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Assessment of Salt-Affected Land in Bhattu Kalan, Fatehabad District Using Remote Sensing and GIS Techniques: A Comprehensive Analysis.

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Abstract:
This study presents a comprehensive assessment of salt-affected land in Bhattu Kalan, Fatehabad District, employing advanced Remote Sensing (RS) and Geographic Information System (GIS) techniques. Salt-affected soil poses a significant challenge to agricultural productivity and land use, necessitating an in-depth analysis for effective mitigation strategies.
This study assesses the amount, distribution, and severity of salt-affected areas inside Bhattu Kalan using multi-temporal satellite images and GIS tools. It is easier to precisely identify zones affected by salt when spectral measures like the Supervised Classification and somewhere used manual classification.
To further guarantee accuracy and dependability in land classification, ground-truthing and validation procedures are used in conjunction with remote sensing analysis. The conclusions are more credible because field surveys investigations support the data derived from remote sensing.
The results of the study not only show the geographic distribution of land impacted by salt, but they also offer important new information about the variables that contribute to soil salinity. Understanding the fundamental causes of salinization requires an analysis of various factors, including land use, irrigation techniques, and soil characteristics.
Furthermore, according on the severity and extent of areas affected by salt contamination, the research suggests customized management and repair strategies. To lessen the negative consequences of soil salinity, recommendations include crop variety, soil amelioration techniques, and precision irrigation.
Keywords: *Salt-Affected Land, Remote Sensing, GIS Techniques, Assessment, Classification.*

I. Introduction:

The worldwide issue of soil salinity and its detrimental impact on agricultural yields calls for a thorough evaluation of lands impacted by salt in particular areas. One such location that is affected by soil salinity is Bhattu Kalan, which is located in the Fatehabad District. This study seeks to assess and characterize the amount and severity of salt-affected land in Bhattu Kalan by performing a thorough analysis using cutting-edge Remote Sensing (RS) and Geographic Information System (GIS) approaches.

Serious problems with soil salinity and alkalinity impact 44% of the world's farmed land. Reduced soil productivity due to salt accumulations is the main issue threatening the sustainability of agricultural systems, especially in irrigated areas. By the turn of the century, 230–250 million tonnes of food grains need be produced in order to meet the growing demands of the growing population. After land reclamation, the potential land reserve for agriculture is predicted to be 6.7 million hectares across several states in the nation that are impacted by salt-affected soils (Mandal et al. 2011). Considerable progress has been made in controlling and lowering the salinity and alkalinity of sand in regions that receive irrigation.

Roughly 6.5 percent of the world's land area is damaged by salinity and sodality, while 19 percent of the 20.8 billion hectares of arable land worldwide are comprised of land affected by salt. Of the 6.74 million hectares of damaged land in India, 2.95 and 3.79 million hectares, respectively, are made up of saline and sodic soils (CSSRI Vision 2050, 2015). An estimated 230 billion Indian rupees are lost annually as a result of salinity and sodality, which restrict crop plant growth and output to varying degrees. By 2050, it's anticipated that 16.2 million hectares of soil will be damaged by salt, which will result in greater losses.

In dry and semi-arid environments, the problems caused by salinity and sodicity of the soil are very noticeable and have an impact on crop development and output. The problems related to salt-affected fields are further exacerbated by waterlogging, structural concerns, and low soil porosity (Bhattacharya, 1992). The

effects on crop output are clear in Haryana, where salt-related problems have resulted in millions of tonnes of lower yield and large financial losses (ICAR-CSSRI, 1996).

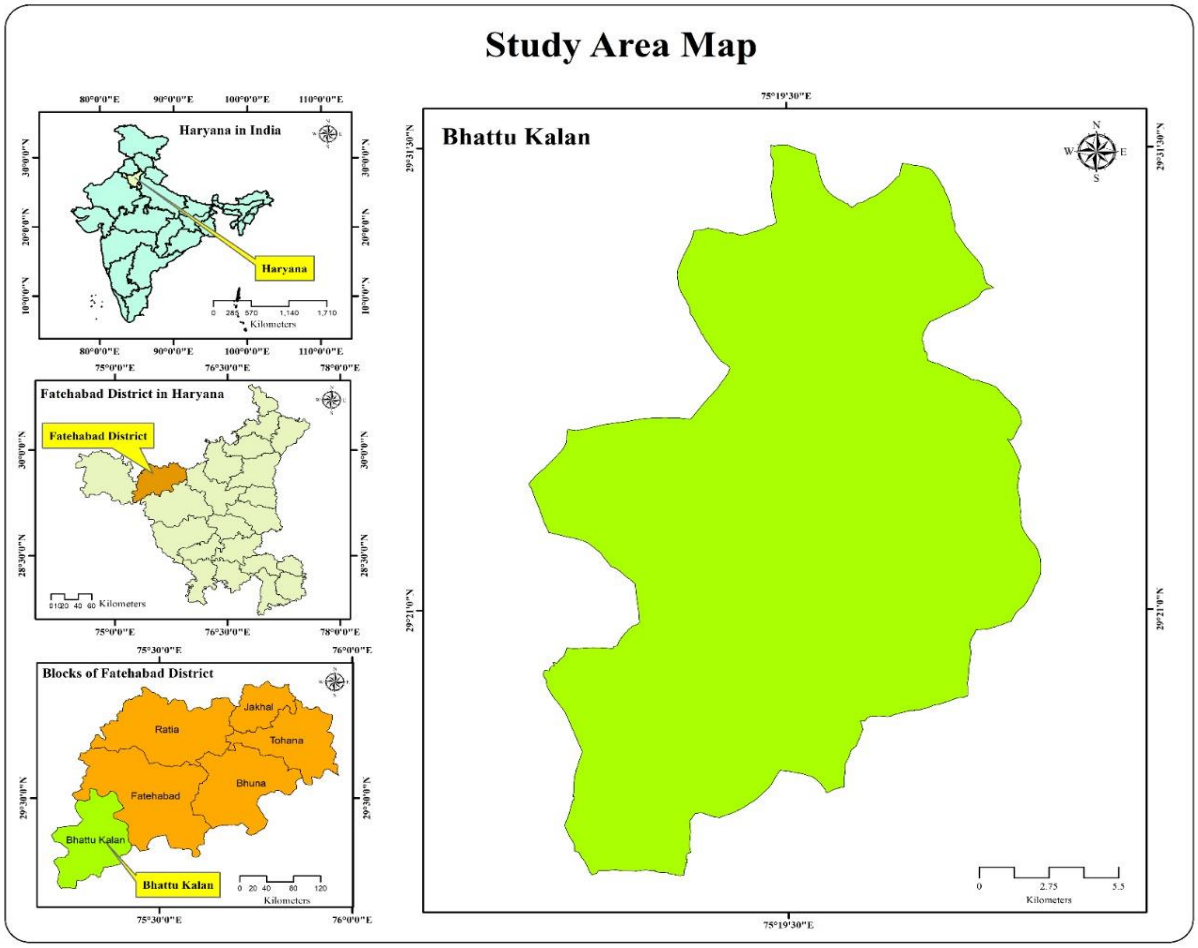
The introduction concludes by stressing the use of GIS in mapping and managing soils impacted by salt and emphasising its function in larger-scale planning and monitoring of salinity management.

Study Area:

Bhattu Kalan, located at coordinates 29°23′14″N 75°20′32″E, is situated in Fatehabad district in the state of Haryana, India. This region, like many areas in the semi-arid zones of Haryana, faces agricultural challenges due to factors such as soil salinity, waterlogging, and poor soil quality.

Bhattu Kalan is a town in the Indian state of Haryana's Fatehabad district. When two villages share a name, they can be separated from one another because the Persian words Khurd and Kalan, which imply tiny and big, respectively, are used.

Map-1: Locational Map of Study area.



Situated north of Hisar, 57 km, it is part of the Hisar Division. It is located roughly 149 miles (239 km) northwest of Delhi, the nation's capital. The entire area measures 203 metres (666 feet) above sea level and encompasses 100 square kilometres (39 sq mi). Rail connectivity is available to Bathinda, Hisar, and Delhi.

II. Methodology And Material:

The following steps are part of the methodology for the thorough assessment of salt-affected land in Bhattu Kalan, Fatehabad District, using Remote Sensing (RS) and Geographic Information System (GIS) techniques:

GIS Integration and geographic Analysis: For mapping and geographic analysis, incorporate data from RS into GIS software. Make thematic maps that illustrate the Bhattu Kalan salt-affected regions' extent, distribution, and severity. For land classification and overlay analysis, use GIS tools (showing in figure:2)

Block-Boundary shapefile of the Fatehabad district was downloaded from https://mapcruzin.com/free-haryana-country-city-place-gis-shapefiles.htm. Sentinel-2 images for the 2016 pre-monsoon season were downloaded from the USGS (28 April 2016). Sentinel 2 images for the 2018 pre-monsoon season were downloaded from the

USGS (28 April 2018). Sentinel 2 images for the 2020 pre-monsoon season were downloaded from the USGS (27 April 2020). Sentinel 2 images for the 2022 pre-monsoon season were downloaded from USGS (17 April 2022). The survey was conducted to collect the primary data using a 'Garmin' GPS. Photographs, Data was collected from the fields. GIS and Remote Sensing Software were used for image processing and data analysis.

Mapping and Visualization:
Generate thematic maps illustrating the extent and severity of salt-affected land in Bhattu Kalan. Create visualizations that effectively communicate the results, including maps, graphs, and charts.

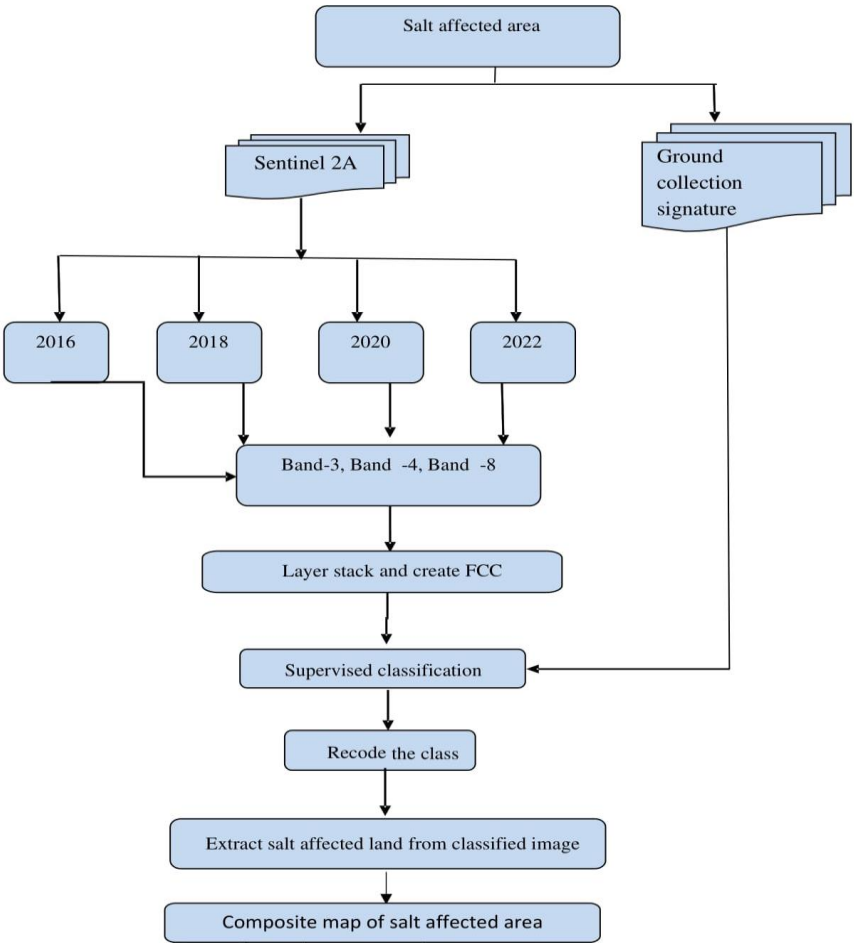


Figure-2: Flow Chart of Methodology used in Research.

Satellite	Launching date	Bands and Spatial Resolution	Data Year	Sensor	Revisit period
Sentinel-2	23 June 2015	B2, B3, B4-10M B5, B6, B7, B8A, B11 & B12-20M B1 &B10-60M	2016-2018-2020&2022 (April)	Optical sensor with near-infrared and shortwave infrared	5days

Table-1: Details of specification of satellite data

Sentinel 2 images have a resolution of 10 meters, were utilized to identify salt affected areas. Images were downloaded in multiple bands, ranging from blue to near-infrared. The various processes were applied on images such as Layer Stacking, and Sub-setting, and clipped to the Block boundary to create the final False Color Composite (FCC) image for mapping in Arc GIS 10.8. In Sentinel 2, FCC is a combination of three bands: band 3 (Green), band 4 (Red), and band 8 (Near-infrared). Tables:1 show the specification of sentinel-2 data.

Ground Truth: In addition to helping with the interpretation and analysis of what is being sensed, ground truth and the collection of ground-truth data on location enable remote sensing data to be calibrated.

Sites were chosen at various places for ground truth. To go to the required site, a location map was made. 'Garmin' GPS units were used to gather ground truth points. In the area damaged by the salt, photos were also taken. In order to validate the results for areas affected by salt using ground truth, the GPS points that were gathered were retrieved and used as a sample in ArcGIS. The areas of Bhattu Kalan damaged by salt are seen in below photographs at various locations.

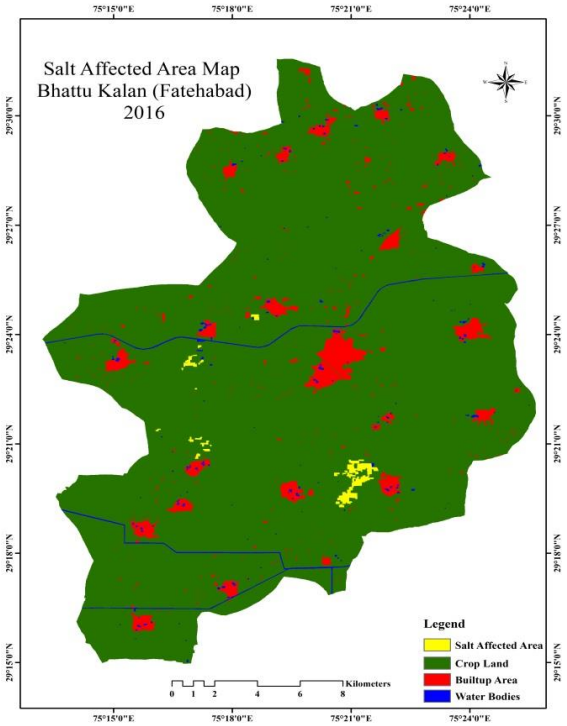
Some location of Salt affected land in Bhattu Kalan Block.

III. Result and Discussion:

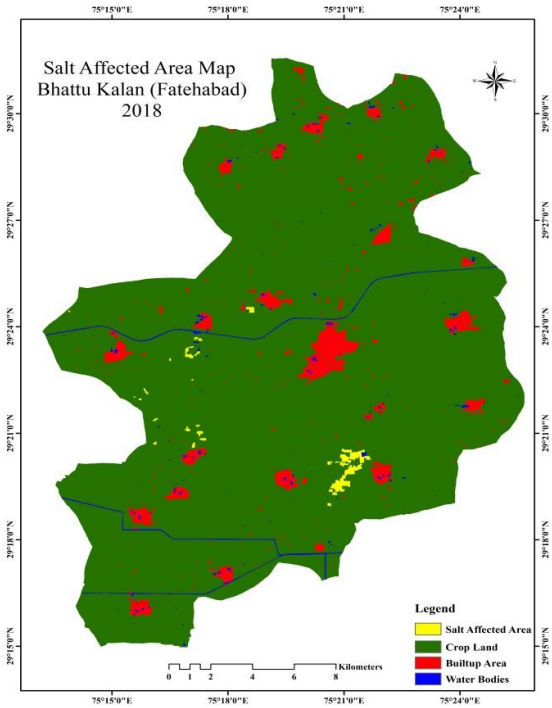
Bhattu Kalan is a block in Fatehabad district of Haryana. The total geographical area (TGA) of village is 4067 hectares. Bhattu block consists two types of soil i.e., Sierozem and Desert soils. The average annual rainfall in the district is 395.6 mm. In areas where inadequate natural drainage as well as in semiarid climates, there may chance a saline and sodic soils. Soils of this area have poor physical characteristics. It may due to their high levels of sodicity and pH. Maps shown below are representing the salt affected areas for the following years- 2016, 2018, 2020 and 2022 with spatial variation of Bhattu Kalan.

Table-2 Salt affected area of Bhattu block

S.No	Year	Area In Hectares (ha)	Percentage of the total area
1	2016	160.93	3.95
2	2018	152.21	3.74
3	2020	25.13	0.61
4	2022	45.75	1.12

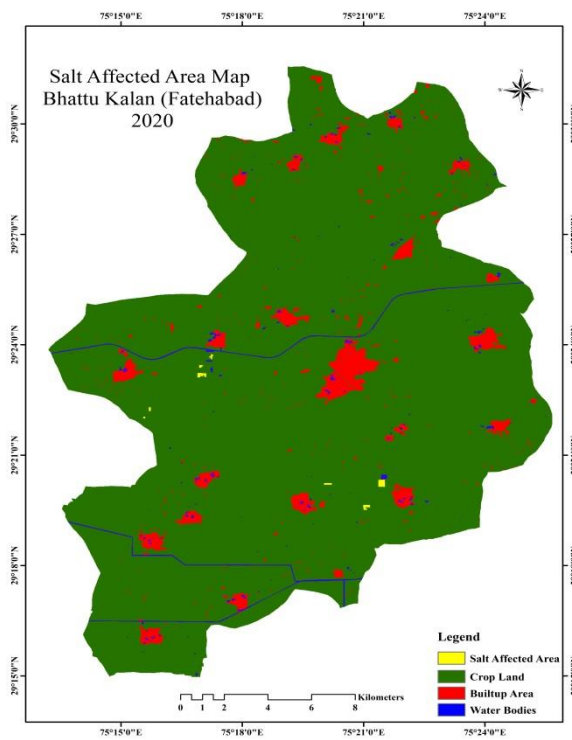


Map-1: Salt affected area in 2016

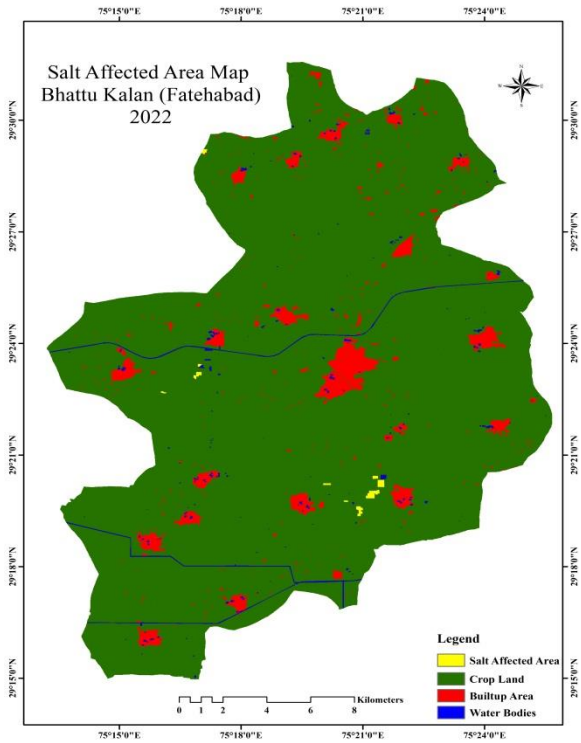


Map-2: Salt affected area in 2018

Map: 1 shows the salt affected area of Bhattu kallan in April 2016. It can be observed from Table-2 that total salt affected is 160.93 ha (3.95%). Map-1 shows more salt affected area in 2016, it may cause due to high water table from surface area.
Map: 2 show the salt affected area of Bhattu kallan in April 2018. It can be observed from Table-2 that the salt-affected areas were decreased to 152.21 ha (3.74%) as compared to 2016.



Map-3: Salt affected area in 2020



Map-4: Salt affected area in 2022

Map: 3 show the salt affected area of Bhattu Kalan in April 2020. It can be observed from Table-2 that the salt-affected areas were decreased to 25.13 ha (0.61%) as compared to 2016 or 2018. This year contains very less salt affected land (0.61%) as compares to the other.
Map: 4 show the salt affected area of Bhattu Kalan in April 2022. It can be observed from Table-2 that the salt-affected areas are 45.75 ha (1.12%). It can be seen from Fig 4.4 that the major area under salt affected is around south eastern part of Bhattu block. It may be increases due to excessive irrigation and poor drainage practices. It can also be observed from Map: 4 that other area, where salt affected area is present in western part of Bhattu block. Salt tolerant crops can grow in such area which improves quality of sand or prevent it by the salty layer.

IV. Conclusion and Suggestions:

Through the use of Geographic Information System (GIS) and Remote Sensing (RS) techniques, the assessment of salt-affected land in Bhattu Kalan, Fatehabad District, has yielded important insights into the extent, distribution, and characteristics of soil salinity in the area.
Following a thorough examination, a number of important findings have been identified:
Extent and Severity of Soil Salinity: The geographical distribution of salt-affected fields in Bhattu Kalan was shown by the RS and GIS-based assessment, which also highlighted areas with changing salinity levels. A more sophisticated knowledge of the varying degrees of severity throughout the region is provided by the division of salt-affected zones into mild, moderate, and severe categories.
Finding Hotspots: Within Bhattu Kalan, the study pinpointed several hotspots, or concentrated locations with excessive soil salinity. These concentrated regions of extreme salinity serve as important hubs for focused management and intervention techniques.
The temporal dynamics of soil salinity were analyzed through the use of modeling approaches and multi-temporal data analysis. This analysis revealed probable tendencies in the growth or mitigation of regions impacted by salinity throughout time. This knowledge is essential for anticipating changes in the future and taking preventative action.

Validation and Accuracy: The robustness of the assessment's conclusions was ensured by ground-truthing exercises and validation using field data, which verified the accuracy and dependability of the information produced from RS and GIS.

Management Implications: To lessen the negative effects of soil salinity on agricultural productivity in Bhattu Kalan, targeted soil reclamation or amelioration techniques, precision agriculture methods, and land-use planning are all based on the findings.

Suggestions for Future Work: The study's findings open the door to particular suggestions for sustainable land management, such as methods for precision irrigation, plans for adding soil amendments, and crop diversification to increase resistance to soil salinity.

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