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A Study on Irrigation Quality Monitoring of Ground Water in Krishna Eastern Delta, Andhra Pradesh

Dr. K. S. R. Prasad[1], Dr T. S. Ramaiah Chowdary[2]

[1]Professor, Department of Civil Engineering, V.R Siddhartha Engineering College, Vijayawada-7, Andhra Pradesh, India

[2]Professor, Department of Civil Engineering, V.R Siddhartha Engineering College, Vijayawada-7, Andhra Pradesh, India

Abstract: ***The quality of irrigation water in 3 villages in eight mandals in Krishna Eastern Delta (KED) has been studied. The ground water samples are collected for suitability of irrigation by performing various tests. Test results have been discussed and compare with the standards .Possible remedial measures have been suggested so as to improve irrigation efficiency.***

Keywords: Salinity, ground water, quality of ground water, physical and chemical parameters, EC, SAR.

1. Introduction

Irrigation is the artificial application of water to the land or soil. It is used to support the growth of agricultural crops, maintenance of landscapes, and vegetation of disturbed soils in dry areas and during periods of inadequate rainfall. Additionally, irrigation also has a few other uses in crop production, which include protecting plants against frost, suppressing weed growth in grain fields and preventing soil consolidation.

The face of irrigated agriculture is changing with respect to water quantity and quality. Irrigators in many watersheds and irrigation districts have had to face and respond with changing practices to increasing scrutiny about how to best manage available water resources. Along with that has come growing attention to the quality of water available for irrigation. Qualities of irrigation water which deserve consideration include the salt content, the sodium concentration, the presence and abundance of macro- and micro-nutrients and trace elements, the alkalinity, acidity, and hardness of the water. Under some circumstances, the suspended sediment concentration, bacterial content, and temperature of irrigation water may also deserve attention.

The agricultural yield is dependent on the quality of water. It has been observed that there is a variation in the yield of crops grown in different regions of the Krishna eastern delta. 8 Mandals are selected and 3 villages from each mandal are chosen and water samples from tube wells in agricultural fields, along with previous yield data are collected and the quality of irrigation water is analyzed by performing various tests. It is seen that one crop is commonly harvested in the selected mandals. Paddy is commonly harvested in most of the fields. Chemical analysis of the collected water samples has been done for:

- Electrical conductivity (EC),
- pH value (pH)
- Sodium (Na^{+})
- Potassium (K^{+})
- Calcium (Ca^{++})
- Magnesium (Mg^{++})
- Chlorides (Cl^{-})
- Alkalinity (HCO_3^{-})
- Sulphates (so_4^{2-})
- Nitrates (NO_3^{2-})

Irrigation water quality has a profound impact on crop production. All irrigation water contains dissolved mineral salts, but the concentration and composition of the dissolved salts vary depending upon the even prohibit source of irrigation water. Too many salts can reduce or crop production while too little salt can reduce water infiltration, which indirectly affects the crop. An understanding of the quality of water use for irrigation and its potential negative impacts on crop growth is essential to avoid problems and to optimize production. Salts break down into ions when they go into solution. The various anions and cat ions produced when the salts are dissolved in water exert considerably different effects on plants.

Nearly all waters contain dissolved salts and trace elements, many of which result from the natural weathering of the earth's surface. Dissolved salts in irrigation form ions. The most common salts in irrigation water are table salt, (sodium chloride, NaCl), gypsum, Epsom salts and baking soda. Salts dissolve in water and form positive ions (cations) and negative ions(anions).The most common cations are calcium(Ca+2),Magnesium(Mg+2)and sodium(Na+) while the most common anions are chloride(Cl-),sulphate(So42-), and bicarbonate(Hco3-). The ratios of these ions, however, vary from one water supply to another. Potassium (K+), Carbonate (Co32-), and Nitrate (No3) also exist in water supplies, but concentrations of these constituents are comparatively low.

(3) have studied the Hydrochemical conditions in the Acu Lagoon are described using spatial and temporal variations of very limn logical variables. Water samples were collected monthly in five sampling established along the lagoon. Both spatial and temporal variation of dissolved nutrients in the beginning of summer, suggesting that nutrient input resulting from rainfall stimulate phytoplankton production, as reflected by chlorophyll concentration increase.(6) studied the Groundwater quality-Salinization, hydro geochemical processes. Groundwater is the main resource for irrigation besides drinking. Chemical parameters, pH, EC, TDS, Ca, Mg, Na, K, CO_3, HCO_3, Cl, SO_4, NO, F and SO_2 are taken

into account. Groundwater is of brackish type, Na^+, Cl^- facies are dominated. The effects of human activities, such as intensive and long-term irrigation, irrigation-return-flow, application of unlimited agricultural fertilizers and recycling of saline groundwater, act to further increase the salinity in the groundwater. To understand the hydro geochemical characteristics of the aquifer system for taking effective management measures to mitigate the inferior groundwater quality for sustainable development.(5) have studied the quaternary aquifers in Nile Delta region, which affect the groundwater quality. The hydrochemistry of major ions (K, Na, Mg, Ca, Cl, SO_4, HCO_3, and CO_3) together with trace elements (Fe, Mn, Zn, Pb, Cd, Cr, Cu, Ni) has been used to constrain the hydrochemical characteristics of groundwater and chemical analysis of pollutants and determination of their source. According to the U.S. Salinity laboratory diagram, most of the groundwater are located in the high salinity and low sodium hazard zone. The groundwater has 1.25 meq/l RSC, which is good quality and suitable for using in irrigation for all types of soils.

A number of other substances may be found in irrigation water and can cause toxic reactions in plants. After sodium, chloride and boron are of most concern. But boron is not considered in India. Crops grown on soils having an imbalance of calcium and magnesium may also exhibit toxic symptoms. Sulphate salts affect sensitive crops by limiting the uptake of calcium and increasing the adsorption of sodium and potassium, resulting in a disturbance in the cationic balance within the plant. The bicarbonate ion in soil solution harms the mineral nutrition of the plant through its effects on the uptake and metabolism of nutrients. High concentrations of potassium may introduce a magnesium deficiency and iron chlorosis. An imbalance of magnesium and potassium may be toxic, but the effects of both can be reduced by high calcium levels.(2) have studied the hydro-geochemical processes and the isotopic characteristics of the Sabkha for its management and rehabilitation. Sabkha water is highly saline, in the hydro-geochemical processes and the isotopic composition indicated that the source of Sabkha water, shallow wells and deep well water is of meteoric origin. It also showed some mixing and ion-exchange phenomenon between Sabkha water, shallow and deep well waters. Further investigations are needed to explore more about the occurrence of these inland Sabkhas and their environmental impact in the area.

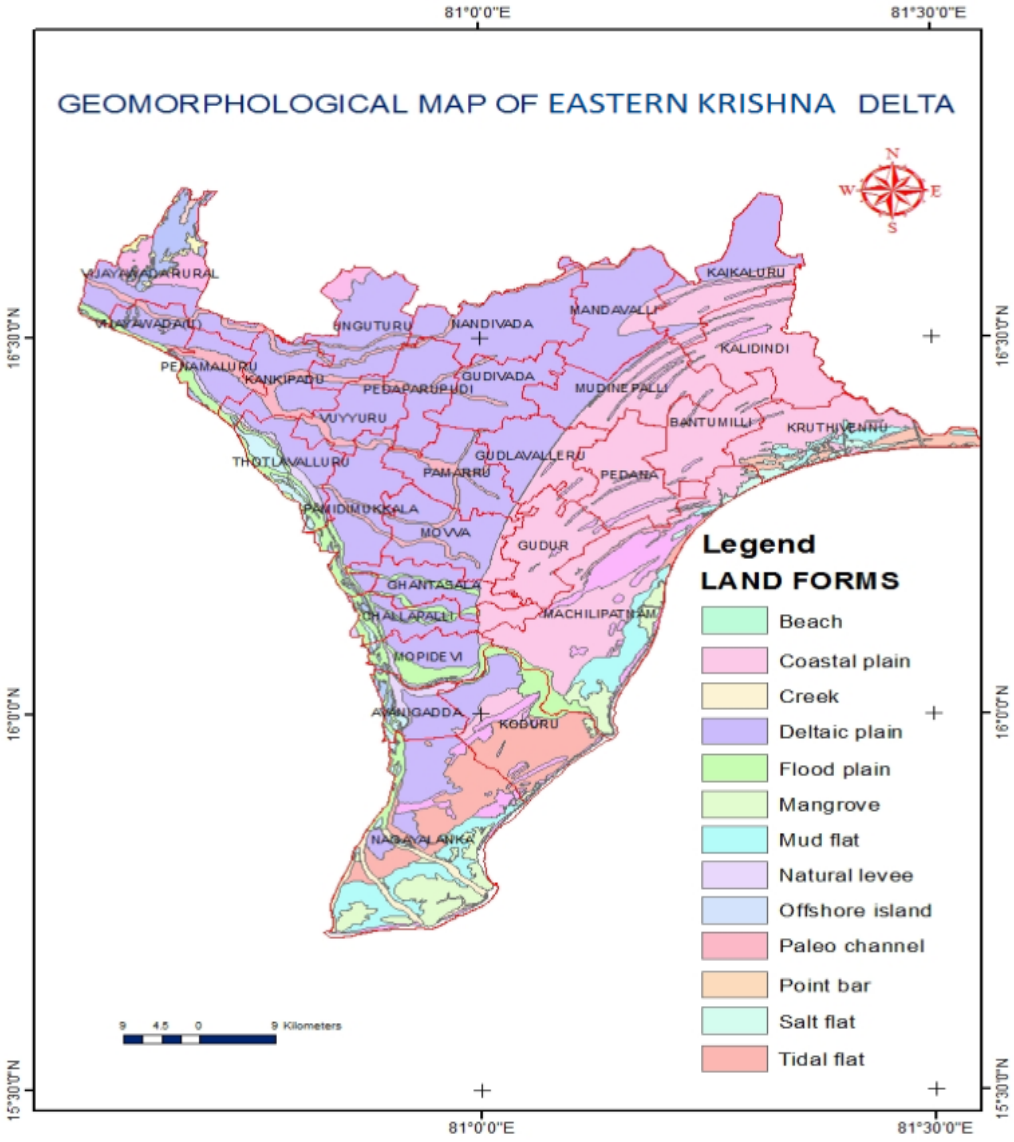

Figure 1: Showing the geomorphologic setting of the eastern Krishna delta, Andhra Pradesh

2. Methodology and Database

2.1Sampling Methodology

- Rinse the sample container three times with the sample before it is filled.
- Leave a small air space in the bottle to allow mixing of sample at the time of analysis.
- Label the sample container properly, preferably by attaching an appropriately inscribed tag or label the sample code and the sampling date should be clearly marked on the sample container or the tag.
- Complete the sample identification form for each sample.
- The sample identification form should be filled for each sampling occasion at a monitoring station. Note that if more than one bottle is filled at a site, this is to be registered on the same form.
- Sample identification forms should all be kept in a master file at the laboratory where the sample is analysed.
- Samples for groundwater quality monitoring would be collected from one of the following three
- types of wells:
- Open dug wells in use for domestic or irrigation water supply,
- Tube wells fitted with a hand pump or a power-driven pump for domestic water supply or irrigation
- Piezometers, purpose-built for recording of water level and water quality monitoring.
- Open dug wells, which are not in use or have been abandoned, will not be considered as water quality monitoring station. However, such wells could be considered for water level monitoring.
- Samples from the production tube wells will be collected after running the well for about 5 minutes.
- Non-production piezometers should be purged using a submersible pump. The purged water volume should equal 4 to 5 times the standing water volume, before sample is collected.
- For bacteriological samples, when collected from tube wells/hand pump, the spout/outlet of the pump should be sterilized under flame by spirit lamp before collection of sample in container.
- Samples are analysed in the laboratory with well established analytical methods in the literature(

Table 1: Showing parameters and permissible limits for irrigation (after wilcox,1948

Parameter	*Excellent*	*Good*	*Permissible*	*Doubtful*	*Unsuitable*
Electrical conductivity	250	250-750	750-2000	2000-3000	>3000
%Na	<20	20-40	40-60	60-80	>80
Parameter	Low	Medium	High	Very High	
SAR	1-10	10-18	18-26	>26	

Table 2: Showing the well information report of study area

Well Information Report

District	Mandal	Village Well No	Well type	Sub-Basin Minor-Basin	Geology	Latitude Longitude
Krishna	vuyyuru	AKUNURU WS/06/07/AK	Tube Well	krishna	Alluvium	16° 10' 0" 81° 7' 60"
	thotlavalluru	BODDAPADU WS/06/10/BO	Tube Well	krishna	Alluvium	16° 26' 2" 80° 46' 1"
	Ghantasala	CHILAKALAPUDI WS/06/18/CHI	Tube Well	krishna	Alluvium	16° 11' 24" 81° 8' 42"
	vuyyuru	CHINAOGIRALA WS/06/08/CH	Tube Well	krishna	Alluvium	16° 23' 24" 80° 49' 8"
	kankipadu	EDUPUGALLU WS/06/06/ED	Tube Well	krishna	Alluvium	16° 28' 23" 80° 46' 5"
	penamaluru	GOSALA WS/06/02/GO	Tube Well	krishna	Alluvium	16° 30' 52" 80° 36' 25"
	kankipadu	JABARLAPUDI WS/06/05/JA	Tube Well	krishna	Alluvium	° ' " ° ' "
	pamarru	JUJJAVARAM WS/06/13/JU	Tube Well	krishna	Alluvium	° ' " ° ' "
	vuyyuru	KODAVAKOLLU WS/06/09/KO	Tube Well	krishna	Alluvium	16° 25' 30" 80° 51' 22"
	Ghantasala	KOTHAPALLI WS/06/17/KOT	Tube Well	krishna	Alluvium	16° 38' 10" 80° 57' 47"

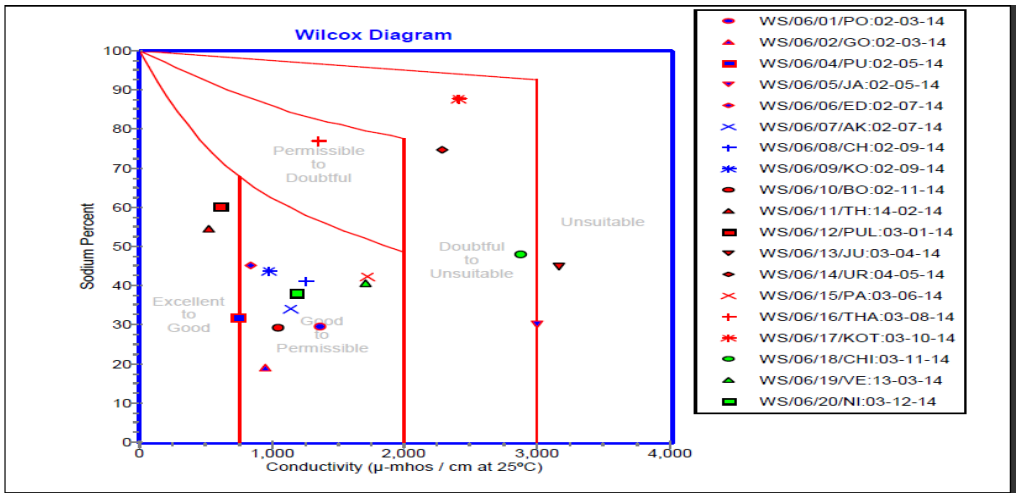

Figure 2: Showing the relationship of physical parameters and Na+ cat ions (after Wilcox, 1948)

3. Results and Discussions

By observing the US salinity diagram drawn from the results obtained after mathematical analysis most of the villages fall under C3-S1 zone which represents that the loss of yield in those areas is due to high salinity and low sodium hazard.

Among all the villages kotthapalli of ghantasala mandalam falls under C4-S4 zone which is affected by both salinity and sodium. Among twenty villages three villages fall under C2-S1 zone, eight villages fall under C3-S1 zone, one village underC4-S1,two villages under C4-S2,one village under C4-S3 and one village under C3-S2. By observing the Wilcox diagram (Figure.2) drawn using %Na and EC, most of the villages fall under good-permissible region which implies that the water used by those villages for irrigation are of good quality.

Among twenty villages, water used for irrigation by two villages is of excellent quality, eleven villages use good quality of water, one village use permissible quality of water, three villages use water which is doubtful for irrigation and one village uses unsuitable water. Due to these differences in quality of water from village to village in adjacent mandals the yield of crops differs a lot due to many reasons as discussed above.

4. Conclusion

From various tests it has been found that the Sodium Adsorption Ratio (SAR) in some of the villages is high, which is not a desirable quantity for the crop production. The Wilcox diagram plotted against %Na and EC. Determines that the ground water in these villages is suitable for irrigation where as in those villages due to high sar the water cannot be used continuously for agricultural purposes.

In the same way the electrical conductivity is high in few villages due to which wilting of samplings is often seen when the water is used for irrigation purpose. Due to more %Na and salinity in ground water, the yield has decreased by 25%-30% when compared with yield acquired in farms irrigated with %Na and EC in desirable limits.

Remedial measures and useful irrigation practices have been proposed to overcome the fall in yield due to these factors have been proposed so that farmers can effectively use the irrigation water and sustainable yield is obtained.

4.1 Future scope of work:

4.1.1 Management of leachates

Soluble salts that accumulate in soils must be leached below the crop root zone to maintain productivity. Leachates are reduced from the soils by adding gypsum and other chemicals to controlling salinity. It can be done experimentally in the laboratory conditions by adding above said salt neutralizers.

4.1.2 Subsurface drainage:

Shallow water tables complicate salinity management since water may actually move upward into the root zone, carrying with it dissolved salts. Installation of a subsurface drainage system and drip irrigation methods are the only solution available for this situation. The drip irrigation methods are highly suitable to reduce and infiltrate the salts to the root zone

4.1.3 Seed Placement

Good salinity control is often achieved with a combination of suitable practices, bed shapes and irrigation water management. In furrow-irrigated soils, planting seeds in the centre of a single-row, raised bed places seeds exactly salts are expected to concentrate. This situation can be avoided using “salt the ridges.” and also control the soil erosion

4.1.4 Skimming wells:

Skimming well is a general term to represent any well in which the depth of the well is defined by taking into consideration the underlying saline water layer and with an intention to extract relatively fresh water.

Table 3: Showing the sample locations and existing crops in the Krshna eastern delta

SAMPLE	*LON.*	*LATT.*	*FARMER NAME*	*VILLAGE*	*MANDAL*	*DEPTH (FT)*	*EXISTING CROP*
06/01/PO	80.696	16.47	U.RAMA RAO	PORANKI	PENAMALURU	140	PADDY
06/02/GO	80.7	16.49	V.RAMBABU	GOSALA	PENAMALURU	120	PADDY
06/03/PE	80.702	16.47	SRINIVAS CHOWDARY	PEDA PULIPAKA	PENAMALURU	120	PADDY
06/04/PU	80.763	16.44	P.SUGUNA MURTHY	PUNADHPADU	KANKIPADU	100	SUGAR CANE
06/05/JA	80.712	16.47	KANAKAM ANJANEYULU	JABARLAPUDI	KANKIPADU	80	PADDY
06/06/ED	80.768	16.47	A.KRISHNA RAO	EDUPUGALLU	KANKIPADU	40-70	PADDY
06/07/AK	81.1332	16.16	GOVINDHA RAJU	AKUNURU	VUYYURU	80	PADDY
06/08/CH	80.819	16.39	HARISH CHANDRA	CHINA OGIRALA	VUYYURU	60-70	VEGITABLES
06/09/PUK	80.856	16.42	P.UDAY KUMAR	KODAVA KOLLU	VUYYURU	80	PADDY
06/10/NSM	80.767	16.43	N.SRINIVASA MURTHY	BODDAPADU	THOTLAVALLURU	130	SUGAR CANE
06/11/RCB	81.1332	16.16	R.CHANTI BABU	THOTLA VALLURU	THOTLAVALLURU	120	PADDY
06/12/SN	81.2332	16.79	SATYA NARAYANA	PULIPAKA	THOTLAVALLURU	200	PADDY

06/13/ANR	80.942	16.30	A.NARAYAN REDDY	JUJJAVARAM	PAMARRU	180	PADDY
06/14/KPR	80.936	16.322	K.PURUSHURAM REDDY	URUTURU	PAMARRU	180-210	PADDY
06/15/BVR	80.97	16.323	B.VENKAT REDDY	PAMARRU	PAMARRU	150	PADDY
06/16/MSRM	80.926	16.182	M.SAI RAMA MURTHY	THADE] PALLI	GHANTASALA	150	PADDY
06/17/GS	80.963	16.636	G.SURESH	KOTTHA PALLI	GHANTASALA	155	SUGAR CANE
06/18/KSR	81.145	16.19	K.SAMBA SIVA RAO	CHILAKALA PUDI	GHANTASALA	40	PADDY
06/19/BMR	80.896	16.21	B.MUNESHWAR RAO	VERRAIHA PALEM	MUVVA	20-30	PADDY
06/20/TVR	80.916	16.226	T.VENKATESWAR RAO	NIDUMOLU	MUVVA	30	PADDY
06/10/NSM	80.767	16.434	N.SRINIVASA MURTHY	BODDAPADU	THOTLA VALLURU	130	SUGAR CANE
06/11/RCB	81.133	16.166	R.CHANTI BABU	THOTLA VALLURU	THOTLA VALLURU	120	PADDY
06/12/SN	81.233	16.794	SATYA NARAYANA	PULIPAKA	THOTLA VALLURU	200	PADDY
06/13/ANR	80.942	16.302	A.NARAYAN REDDY	JUJJAVARAM	PAMARRU	180	PADDY
06/14/KPR	80.936	16.322	K.PURUSHURAM REDDY	URUTURU	PAMARRU	180-210	PADDY
06/15/BVR	80.97	16.323	B.VENKAT REDDY	PAMARRU	PAMARRU	150	PADDY
06/16/MSRM	80.926	16.182	M.SAI RAMA MURTHY	THADEPALLI	GHANTASALA	150	PADDY
06/17/GS	80.963	16.636	G.SURESH	KOTTHA PALLI	GHANTASALA	155	SUGAR CANE
06/18/KSR	81.145	16.19	K.SAMBA SIVA RAO	CHILAKALA PUDI	GHANTASALA	40	PADDY
06/19/BMR	80.896	16.21	B.MUNESHWAR RAO	VERRAIHA PALEM	MUVVA	20-30	PADDY
06/20/TVR	80.916	16.226	T.VENKATESWAR RAO	NIDUMOLU	MUVVA	30	PADDY

Table 4: showing physical parameters of the samples collected from the various agricultural fields in Krishna eastern delta

S.NO	*VILLAGE NAME*	*MANDAL*	*E.C*	*PH*	*THD*	*%Na*	*SAR*
06/01/URR	PORANKI	PENAMALURU	1356	7.24	738	35.92	14.90
06/02/VR	GOSALA	PENAMALURU	948	7.05	680	25.38	7.07
06/03/SC	PEDA PULIPAKA	PENAMALURU	499	6.32	254	39.99	9.30
06/04/PSM	PUNADHIPADU	KANKIPADU	736	7.82	338	39.64	9.94
06/05/KA	JABARLAPUDI	KANKIPADU	3000	7.66	1300	38.34	18.04
06/06/AKR	EDUPUGALLU	KANKIPADU	844	8.19	242	53.39	14.77
06/07/GR	AKUNURU	VUYYURU	1140	7.4	146	43.77	13.08
06/08/HC	CHINA OGIRALA	VUYYURU	1256	7.1	482	50.68	18.51
06/09/PUK	KODA VAKOLLU	VUYYURU	971	7.4	306	52.63	16.37
06/10/NSM	BODDAPADU	THOTLAVALLURU	1038	7.28	456	35.14	9.91
06/11/RCB	THOTLA VALLURU	THOTLAVALLURU	525	7.66	148	62.20	16.77
06/12/SN	PULIPAKA	THOTLAVALLURU	605	7.49	444	65.31	20.80
06/13/ANR	JUJJAVARAM	PAMARRU	3160	7.41	1024	51.85	29.07
06/14/KPR	URUTURU	PAMARRU	2280	7.62	314	80.36	61.00
06/15/BVR	PAMARRU	PAMARRU	1712	7.56	550	48.31	18.76
06/16/MSRM	THADEPALLI	GHANTASALA	1350	8.2	186	84.62	59.56
06/17/GS	KOTTHAPALLI	GHANTASALA	2410	7.83	150	90.75	104.38
06/18/KSR	CHILAKALA PUDI	GHANTASALA	2870	7.37	874	56.81	31.65
06/19/BMR	VERRAIHA PALEM	MUVVA	1707	7.36	628	51.63	21.05
06/20/TVR	NIDUMOLU	MUVVA	1189	7.4	494	48.82	16.86

Table 5: Showing chemical parameters (cat ions) of samples collected from the various agriculture fields in Krishna eastern delta

S.NO	*MANDAL*	*VILLAGE NAME*	Na^+	K^+	Ca^{2+}	Mg^{2+}

06/01/PO	PENAMALURU	PORANKI	157	58	108.8	113.23
06/02/GO	PENAMALURU	GOSALA	73.01	1.6	121.6	91.36
06/03/PE	PENAMALURU	PEDAPULIPAKA	63.28	2.43	78.4	14.09
06/04/PU	KANKIPADU	PUNADHIPADU	73.12	3.12	66.4	41.79
06/05/JA	KANKIPADU	JABARLAPUDI	258.4	5.4	240	170.1
06/06/ED	KANKIPADU	EDUPUGALLU	92.44	2.42	49.6	28.67
06/07/AK	VUYYURU	AKUNURU	106.72	4.07	64	69.01
06/08/CH	VUYYURU	CHINAOGIRALA	158.2	7.9	73.6	72.41
06/09/PUK	VUYYURU	KODAVAKOLLU	111.46	7.58	48	44.71
06/10/NSM	THOTLAVALLURU	BODDAPADU	87.56	5.52	115.2	40.82
06/11/RCB	THOTLAVALLURU	THOTLAVALLURU	82.61	1.66	32	16.52
06/12/SN	THOTLAVALLURU	PULIPAKA	105.24	4.72	40	11.17
06/13/ANR	PAMARRU	JUJJAVARAM	386	5.9	264	88.45
06/14/KPR	PAMARRU	VURUTURU	435.8	4.4	65.6	36.45
06/15/BVR	PAMARRU	PAMARRU	186	2.5	160	36.45
06/16/MSRM	GHANTASALA	THADEPALLI	296.6	4.3	11.2	38.39
06/17/GS	GHANTASALA	KOTTHAPALLI	513.4	3.9	30.4	17.98
06/18/KSR	GHANTASALA	CHILAKALAPUDI	374.5	4.8	172	107.89
06/19/BMR	MOVVA	VERRAIHA PALEM	199.4	7.5	68	111.29
06/20/TVR	MOVVA	NIDUMOLU	142.3	6.8	56.8	85.53

Table 6: Showing chemical parameters (anions) of samples collected from the various agriculture fields in Krishna eastern delta

S.NO	*MANDAL*	*VILLAGE NAME*	Cl^-	SO_3^{-2}	No_3^-
06/01/PO	PENAMALURU	PORANKI	390	5.23	S
06/02/GO	PENAMALURU	GOSALA	216	15.37	7
06/03/PE	PENAMALURU	PEDAPULIPAKA	144	64.1	5.1
06/04/PU	KANKIPADU	PUNADHIPADU	110	11.67	22.5
06/05/JA	KANKIPADU	JABARLAPUDI	122		14.9
06/06/ED	KANKIPADU	EDUPUGALLU	148	39.89	12.7
06/07/AK	VUYYURU	AKUNURU	192	33.85	3.9
06/08/CH	VUYYURU	CHINAOGIRALA	186.667	61.22	27.9
06/09/PUK	VUYYURU	KODAVAKOLLU	260	51.38	5.5
06/10/NSM	THOTLAVALLURU	BODDAPADU	224	28.92	6.1
06/11/RCB	THOTLAVALLURU	THOTLAVALLURU	86	28.91	3.1
06/12/SN	THOTLAVALLURU	PULIPAKA	98.667	3.87	4.6
06/13/ANR	PAMARRU	JUJJAVARAM	962		33
06/14/KPR	PAMARRU	VURUTURU	828	6.69	4.8
06/15/BVR	PAMARRU	PAMARRU	390	35.46	87.2
06/16/MSRM	GHANTASALA	THADEPALLI	190	22.94	8.5
06/17/GS	GHANTASALA	KOTTHAPALLI	670	58.07	16.4
06/18/KSR	GHANTASALA	CHILAKALAPUDI	1010	69.99	9
06/19/BMR	MOVVA	VERRAIHA PALEM	880	4.89	4.3
06/20/TVR	MOVVA	NIDUMOLU	258		13.9

Table 7: Classification based on EC, SAR&%Na

S.NO	*Name of village*	*EC*	*SAR*	*%Na*
1	PORANKI	P	M	G
2	GOSALA	P	L	G
3	PEDA PULIPAKA	G	L	G
4	PUNADHI PADU	G	L	G
5	JABARLAPUDI	D	M	G
6	EDUPUGALLU	P	M	P
7	AKUNURU	P	M	P
8	CHINA OGIRALA	P	H	P
9	KODAVAKOLLU	P	H	P
10	BODDAPADU	P	L	G
11	THOTLAVALLURU	G	M	D
12	PULIPAKA	G	H	D
13	JUJJAVARAM	U	VH	P
14	URUTURU	D	VH	D
15	PAMARRU	P	H	P
16	THADEPALLI	P	VH	U
17	KOTHAPALLI	D	VH	U
18	CHILAKALAPUDI	D	VH	P
19	VEERAIHA PALEM	P	H	P

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Authors Profile

KSR Prasad received B.Tech Civil Engineering1983, M.Tech 1989Water Resources Engineering and also obtained, PhD degree from Water resources Engineering (2013). He is working as a professor department of civil Engineering from 1990. Department of civil Engineering, VR Siddhartha Engineering College, Vijayawada, Andhra Pradesh

T. S Ramaiah Chowdary obtained, M.Phil and PhD from Geology (1990) and working as a Professor in geology from 1990, Department of Civil Engineering, VR Siddhartha Engineering College, Vijayawada, Andhra Pradesh, India