Mapping of Salt Affected Land of Unnao District in Uttar Pradesh Using Geo-Spatial Techniques

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Abstract–*Soil salinity/sodicity caused by natural or human-induced processes could be a major environmental hazard. The worldwide extent of primary salt-affected soils is about 120 M ha, about 50% of these are in cultivable areas. Almost 20% of all irrigated land is salt-affected, and this share tends to increase although large efforts dedicated to land reclamation. They adversely effects agriculture practices and soil quality but also have impacts economic conditions of farmers. Local names of salt affected soils are Reh, Kallar, and Chopan, Rakar, Thur, Karl etc. The monitoring and mapping of salt affected land can be done by using the Remote Sensing & GIS technologies as such and use of alternative measures to minimize the time and cost in reclamation processes. This study helps in treating or reclaiming the mapped salt affected soil. The treated area will be utilized for agriculture, gardening and fish rearing by utilizing existing ponds and the rest is covered in construction.*

***Key Words*: Remote Sensing, Salt Affected Soil, GIS, Sodicity, Salinity.**

1. INTRODUCTION

Salt affected soils occur both naturally and due to anthropogenic activities which increases accumulation of salts within the landscape. However, it should be noted at the outset that there are two broad classes of salt affected soils. Saline soils are those with an elevated concentration of any kind of salt, whereas “sodic” soils are those soils with a high proportion of sodium ions relative to other cations in the soil or water. A large proportion of land disturbance activities, including road construction, occur on sodium-affected soils. Soils with high levels of exchangeable sodium and low levels of total Soluble salts are susceptible to clay dispersion which leads to sealing, crusting, low permeability, high bulk density and low porosity. Sodic soils also tend to have a high soil erodibility due to the susceptibility of these soils to gully and tunnel erosion. The reclaimed area was utilized for crop production, fruit production, forestry and fish rearing by utilizing existing ponds and the rest is covered in building, threshing floor, channels, roads, etc.

In this study, Unnao district has been taken as the study area for mapping sodic lands. The salts hold water in the soil at high osmotic potential, which restrict easy exchange of water and nutrients with the plant roots. Consequently, they slow down the growth and development of plants. As a World Bank aided project is running in the district since last 15 years to reclaim the sodic area and make the area for cultivation of normal crops. The major changes have been reported mainly in terms of sodic land areas, which have been reported to decrease over the years. Gypsum application is advocated for the reclamation of sodic soils. Recently, the remote sensing technologies have been used increasingly in various domains like climate changes, global warming, in order to explain or detect different phenomena in a rapid manner and covering large areas. Soil salinization is the accumulation of salt in soils, which is considered as an ecological problem that is often attributed to natural influences (80% in salinized lands), rather than anthropogenic activities. Evaluating the spatial distribution of salt affected soil becomes so important to suitably manage and preserve the soils for agriculture purpose. In recent decades, with the progress of remote sensing technologies, the prediction of soil salinity and mapping its spatial distribution in large-scales are becoming more important and easy. This prediction helps to prevent and minimize the salinity phenomena (Zhang, Wang, & Wang, 2002). The new remote sensing technologies become a powerful method to provide global and rich information on the spatio-temporal evolution of surface soil without any direct contact. The present soil salinity problem is related to time and space, for which traditional methods like field investigation and laboratory analysis are not enough to monitor this. The aim of this research article is to identify the salt affected areas.

2. STUDY AREA

Unnao is the head quarter of Unnao district in Uttar Pradesh. It is situated between Kanpur and Lucknow. Unnao is a big commercial metropolis with three commercial suburbs round it. The town is famous for its leather-based, mosquito internet, zardozi and chemical industries. Unnao is an historical city with many ancient buildings and systems. Transganga city, a new satellite, town of Unnao is being developed in order to broaden Unnao as a major commercial and infrastructural hub because the place comes under Kanpur-Lucknow counter magnet region. Unnao district is a part of central Ganges simple of the country covering an area of 4558 km2. The metropolis is enlisted as a municipality of Kanpur metropolitan location and is the second biggest city inside the metropolitan place. The district is roughly a parallelogram in shape and lies between range 26°8 N & 27°2 N and longitude 80°3 E & 81°3 E. it's miles bounded on the north by using district Hardoi, at the east with the aid of district Lucknow, on the south with the aid of district Rae Bareli and at the west via the Ganga which separates it from districts of Kanpur & Fatehpur.

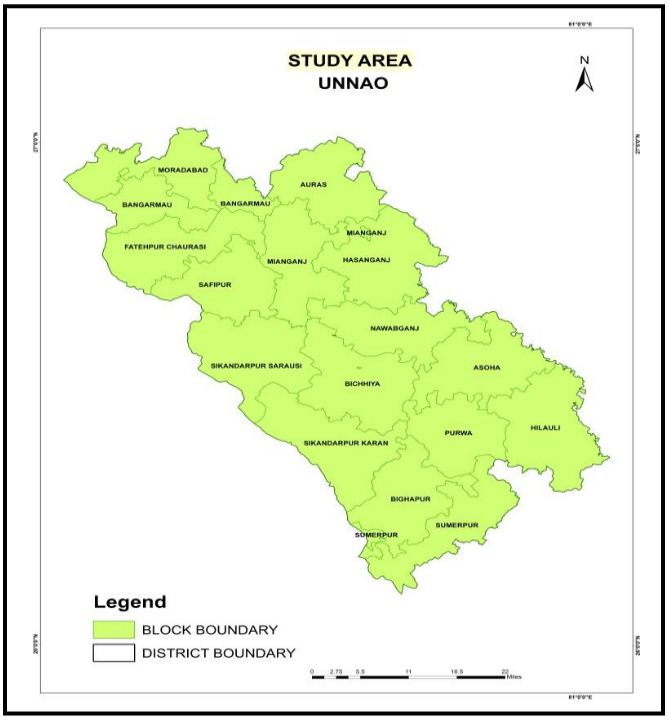


Fig-1: Map of Unnao

3. DATA AND SOFTWARE USED

(1) IRS 1C LISS III (RESOURCESAT-1) for Feb 2018. The specifications are shown in Table 1

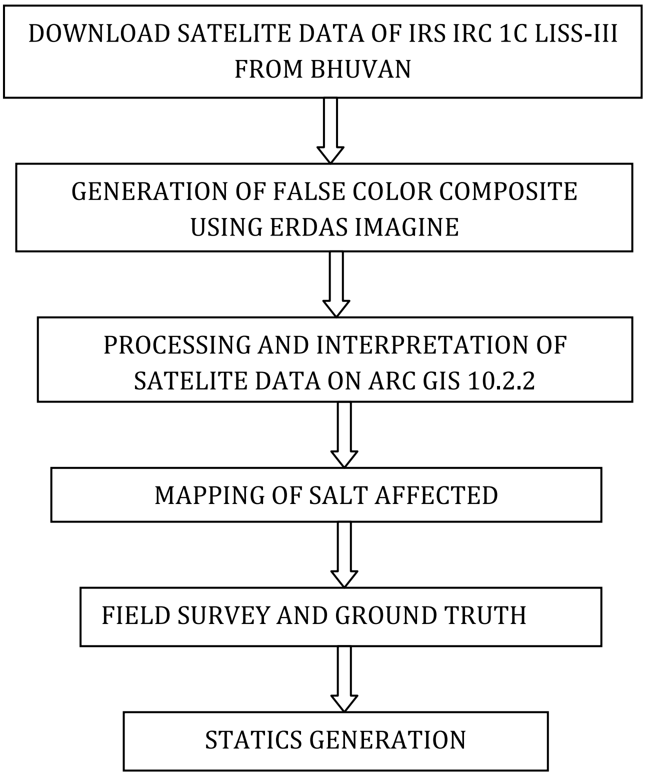
(2) Software: MS Office-Excel (2007), ERDAS IMAGINE, ARC GIS 10.2.2

Table -1: Satellite specifications

Satellite	Sensor	Path	Row	Season	Year
IRS-1C	LISS III	100	53	Rabi	2018

4. METHODOLOGY

The methodology primarily based on the use of digital image analysis technique and mapping of Sodic land on satellite data of RESOURCESAT-1 of Unnao region using ARC GIS and ERDAS IMAGINE.



5. RESULT & DISCUSSION

Free satellite images from BHUVAN became widely used in several domain, According to the produced map of salt affected land after mapping of satellite data and analysis, it is found out that 10778.53 hacters of land is salt affected. North-eastern portion of Unnao having more salt affected soil in compare to remaining portion. Blocks like Auras, Bichiya &Manganj are the regions which are severely affected by sodicity/salinity. Map of salt affected land of Rabi season 2018 using satellite date of IRC 1C LISS-II shown below.

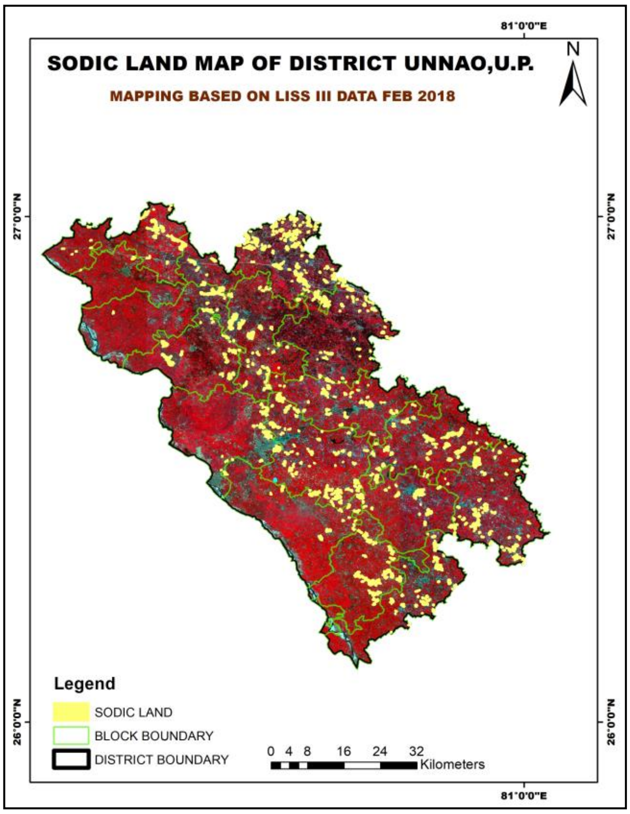


Fig -2: Mapping of salt affected land in Unnao

The digital analysis of remote sensing data revealed mixed surface properties for salts, soil particles during dry (June) season and complex spectral signatures of moist soil surface and moderate crop cover in salt-affected soils (Khan et al., 2005). The similarity of spectral signatures for village settlements (muddy roof top) and barren salt-affected soils caused spectral confusion during digital analysis. Visual analysis revealed definite shape and sizes of rural settlements that differs from irregular pattern in salt-affected soils (Khan et al., 2005). Mixed gray to reddish gray and mottled red tones indicated waterlogging in cropped areas (Mandal & Sharma, 2013), which was authenticated during field studies. The linear shape of canals and typical curvilinear meandering rivers differs from stagnant water bodies (waterlogged surface) though these elements showed similar spectral reflectance. Irrigated areas with poor quality ground water showed mixed spectral signatures for poor crop stand (light to red tone) and moist soil surface (light to gray tones). Ground truth studies showed salt enrichment, unfavorable physical properties and poor drainages in soil profiles (Mandal et al., 2013; Sharma & Mondal, 2006). The low reflectance values of irrigated sodic soils in March data (40–60) appeared to be due to surface moisture. Similar results were reported for carbonate rich salts in visible (0.55–0.77 um) and infrared (0.9–1.3 um) ranges (Csillag, Pasztor, & Biehl, 1993; Khan et al., 2005; Rao et al., 1995). The higher NDVI values of moderately sodic soils (0.29–0.52) may be ascribed to higher vegetative cover and also management interventions at selected locations (Mandal & Sharma, 2011; Raghuwanshi, Tiwari, Jassal, Raghuwanshi, & Umat, 2010). The mixed reddish gray to dark gray tone for sub-surface waterlogged areas indicated scattered crop cover, and higher moisture content at soil surface.

6. CONCLUSIONS

Satellite data have become valuable tool in studying the spatial extend of salt affected land and for monitoring the changes that have taken place over period of time due to reclamation process. The methodologies can be used to extract precise and timely information on different aspect of salt affected land in a cost effective manner on operational cost. Thus, this proposal can be employed for decision-making to develop effective plans to reduce or prevent future increases in soil salinity. Visual and digital analysis of IRS LISS III multi-spectral data was used for identification and delineation of sodic soils. Field validation facilitated development of map legends for accuracy. High values for spectral reflectance were observed from salty surfaces, and higher energy absorption in visible and infrared bands suggested the identification of strongly sodic soils. The mixed spectral signatures for salt, scattered crop covers were authenticated by field investigation. Saturation of Na_2CO_3 and $NaHCO_3$ salts in soil alkalization and low soil productivity. Sodic soils can be reclaimed with suitable amendments such as gypsum or pyrite.

7. SUGGESTIONS

The remote sensing technologies are now used increasingly in numerous domains in order to analyse or detect different phenomena in a rapid manner and covering large areas. Sodic soils of the Gangetic plain in Central Haryana are rich in sodium carbonate and bicarbonate salts and showed high ESP and variable soil texture. Strongly sodic soils (P1 and P2) containing high Na_2CO_3 and $NaHCO_3$ salts, coarse soil texture and sodic ground water needs gypsum application @ 8–10 t ha^{-1} to reduce alkalinity in soil and water followed by leaching of excess soluble salts. Moderately sodic soil (P3) containing soluble Na_2CO_3 and $NaHCO_3$ salts and fine soil texture can be reclaimed by addition of 4–6 t ha^{-1} gypsum. Due to high clay content and presence of $CaCO_3$ concretions, P4 (slightly sodic soil) showed drainage restrictions and waterlogging. It may be used for growing salt-tolerant rice and wheat crops. The addition of farm yard manure in soils and cultivation of Dhaincha (*Sesbania* sp.) is suggested to improve physical properties, drainage conditions and reduce waterlogging.

It is a dynamic process and quite often, the socio-economic and political considerations become extremely important in increasing extend of salt affected soil. Generally, such factor is out of control of individual farmers and is call for the attention of the policy makers. It becomes the responsibility of respective governments to take responsibility and make decisions regarding corrective measures to prevent soil salinization and also to restore the soils that already affected by salts.

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