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UTILITY OF REMOTE SENSING DATA AND GIS FOR LONG TERM ASSESSMENT OF LARGE SALT-AFFECTED BLOCKS IN A PART OF GANGETIC ALLUVIAL PLAIN, INDIA

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Abstract: *Remote sensing techniques have repeatedly proven its utility in monitoring the changes in spatial extent of unproductive lands like barren salt affected lands. Using the satellite images of 2008-09; salt affected area of 23,842 ha. was mapped in Kanpur Nagar and Kanpur Dehat taken together, which was 381 ha. Less compared to area mapped in 2005-06.In present study, nine large blocks of salt-affected soils ground surveyed in 1956 by Mehrotra et.al. in parts of Kanpur Nagar and Kanpur Dehat have been mapped using 2013 high resolution satellite data. The old ground survey map were digitized and geo-referenced to facilitate the monitoring the spatial extent of cultivated area after a period of 56 years in the selected usar blocks. The result reveals that maximum area under cultivation is 678 ha. In block no 43 & 46 followed by 599 ha. In block no 32 after a period of 56 years. The present increase in cultivated area found ranging from 60 to 90 percent, thereby helping in reducing the atmospheric carbon dioxide and increasing the soil carbon pool. Salt-affected soils are still lying barren even after 56 years, which calls for more specific efforts for reclamation of these soils or best land use in contributing towards mitigating the impact of climate change. The markedly higher increase in percent ranging from 37 to 61 after 1986 (Singh, 1994) indicate more efforts or success of reclamation programs between 1986 and 2013. The very long time taken for increase in cultivation area in the selected usar blocks in spite of well established reclamation technology , bring forth the complexity of severe adverse soil conditions, ownership factor and socio-economic conditions involved.*

Keywords: *Remote sensing, salt-affected blocks, GIS.*

Introduction: In Gangetic alluvial plains where pressure on land resources has been mounting with the increase in population and presence of large areas occupied by unproductive lands like barren salt –affected land. For assessment of these salt-affected lands various methods have been employed since first reporting about their occurrence in India. Various estimates ranging from 6.32mha to7.14mha are reported in literature in India [1]. In present scenario, the easy access to satellite data has made the task of identifying and mapping the barren salt-affected land much more accurate and time efficient. In Kanpur District of Uttar Pradesh, a systematic ground survey of salt-affected lands was carried out in 1956 [2], who mapped 106 large blocks of salt-affected soil of more than 80 ha. covering 38,825 ha area. More than half a century later using the satellite images of 2008-09, salt-affected area of 23,842 ha was mapped in Kanpur Nagar and Kanpur Dehat taken together (NRSC,2011), which was 381 ha less compared to area mapped using 2005-06 data following the same methodology (NRSC, 2010). Singh (1994) attempted to monitor the changes in some of the 'usar' (salt-affected) blocks using aerial photograph and LANDSAT data which were earlier mapped in 1956 showed the increase in cultivated area in the selected 'usar' Blocks [3]. The increase ranged from 5 to 44 % indicating the continuous efforts made by farmers over a period to bring these salt affected soils under crop production through various reclamation schemes run by the government from time to time.

Uttar Pradesh Bhumi Sudhar Nigam (UPBSN) also undertook reclamation programme through its World Bank aided UP

Sodic Land reclamation project in two phases from 2001-2005 and 2009-2016, in Kanpur Nagar and Kanpur Dehat covering 14955 ha of barren salt-affected lands, thereby triggering a large scale motivation for bringing these problematic soil under crop production. In order to understand the changes taken place since the first survey in 1956 of salt-affected area in selected blocks of salt-affected soil in Kanpur Nagar and Kanpur Dehat, a study has been attempted using 2013 IRS LISS-IV satellite data.

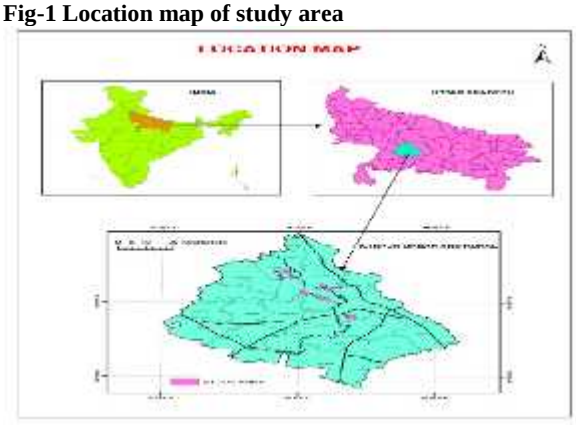
Study Area: The study area cover selected nine large salt-affected blocks surveyed in 1956 [2], in Kanpur Nagar and Kanpur Dehat district. Kanpur is one of the important district of Uttar Pradesh and has since1981 been divided into Kanpur Dehat and Kanpur Nagar. The districts lie between 25°55' and 27° North latitude and 79°30' and 80°35' East longitudes in Survey of India Toposheet No. 54N and 63B. The main river Ganga and Yamuna with their tributaries form the dendritic drainage system. Lower Ganga canal is the major canal network for irrigation in districts. The study area is covered by four Agro-ecological zone namely AES-I, AES-II, AES-III, and AES-IV with main soil type varying from sandy loam to silty loam, silty loam to clayey loam and normal loamy texture. The average annual rainfall in the area is 821.9 mm. The climate is sub humid and it is characterized by hot summer and general dryness except in the south west monsoon. About 90% of rainfall takes place from third week of June to September. During monsoon surplus water is available for deep percolation to ground water. May and early part of June constitute the hottest part of the year. The mean daily maximum temperature in May is 41.7^0 C. The mean daily minimum temperature is 27.2^0 C and maximum temperature rises up to 45^0 C. The districts are part of the Ganga basin which is formed of alluvium of the early quaternary period. There are no hard or consolidated rock exposures in the area. The mineral products of the district of saline earth from which salt petre and salt are derived and limestone conglomerates (U.P. District Gazetteers Kanpur).Following 9 blocks which constitute the study area were randomly selected for the study. They are block no 32, 42, 43, 46, 84, 86, 88, 100, and 101 which were also studied earlier using remote sensing data of 1986 by Singh(1994).The location of the selected blocks has been given in Fig. 1 and the area of blocks and village involved are shown in table-1.

Table-1: Selected 'usar' blocks and name of villages of study area

Sl.No.	Block* No.	Area of block (ha.)	VILLAGES INVOLVED WITH TAHSIL
1	32	780.52	Bhaiarampur, Sonah, Binaur and Sachandi: Tahsil- Kanpur, District-Kanpur Nagar
2	42	654.96	Ranipur Sheoli, Sheeoli, Arshadpur, Sarainyan and MakrandpurBantha: Tahsil-Akbarpur, District-Kanpur Dehat
3	43	991.18	Kakarmau, Kakardahi, Manda and Barar: Tahsil-Akbarpur, District-Kanpur Dehat
	46		
4	84	260.68	Dalipnagar, Jaddepur, and Nigoh;Tahsil-Bilhaur, District-Kanpur Nagar
5	86	323.80	RawatpurKalan, Biroha, and Gaurilakhapur: Tahsil-Bilhaur, District-Kanpur Nagar
6	88	565.66	Dalipnagar, Bisen and Bojha: Tahsil-Bilhaur; District-Kanpur Nagar
7	100	732.14	KheraKursi; Tahsil-Bilhaur, District-Kanpur Dehat
8	101	728.54	Manwan, Rasulabad, Surajpur, Uria, Sonasi and Tista; Tahsil-Bilhaur, District-Kanpur Dehat

**Block No. as per Mehrotra at al. (1975)*

Fig-1 Location map of study area



Methodology

A scheme of reconnaissance survey of large 'Usar' (local name of saline –alkali soils) blocks in five predominantly salt –affected soils districts including Kanpur was initiated by the Govt. of Uttar Pradesh in 1952. Boundary of selected usar blocks of 1956 survey in kanpur have been taken [3].The usar soil map of 9 usar blocks were digitized after scanning and georefrencing done with the help of IRS LISS-IV satellite data and using permanent ground control point like road, canal, and their intersection

points. The digitized blocks were superimposed on salt affected soil map prepared from LISS-IV data using Arc GIS 10.2 software. The sodic and cultivated areas were visually interpreted on screen using element of visual image interpretation. Field visits were undertaken to collect the information on change in the extent of salt-affected soils. Area calculation for each block was done on IRS LISS-IV Feb (2013) satellite data using Arc GIS 10.2 software.

Result and Discussion

The area of digitized'Usar' Blocks and salt affected soils mapped in 1956 was calculated using Arc GIS and is presented in Table-2 which shows the spatial extent of usar areas in each selected 'Usar' blocks. The largest block comprising of block number 43+46, covers an area of 971 ha and smallest block no.84 is of 206 ha only, The table no-2 shows the barren salt affected area brought under cultivation from 1956 to 2012 in each selected block taken up for study. Maximum area mapped under cultivation is 678 ha in block 43+46 followed by 599 ha in block no 32 in a period of 56 years. The minimum area under cultivation is 133 ha in 2012 in block no 84 which is smallest i.e. 206 ha amongst all blocks taken up for study (Table-2).Map of one selected 'usar' block is shown in fig-2. It is noteworthy that even after 56 years, large areas under salt-affected soils are still lying barren despite all the efforts for reclamation of salt affected soils by the government and farmers. This status brings in the forefront that further more focused and concentrated efforts are required not only to reclaim but sustain the reclamation of salt affected soil.

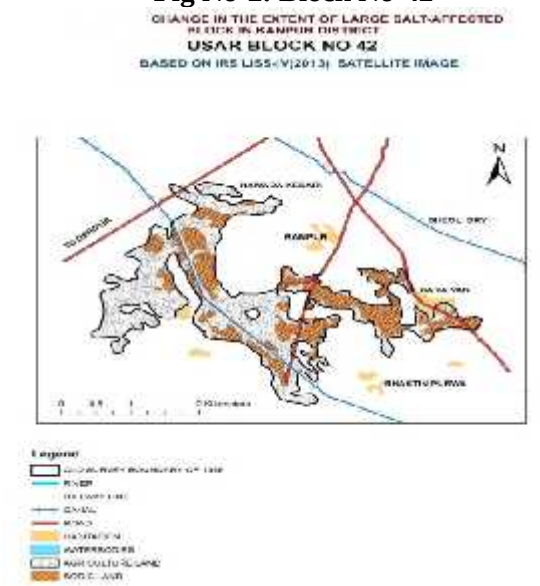
During the two of U.P. sodic land reclamation project phases for reclamation of salt affected soil in Kanpur Nagar and Kanpur Dehat a total of 408 villages with 14955 ha. barren salt affected soils were taken up for reclamation . The selected 'Usar' blocks under study cover either full or part of many villages which have been taken up for reclamation during the period of monitoring. Some of the villages namely Kakarmau, Nigoh and Sonah were covered during 2000-2005(RSAC,2006) while villages vizs Binaur, Bansathi, Uria, Ranipur, Sheoli, Kherakursi, Hirdepur, Gokula, Kakardahi, Kakarmau, Arshadpur, Gauri, Dalipnagar and Bhoja have been taken up in the period from the 2012 to 2015(RSAC,2014). Therefore the result of reclamation and sustainability are seen in the block 32, 43 and 84 which include Kakarrmau, Nigoh and Sonah Villages. It is noteworthy that the increase in cultivated area in selected usar blocks is found ranging from 60 to 96 percent in year 2012-13 with respect to year 1956. 98 percent of 'Usar' block no. 86 is under cultivation in year 2013, marking an increase of 96 percent with respect to 1956. On the other hand minimum increase of 60% in cultivated area has been noticed in 'Usar' block no.42 with reference to cultivated area in 1956. Net cultivation increased in nine 'Usar' blocks from 1956 was 2.93% to 63.75% in 2013 It indicates to increase in soil organic carbon. Its play very small role in carbon sequestration. It is important to note that 98% of 'Usar' block no 86 could be brought under cultivation in a very long time. The predominant reason appear to be severe sodicity, ownership factor and socio-economic conditions involved in spite of existing reclamation technology which came into being after establishment of Central Soil Salinity Research Institute in Karnal, Haryana. A comparison of percent increase in cultivation calculated [3] between 1956 & 1986 reveal that the increase in cultivation in 'usar' blocks during the period between 1986 and 2013 was markedly higher ranging from 37 to 61 percent, indicate that more efforts or success of reclamation programmes after 1986.

Table-2: Changes in area under cultivation within USAR blocks between 1956 and 2013

S.N	Block no.	Total block area (ha) Singh (1994)	Total block area (ha) as per GIS	Area(ha) in 1956 (Ground survey)	Area in 2013 (IRS-LISS-IV)				Increase in area under cutivation	
				Cultivated	Cultivated (ha)	Cultivated(%)	Usar (ha)	Usar (%)	1956-2013 (%)	1986-2013 (%)
1	32	818	780.52	55(67%)	561.14	78	219.38	28%	71	47
2	42	737	654.96	46(6.2%)	427.03	66	227.93	34%	60	60
3	43 &46	971	991.18	29(3%)	697.5	71	293.68	29%	68	60
4	84	206	260.78	Nil	187.46	72	73.32	28%	72	40
5	86	231	323.80	4(1.7%)	316.59	98	7.21	2%	96	61
6	88	559	565.66	6(1%)	420.65	75	145.01	25%	74	50
7	100	609	732.14	Nil	587.9	81	144.24	19 %	81	37
8	101	652	728.54	Nil	543.14	75	185.40	25%	75	44

9				**Total** 140(2.93%)	**Total** 3211.41 (63.75%)					

Fig No-2: Block No-42



Conclusion: In the period of 56 years, more sodic soils have been brought under cultivation in the selected Usar blocks.96% increase in cultivation found in Usar blocks number 86 and minimum 60% in block number 42.The increase between 1986 & 2013 is markedly higher compared to the period from 1956 to 1986 indicating more efforts by the government & farmers. However, large contiguous barren salt-affected lands are still lying untreated and uncultivated. The prominent reasons appears to be related to management coupled with the severity of sodicity in the remaning barren areas of selected blocks comprising of village Nigoh (usarblock84), village Dalipnagar and Bojha (usar block 84 &88), village Sonah and Binnaur (usarblock32) and village Uria (usar block 101).Large areas of these selected blocks falling in the above mentioned villages are under “Gram Samaj Land” and with forest department for example in village Dalipnagar. Analysis of scanty ground information points towards more location specific and focused efforts are required to bring these problematic soil under green foliage, which will not only improve the soil quality but also stop the further threat of sodicity in adjoining areas.

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