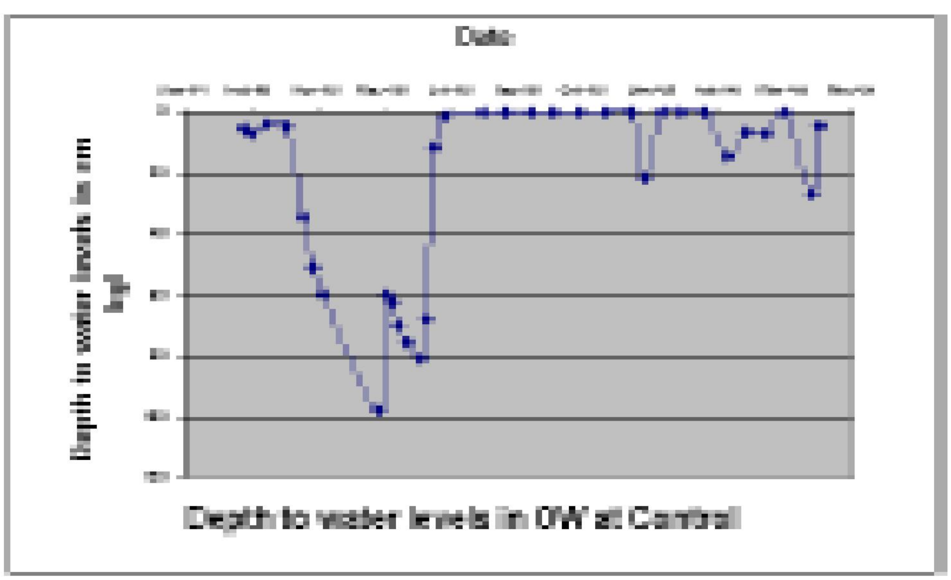

Table1. Monthly changes in ground water salinity in the Kalipatnam study area from May-05 to May-06

| OW No | Location OW | May-05 | June-05 | July-05 | Aug-05 | Sept-05 | Oct-05 | Nov-05 | Dec-05 | Jan-06 | Feb-06 | March-06 | April-06 | May-06 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 13 | Near KEC | 23.6 | 19.3 | 21.2 | 19.3 | 20.53 | 23.8 | 14.2 | 25.0 | 26.7 | 26.8 | 27.0 | 29.9 | 29.8 |
| 14 | Middle | 28.8 | 29.8 | 35.6 | 32.8 | 29.75 | 29.5 | 31.8 | 33.9 | 34.0 | 33.6 | 33.7 | 37.4 | 27.8 |
| 15 | Near Upputeru | 19.3 | 17.6 | 19.6 | 18.9 | 15.20 | 20.5 | 21.1 | 19.6 | 20.5 | 23.0 | 23.5 | 24.0 | 19.2 |
| 16 | Near Upputeru | 20.7 | 21.7 | 25.7 | 22.5 | 27.70 | 20.7 | 22.1 | 26.1 | 29.2 | 29.6 | 33.7 | 30.7 | 30.4 |
| 17 | Middle | 41.8 | 40.1 | 29.4 | 21.6 | 18.92 | 9.4 | 10.1 | 9.9 | 11.1 | 13.8 | 41.0 | 15.4 | 26.3 |
| 18 | Near KEC | 28.8 | 29.8 | 31.1 | 28.6 | 32.05 | 30.4 | 29.9 | 32.1 | 32.6 | 33.2 | 36.2 | 37.1 | 30.5 |
| 19 | Near KEC | 40.2 | 51.6 | 51.3 | 39.9 | 52.60 | 49.2 | 54.0 | 58.6 | 59.3 | 61.8 | 43.8 | 67.3 | 48.3 |
| 20 | Middle | 46.0 | 47.0 | 35.9 | 23.6 | 28.40 | 29.3 | 29.0 | 31.8 | 34.4 | 37.9 | 41.1 | 39.5 | 28.3 |
| 21 | Near Upputeru | 70.5 | 70.4 | 45.1 | 21.2 | 24.10 | 23.2 | 24.1 | 26.6 | 26.6 | 20.1 | 14.8 | 19.4 | 30.7 |
| 22 | Near Upputeru | 35.5 | 34.7 | 20.8 | 12.1 | 9.66 | 6.9 | 6.6 | 10.1 | 15.2 | 6.9 | 6.6 | 22.2 | 17.0 |
| 23 | Middle | 38.9 | 41.2 | 37.5 | 29.4 | 33.40 | 32.4 | 34.2 | 36.4 | 37.0 | 37.6 | 34.4 | 42.1 | 41.8 |
| 24 | Near KEC | 32.8 | 46.4 | 50.1 | 39.4 | 47.20 | 44.3 | 51.8 | 54.1 | 54.9 | 57.7 | 51.0 | 63.3 | 63.4 |
| | Mean | 35.6 | 37.5 | 33.6 | 25.8 | 28.3 | 26.6 | 27.4 | 30.3 | 31.8 | 31.8 | 32.2 | 35.7 | 32.8 |
| | Maximum | 70.5 | 70.4 | 51.3 | 39.9 | 52.6 | 49.2 | 54.0 | 58.6 | 59.3 | 61.8 | 51.0 | 67.3 | 63.4 |
| | Minimum | 19.3 | 17.6 | 19.6 | 12.1 | 9.7 | 6.9 | 6.6 | 9.9 | 11.1 | 6.9 | 6.6 | 15.4 | 17.0 |
| | Standard Deviation | 16.0 | 17.0 | 11.5 | 9.1 | 13.7 | 13.5 | 15.8 | 16.1 | 15.6 | 17.6 | 14.0 | 17.5 | 14.6 |

**Changes in ground water quality:**

To observe the fluctuations in ground water salinity and depth, 12 observation wells were installed at 150 m x 150 m interval. Fortnightly ground water samples were collected from May-05 to May-06 and analysed for pH and Electrical Conductivity.

**Monitoring Salinity of Salt Stream (Upputeru):**

Upputeru (salt stream), which is flowing adjacent to the pilot area, is the only out let of drained water from Kolleru Lake and directly connected to sea, which is located at 8Km away. Salinity of Upputeru water was recorded for the study period (May - 05 to May - 06) on daily basis.

## RESULTS AND DISCUSSION

**Ground water salinity:**

Temporal variability of ground water salinity indicates (Table1) that ground water salinity recorded its peak during summer months ie April (35.7 $dSm^{-1}$), May (May - 05 - 35.6 $dSm^{-1}$ and May- 06 - 32.6 dS/m) and June (37.5 $dSm^{-1}$), gradually started declining after on set of monsoon reached its lowest level during months of August (25.8 $dSm^{-1}$ ) to November (27.4 $dSm^{-1}$) gradually started rising afterwards. Corresponding ground water pH does not show much difference, but there was significant decrease in soil pH during summer months and negative correlation (r=-0.615*) was observed between the ground water pH and salinity (Fig 3). This decrease in soil pH with increase ground water salinity can be attributed to the suppression of $OH^-$ ions over excess $Cl^-$ ions. As the study area is nearer to sea and adjoining salt stream is having strong influence (r=0.89**) on ground water salinity (Figure 2).

**Soil Salinity:**

Spatial variability of soil salinity (Figure 4 to 9) indicates that soil salinity is lower in NW direction and increasing in the W side direction. Soil salinity is followed the pattern of ground water salinity. This indicates the ground water being very shallow (Figure 10) through out the crop period which inturn influenced by the sea water through salt stream (Figure2) is the main source of development of soil salinity.

Subsurface soils are having higher salinity (Figure 5,7 & 9) than the surface soil (Figure 4,6 & 8) indicates capillary rise of saline ground water (Table1) at shallow depth (Figure 10) is resulting in capillary rise of salts and hence the soil salinity.

Temporal variability of soil salinity indicates that during Summer period soil salinity is rising due to the capillary rise (Figure 4,5,8& 9) than after *Kharif* soil salinity (Figure 6 & 7). This lower salinity after *Kharif* soil can be attributed to standing water presented through out the crop period and cleaning affect of soil with good quality of irrigation water.

***Conclusion:*** Capillary rise of salts from the ground water contributing to the development of soil salinity especially during Summer fallow period. Ground water is influenced by seawater through Upputeru. Spatial heterogeneity in the soil and ground water helpful in the design of subsurface design or fixing the sampling points. Effective salinity control must include not only adequate drainage to control and stabilize the water table but also net downward movement of water to prevent salinization during cropping period and control capillary rise during Summer fallow periods for these soils.

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