

RESOURCE CHARACTERIZATION AND SPATIAL DISTRIBUTION OF GROUND WATER QUALITY IN KANDUKUR MANDAL OF PRAKASAM DISTRICT, ANDHRA PRADESH

L.K. PRASAD, D. DAMODAR REDDY AND V. KRISHNAMURTHY

Central Tobacco Research Institute Research Station, Kandukur - 523 105

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Natural resources (land and water) in 17 villages of Kandukur (15°07'01.17 to 15°19'40.0 N latitude and 79°50'26.35 to 79°58'39.32 E longitude) mandal was recorded during transect of the area and ground water sampling. Land forms are uplands, low lands, river alluviums and uncultivated barren lands. Soil type varied with different land forms and the area is a conglomerate of red, black and mixed soils. Red sandy loams to sandy clay loams are in uplands. Black clay loams to clay in lowlands spread over villages of Machavaram, Dondapadu, Mopadu and Anandapuram. Some patches are seen with mixed soils. Some lands in Vikkiralapeta, Pandulapadu, Palukuru and Machavaram villages are on river beds of Manneru and Paleru where the soil is alluvium (sandy loams to silty loams). Rice is grown during *kharif* followed by summer pulses in fallows in low lands. Cotton is grown in black soil with good ground water because of Manneru and Paleru streams. Redgram is grown in all types of soils as *kharif* crop. During *rabi*, sole crops like tobacco and chickpea are grown. Tobacco is grown under rainfed tanks and ponds in Mopadu and Kondamudusupalem, during dry periods. Spatial distribution of the analyzed water quality parameters with thematic maps using Arc GIS showed that pH varied from 7.4 to 9.2. EC varied from 0.24 to 4.25 dSm⁻¹, but most of the area was in the range of 1.5-3.0 dSm⁻¹. Higher concentrations of HCO₃⁻ content were recorded in the ground water of light textured red soil areas. Chloride concentration varied from 0.9 to 87.1 meq/l. CO₃⁻ and HCO₃⁻ contents ranged from 0.0 to 4.4 and 1.8 to 23.8 meq/l, respectively. Anion concentration followed an order of chlorides > bicarbonates > carbonates. The carbonate/bicarbonate ratio in the sample varied from 0.02 to 0.53. With increase in carbonate and bicarbonate concentration, chloride concentration decreased.

INTRODUCTION

Exploring variation in water quality in areas under commercial crops is important to have comprehensive information for managing natural

resources and improving production. Irrigation water quality is one of the important components of crop production which affects the overall quality of soil and thereby the agricultural produce. Importantly if the water is polluted by yield-restricting nutrients like chlorides and concentration in the irrigation water crosses the critical limits prescribed for the agriculture use, deteriorates quality especially for tobacco and other commercial crops where quality of the produce is more important. Few studies related to irrigation water quality and its effect on FCV tobacco were done earlier (Krishnamurthy *et al.*, 1981, 2002; Murthy *et al.*, 1996). However, with the development of new techniques, an evocative classification of a given area with the help of GIS can be a powerful means for developing solutions for natural resource status and for assessing water quality, on a local or regional scale (Ferry Ledi Tjandra *et al.*, 2003). Hence, the importance of spatial and temporal distribution of any quality parameter in an area cannot be ignored. Therefore, considering above problems and availability of tools for solutions, a study on water quality of tobacco growing areas of Kandukur mandal, Prakasam district was undertaken.

MATERIALS AND METHODS

Natural resources (land and water) in the 17 villages of Kandukur (15°07'01 to 15°19'40 N latitude and 79°50'26 to 79°58'39 E longitude) mandal were studied. Based on spatial distribution of identified land forms (uplands, low lands, river alluviums and uncultivated barrens), cropping pattern and natural water sources. Forty seven water samples were collected from dug wells, dug-cum-bore wells, and bore wells. Surface water samples from rivers, streams and ponds were collected for quality comparison with ground water. All the samples were analyzed for pH, EC, chlorides, carbonates and bicarbonates

using standard methods of water analysis (Richards, 1954). Geo-referencing and digitization of village boundaries was done with the help of longitude and latitude points extracted from digital spatial data sources. Boundaries of 17 villages were digitized with the help of digitizing tool of natural resource data base software. Spatial analysis was done using interpolated surface from input data points using an inverse distance weighted (IDW) technique with help of Arc GIS spatial tool (Asadi *et al.*, 2007, 2008).

RESULTS AND DISCUSSION

Natural resources and landforms

Soil type: Soil type varied with different land forms. Land forms observed are uplands, low lands, river alluviums and uncultivated barren lands. The area is a conglomerate of red, black and red-black mixed soils. Red sandy loams to sandy clay loams are found in uplands. Depth of the soil is very shallow (<30 cm) to moderate. Very shallow soils are seen in Ananthasagarm, Kanchragunta and Kovur villages. In low lands, soil type is black clay loams to clay spread over villages of Machavaram, Dondapadu, Mopadu and Anandapuram. Some patches are seen with mixed soils. Some lands in Vikkiralapeta, Pandulapadu, Palukuru and Machavarm villages are on river beds of Manneru and Paleru where the soil is alluvium (sandy loams to silty loams) in nature.

Water sources: Irrigation sources available in the area are dug wells, dug-cum-bore wells, shallow and deep tube wells, tanks and filter points near streams. Local streams like Manneru and Paleru help in maintaining shallow water table and better water quality in the areas. Kandukur mandal is having a total of 27 wet tanks including *kuntas* and 6 dry ponds. The depth of ground water wells/bores ranged between 25-160 feet. Most of the bores run on electrical pumps used for irrigation.

Gross area under cultivation is 11.62 thousand ha and net sown area is 10.98 thousand ha while barren lands are 1.51 thousand ha. Land under non-agricultural use is 1.65 thousand ha. In low lands, rice is grown during *kharif* followed by summer pulses in rice fallows. Cotton is grown in black soil with plenty of ground water and

nearer to Manneru and Paleru streams. Redgram is grown in uplands, low lands and all types of soils as *kharif* crop. During *rabi*, tobacco and chickpea are grown as sole crops.

Tobacco is irrigated with the help of rainfed tanks and ponds in Mopadu and Kondamudusupalem, during dry spell. Stream water is also being extensively used especially for tobacco nurseries. The seasonal vegetables include all types of gourds, brinjal, chillies and tomato which are grown on river beds of *Paleru* in Vikkiralapeta and Jillelamudi. Chillies are grown as commercial crop in black soils. Major fruit crops existing in the area are *Mango and Sapota*. Most of the orchard crops are grown in upland red soils in villages Anathsagaram, Kanchragunta, Palukuru, Madanagopalapuram and Kandukuru where ground water quality is poor and fresh water is scarce. Sunflower and betelvine are also grown in small patches in Machavaram and Anandapuram. Soft wood trees *Subabool, Eucalyptus and Casuarina* are grown extensively in red soils and other light soils. Large areas of barren lands with shrubs mostly of *Acacia arabica and Prosopis* spp. are seen in Kandukuru Ananthasagaram, Kovuru, Kanchragunta and Palukuru villages. Correlating present land use, water resource and its quality result in a meaningful approach of classification suitable for different uses and also to evaluate the impact of land use on water quality (Asadi *et al.*, 2007).

Geo-referencing and digitization of village boundaries

Land marks (tanks, ponds and permanent structures) were identified in all the 17 villages (Kandukur mandal) of the study area and boundaries of 17 villages were digitized after geo-referencing the maps.

Physico-chemical characteristics of irrigation water

Ground water pH varied from 7.44 to 9.23 in villages of Kandukur mandal. The pH of the ground water was highest in red soils area. It was near neutral to slightly alkaline in fine textured and areas nearer to fresh water streams and ponds (Table 1). Electrical conductivity of

different villages ranged between 0.24 dS/m and 4.25 dS/m. Higher EC values were recorded mostly in ground water in red soil area.

Concentration and distribution of anions in irrigation water

Water samples were subjected to chemical analysis for determination of 3 chlorides, carbonates and bi-carbonates. Chloride concentration in the ground water samples varied from 0.9 (Oguru) to 87.1 (Kondamudusupalem) meq/l. Carbonates concentration ranged from 0.0 to 4.4 meq/l, whereas, bi-carbonate content is in the range of 1.8 (Ananthasagarm) to 23.8 (Mahadevapuram) meq/l. Bicarbonates were high in the ground water of red soil areas. Total dissolved solids in ground water originate from natural resources, run-off and industrial wastes (Kurian Joseph, 2001). High concentrations of all

these anions were observed in irrigation tube wells and shallow bore wells only (Krishnamurthy *et al.*, 2002). The distribution of ion concentration in ground water samples are depicted below through pie diagrams (Fig.1).

Relationship of different anions

Studies on relationship of anions showed that with the increase in carbonate concentration, chloride concentration decreased. There was inverse relationship between bi-carbonate and carbonate levels. Bicarbonate levels were more where carbonate and chloride concentration in the samples were low. Dominating anion was chloride in the system and following an order of chlorides > bicarbonates > carbonates. Concentrations of ground water varied spatially and alkali earths and strong acids dominated over alkalis and weak acids (Subramani *et al.*, 2005).

Table 1: Physico-chemical properties and anionic concentration in ground water samples of villages in Kandukur mandal

Village	Source	Physico-chemical properties		Anionic concentration		
		pH	E.C (dS/m)	Chlorides	Carbonates	Bi-carbonates
				(meq/l)	(meq/l)	(meq/l)
Anandapuram	SBW	8.1	3.19	47.7	2.0	13.6
Kandukur	SBW	9.2	2.49	42.0	2.4	16.6
Mahadevapuram	SBW	7.9	2.83	25.1	0.4	23.8
Kancharagunta	SBW	7.4	2.60	29.1	0.0	17.0
Machavaram	SR	7.5	1.10	2.0	0.8	7.2
	TW	7.8	1.30	4.8	2.4	13.4
Pandulapadu	SR	7.6	0.72	2.0	1.2	3.8
	TW	8.9	0.74	2.6	0.0	10.0
Ananthasagaram	SBW	9.1	3.19	58.9	2.0	1.8
Dondapadu	TW	7.5	2.36	19.5	0.4	14.2
Vikkiralapaeta	SR	8.1	3.30	12.7	2.8	5.8
	TW	8.2	1.65	31.9	0.0	11.2
Palukuru	SBW	8.6	0.50	19.5	0.4	15.8
Jillelamudi	TW	8.9	1.30	8.8	2.0	15.4
Kovuru	SBW	8.0	2.83	24.6	1.2	15.0
Kondi Kandukur	SBW	7.7	2.24	17.2	4.4	9.4
Mopadu	TW	7.9	1.77	9.4	1.6	9.0
Madanagopalapuram	TW	7.7	1.65	11.6	2.8	11.6
Kondamudusu palem	TW	8.3	0.24	87.1	0.0	9.0
Oguru	TW	8.9	4.25	3.0	1.2	4.8

Note: TW: Tube Well; SBW: Shallow Bore Well; SR: Stream

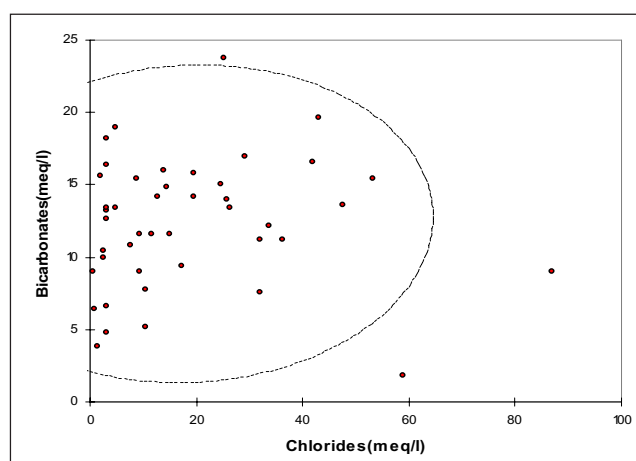
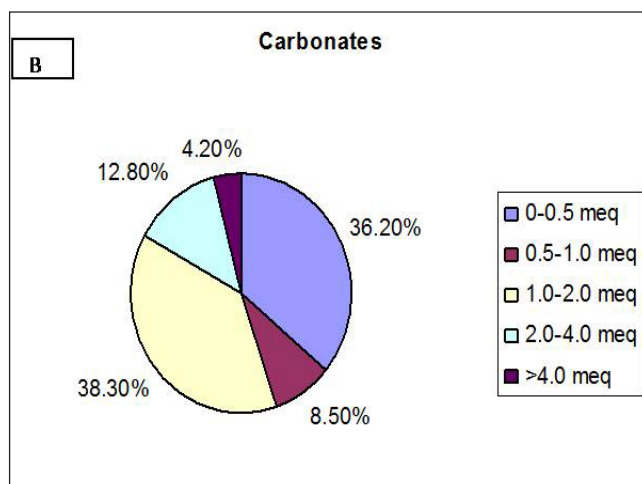
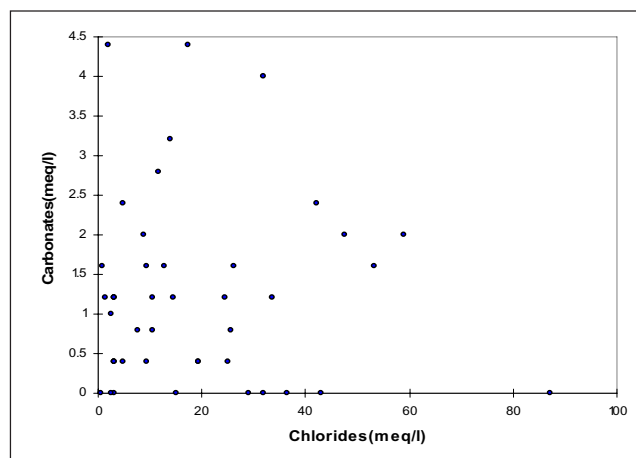
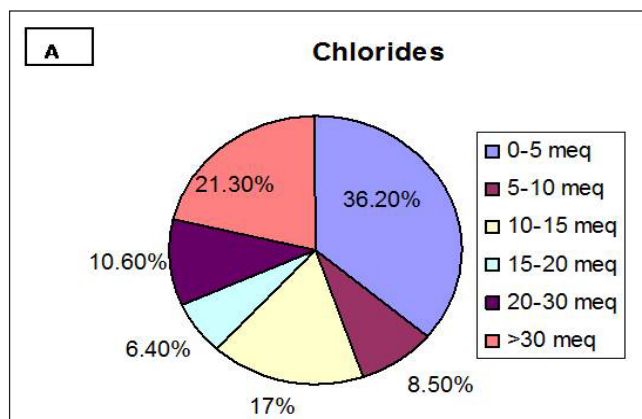


Fig. 1: Distribution of chloride (A) and carbonate (B) concentration in ground water samples of Kandukur mandal.

Fig. 2: Relationship of carbonate and chloride concentration in ground water of Kanduku villages.

Samples with high pH and EC showed low chlorides and dominated by bicarbonate salts (Krishnamurthy *et al.*, 2002). The carbonate/bicarbonate ratio in the sample varied from 0.02 to 0.53 (Fig. 2).

Spatial distribution of anions and physico-chemical parameters

Spatial distribution of the analyzed water quality parameters with thematic maps using Arc GIS showed that pH varied from 7.4-9.2. Most of the area was in the range of 7.5-8.5. The highest values were recorded in Ananthasagaram and Kandukuru villages. EC varied from 0.24-4.25

dSm^{-1} but most of the area was in the range of 1.5-3.0 dSm^{-1} . Chlorides varied from 22.5-60.0 meq/l in red soil area, whereas, in ground water nearer to local streams and ponds, chlorides varied from 7.5 to 22.5 meq/l. Carbonates varied from 0 to 1.5 meq/l in most of the area and were in the range of 1.5-3.6 meq/l along the local streams. Bicarbonates were highest in red soils area (15-25 meq/l), but in most of the area, ranged between 10-15 meq/l and areas nearer to streams and ponds, bicarbonates ranged from 5-10 meq/l (Fig.3). Spatial representation of quality parameters at local or village level help in decision making by farmers and local organizations (Asadi *et al.*, 2007; Iftikar *et al.*, 2010).

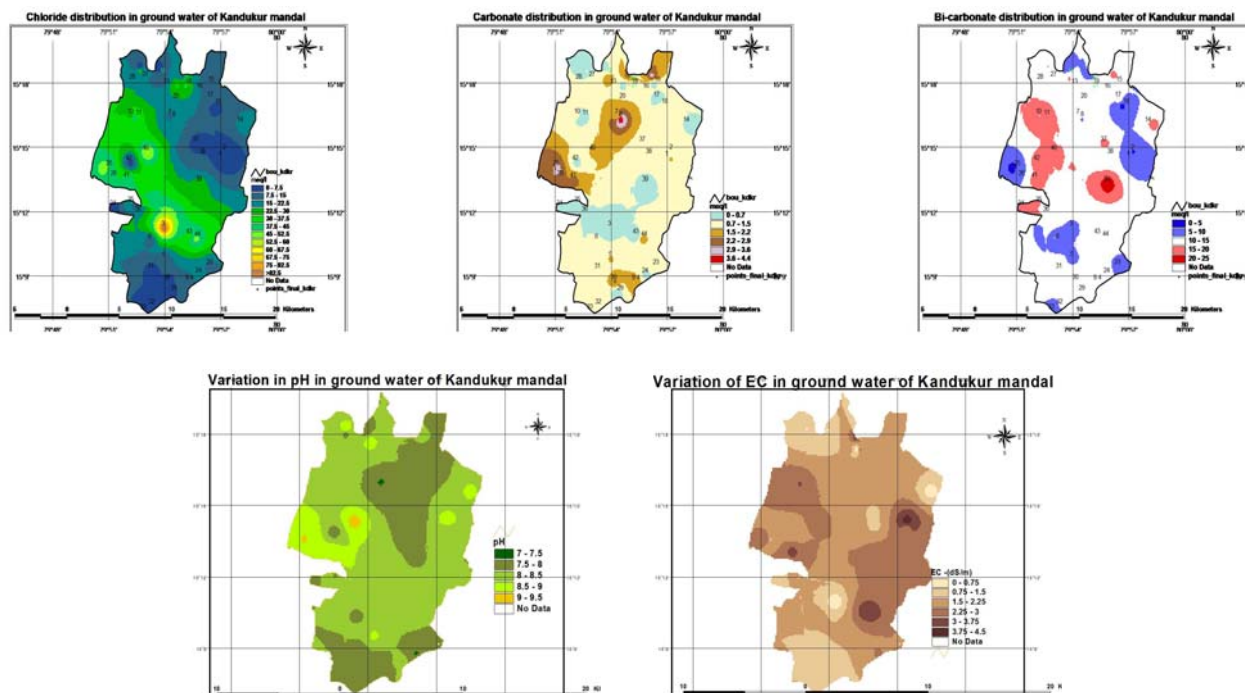


Fig. 3: Spatial distribution of different quality parameters of the ground water

The study area is having red, black and mixed soils with poor ground water quality especially rich in chlorides. High chloride concentration was observed in uplands mostly under coarse textured red soils. Mostly the pH is slightly alkaline to alkaline in nature. Ground water quality is of low chlorides and high carbonates in villages near local streams *i.e* Manneru and Paleru. High bicarbonates were found in ground water samples with low chloride content. The spatial analysis and thematic maps help in visualizing the ground water quality situation in a local scale.

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