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Micro Level Study of Soil Degradation in Krishna Canal Command Area (Maharashtra) Using Geospatial Techniques

Authors & Affiliation:

Sagar P. Mali

Project Fellow UGC Major Research Project, Dept. of Geography, Shivaji University, Kolhapur, MS, INDIA

Sachin S. Panhalkar

Associate Professor, Department. of Geography, Shivaji University, Kolhapur, MS, INDIA

Sunil B. Patil

GIS Engineer, Infraplan Engineering Services Pvt. Ltd, Pune

C. T. Pawar

Former Professor & Head, Department. of Geography, Shivaji University, Kolhapur, MS, INDIA

Correspondence To:

Sachin S. Panhalkar

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ABSTRACT

Soil degradation due to waterlogging and salinazation in sugarcane zone of western Maharashtra is a serious problem. Here an attempt has been made to assess the problem of the salt affected and waterlogged areas by preparing an inventory using GIS techniques. The study area is 3rd Segment of Krishna Canal command which is situated in Walwa and Palus taluka of Sangli district of Maharashtra State. Study area comprises 4092 hectare area land of 11 villages and 1792 agricultural Plots. Elevation, ECe, pH and water table surface map were generated by using Spatial Analysis tool. Risk zonation area is demarcated by using the critical limits given by Irrigation Research Division (IRD), Pune. Water table surface was intersected with survey plots and village boundary layers and prioritization of plots and villages were carried out according to intensity of water logging problem. The analysis reveals that there are many problems arising in Krishna canal command area. About 199 hectare area out off 4092 hectares is under risk of waterlogging. Hence, four priority zones have been prepared to implement the soil reclamation measures such as agronomical, chemical and biological.

Introduction:

Soil is one of the important resources of any country and no country can afford its neglect or waste. Soil supports all living as well as non-living organisms on the earth. Soil formation is a complex process that takes 600 to 1000 years to form one inch of top soil from parent material. Soil varies with depth, colour, composition and behaviour from place to place depending upon the climate, topography and other factors.

In India after Green Revolution and modernization of agriculture, the crop production has increased enormously. However, it was realized after two decades of Green Revolution that improper management of agro-inputs, good fertile soils are getting converted into degraded soils as salt affected areas and water logged areas (Pawar, 1989, Pawar & Pujari, 2003, Pawar, 2005). In India, it is 8.6 million ha., while in Maharashtra 6.0 lakh hectares of land is reported to be saline. It is increasing by 10% every year due to waterlogging (Gupta and Abrol, 1990).

The precise analyses of degraded soil have been made by various scholars by using modern techniques namely Rao et. al. (1996) followed a systematic visual interpretation approach using Landsat MSS and TM data to map salt affected soils of Manipuri district of Uttar Pradesh and advocated use of remote sensing data. Khan et. al. (2001) used IRS 1B LISS-III image for mapping salt affected soils in Pakistan. During the analysis correlation between various salinity indices like NDSI (Normalized Difference Salinity Index), SI (Salinity Index), SBI (Soil Brightness Index) and salt affected lands were derived. Regression equation was generated for classification of various salinity levels using IDRISI software. Goyal et. al. (2005) in their study in the command area of Ravi-Tawi Irrigation complex in Jammu region, studied attributes of waterlogged area with the terrain and hydrological parameters. They concluded that Remote Sensing and GIS are powerful tools to study the dynamic behaviour of waterlogged areas effectively.

Objective:

The objective of the present study is to identify the land degraded area in 3rd sector of Krishna Canal Command area on the basis of water level by using GIS techniques

Study Area:

The study area is situated between Krishna canal and Krishna River comprising part of Palus and Walwa tahsils of Sangli district in Maharashtra state (Fig.1). The total length of study area is 21 km and its Latitudinal and Longitudinal extent is 17° 03’’ to 17° 07’’ N and 74° 16’’ to 74° 23’’ E respectively. It includes eleven villages namely Shirate, Yede, Bichud, Rethare Harnaksha, Dudhari, Takari, Tupari, Dhayari, Ghogaon, Dudhondi and Punadi (Fig.3 & Table 3). The total area of the study region is 3091 hectares.

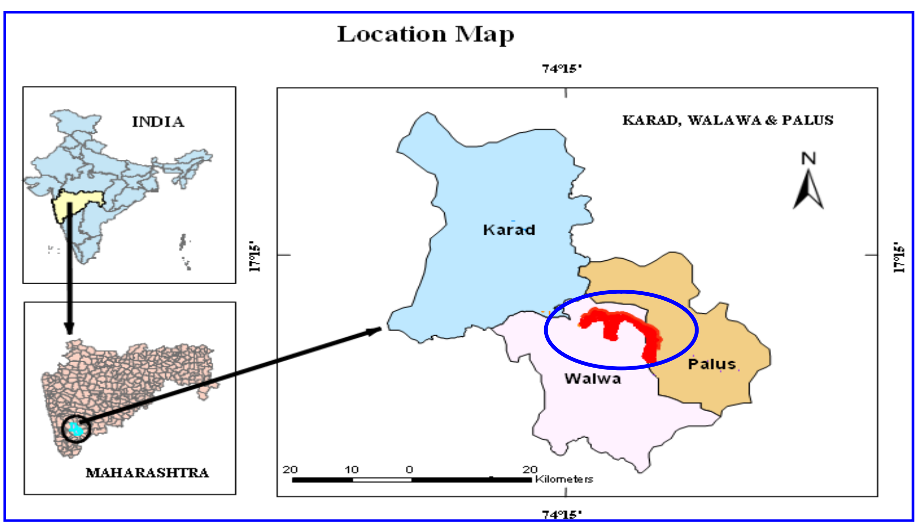

Fig.1 Location Map of Study Area

Climate of the study area is characterized by general dryness throughout the year. The mean daily maximum temperature is 29.5°C while the mean daily minimum temperature is 14.3°C and average annual rainfall is 692mm. Black cotton soil is predominant in the study area. *Kharif* and *Rabi* are the two important agricultural seasons and sugarcane is the dominant crop. The major sources of irrigation in this area are well, Tube well, canal and lift irrigation from Krishna River.

DATABASE & METHODOLOGY:

GIS is a powerful tool to generate maps, integrate spatial and non-spatial information, visualization of actual scenarios and to find out solutions for the problems. Data plays a central role in the analysis and decision making process. For present study following database has been used.

- Well distributed 173 Ground Control Points (GCPs) were collected by using GPS to generate data of latitude, longitude and elevation define from the field.
- System (GPS) from the field with the help of 1:4000 scale cadastral map of the study area.
- Water table data for the year 2005-2006 has been collected from DIRD, Pune division.

Cadastral map and water table data provided by IRD, Pune have been used. Plot wise and village wise cadastral map vectorized in GIS environment and georeferenced with GCP's. Vector layer has been normalized by using Alfa-numeric code. Point layer of 338 wells and Augur pits were generated and attributed to the water table data. The IDW interpolation technique has been employed for generation of water table surface to understand the regional water table variation. Water table surface was reclassified according to the IRD norms and risk zonation map is prepared. Finally by using the AWI $_{(1000)}$ formula, village wise and plot wise priority map has been prepared for improving the status of soil.

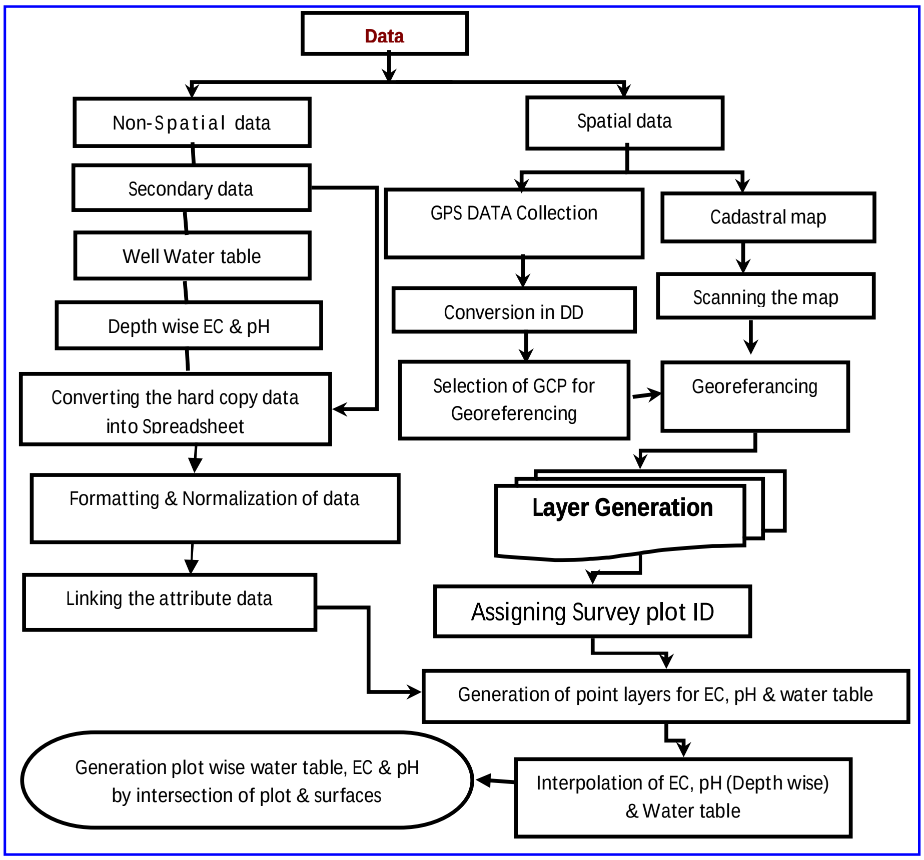

Fig.4 Research Methodology

Result & Discussion:

In the study region 198 hectare area is identified as waterlogged area out of the total study area (3809 ha.), , It is 5% of total area. Here, water table is found within 1 meter from the ground surface which indicates highest risk of Waterlogging. 34 percent area which is showing presence of water table between 1 to 2 meter. It is also having higher risk of water logging. The analysis reveals that as the distance from the canal increases, the risk of water logging is also decreases as water table decreases In about 1792 hector area, water table is between two to three mts, indicating as less critical to water logging which covers 45% of total area. In 627.0774 ha. area water table is below three mts and it shares 16% to the total area. In short, in the study region large area occupy two to three meter water table and less area is having water table less than one meter below the surface.

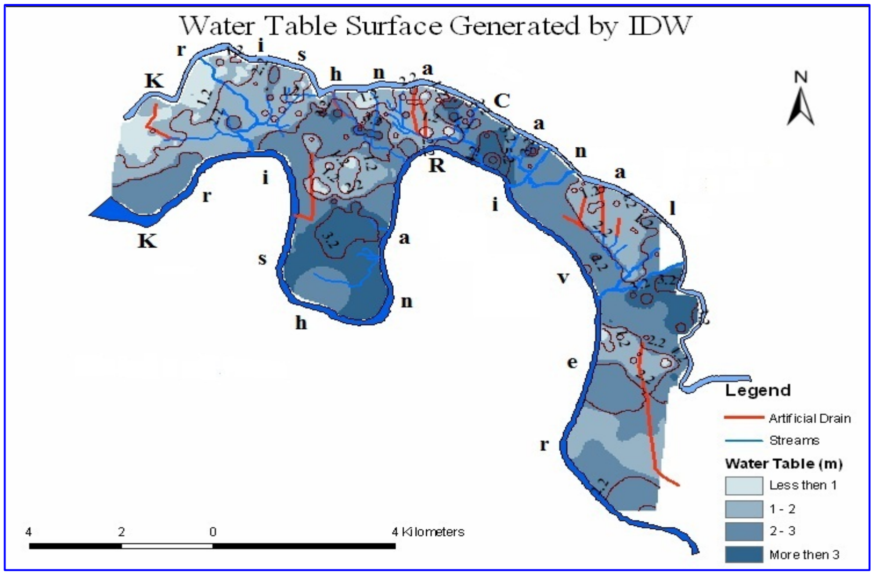

Fig.5 IDW Surface from Water table Location

- **Risk Zonation Map with respect to Salinity & Waterlogging:**

Following criteria given by IRD for zonation and classification of ECe, pH and water table have been employed for further analysis.

Table-1: Waterlogging criteria for risk Zonation

Classification of land	Water table (m)
Most critical	< 1
Critical	1 to 2
Less critical	2 to 3
Not critical	> 3

Table-2: Salinity Criteria for Risk Zonation

Magnitude of salinity	EC ds/m	pH
Slight	4 - 8	8.5 - 9.0
Moderate	8 - 30	9.0 - 9.8
Strong	> 30	> 9.8

Source: Irrigation Research Division, Govt. of Maharashtra, Pune

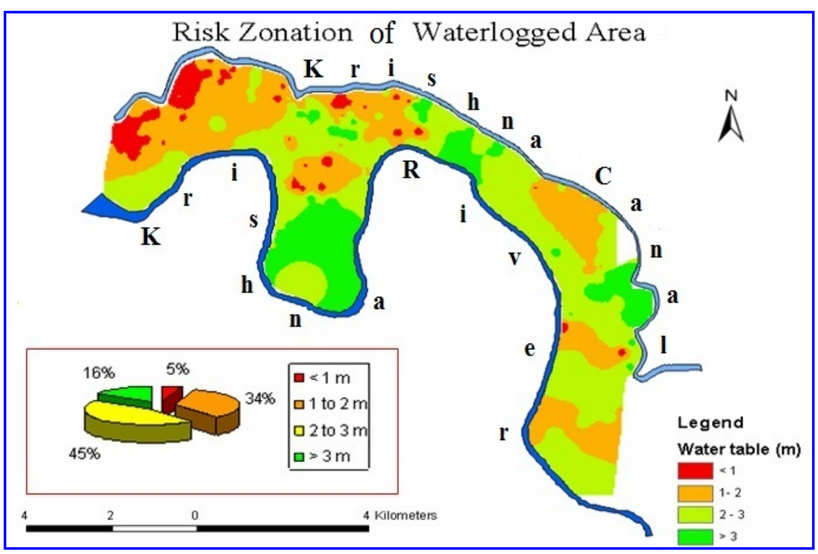

Fig.6 Risk Zonation map of Waterlogged area

- **Village wise Water Table Distribution:**

Table-3 Village wise distribution of water table.

code No	Village Name	Water Table < 1 m	Water Table 1- 2 m	Water Table 2 - 3 m	Water Table > 3 m
3	Bichud	3.3431	117.627	94.8777	
8	Dahyari	0.2676	33.7224	53.26	
5	Dudhari	8.2967	95.2792	78.8194	18.1994
10	Dudhondi	5.6204	67.8121	169.8165	128.3325
9	Ghogaon		168.6121	161.3858	4.0145
11	Pundi		208.3564	415.3746	
4	Re. Harnaksha	28.102	222.9432	434.6457	398.113
1	Shirate	77.3474	285.9715	163.527	
6	Takari			79.3547	77.6151
7	Tupari		0.1338	131.678	0.8029
2	Yede	75.7416	126.0576		

Source: Field work, water samples and GIS Analysis.

- **Prioritization of Survey Plot & Villages:**

The classified surfaces were intersected with village and plot boundaries separately. Area under various intensity classes was measured. Intensity classes were given weights as most critical, critical, less critical, not critical as 9, 7, 5 and 2 respectively. Area-weighted Waterlogged Index (AWI) was calculated for class wise area in a survey plot as follows.

$AWI_{(1000)}$ = [most critical*9]+[critical*7]+[less critical*5]+[not critical*2]\TGA

where TGA is total geographical area

Village wise prioritization was carried out for class wise area in a village as

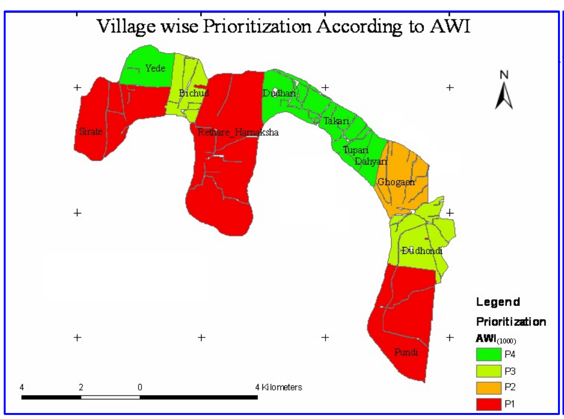

Fig.7. Village wise Prioritization

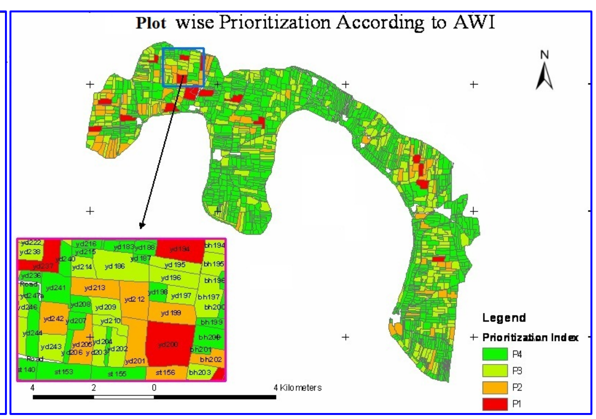

Fig.8. Plot wise Prioritization

Table-4 Village wise prioritization of survey plots based on AWI ($_{1000}$)

		P1		P2		P3		P4		Total
code. No	Village Name	No of plots	Area	No of plots	Area	No of plots	Area	No of plots	Area	
11	Punadi (P1)			10	57	46	160	297	298	**515**
4	Rathare Harnaksha (P1)	2	17	6	31	61	217	360	497	**762**
1	Sirate (P1)	4	32	24	128	44	128	97	104	**392**
9	Ghogaon (P2)	3	22	8	43	28	96	89	85	**246**
3	Bichud (P3)	4	33	5	27	10	33	69	65	**158**
5	Dudhari (P3)			1	6	9	28	95	73	**107**
8	Dhayari (P4)	1	7	1	4	7	21	47	47	**79**
10	Dudhondi (P4)			5	28	18	71	124	163	**262**
6	Takari (P4)					3	11	94	84	**95**
7	Tupari (P4)			1	7	10	42	60	78	**127**
2	Yede (P4)	3	22	7	34	24	63	61	46	**165**
	Total		**133**		**365**		**870**		**1540**	**2908**

Conclusion:

The analysis reveals that in the study region around 199 hectares area is under the risk of waterlogging. Water table near canal side is available at 1.5 meter and towards Krishna river side it is at 2.5 meter from ground surface. It indicates that problem of seepage from canal is more serious. Water table risk zonation map suggests that Shirate, Punadi are close to canal and are more vulnerable due to high water table. 17 plots falling in P1, 370 plots in P2, 870 in P3 & 1540 plots are in P4 category. Punadi, Rethare Harnaksha and Shirate villages are falling in P1 category, so the soils of these villages have to be reclaimed first. Ghogaon village is in P2, Bichud and Dudhari village in P3 and Dhayari, Dudhondi, Takari, Tupari, and Yede village are in P4 category which need sequential priority for soil reclamation.

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