e-ISSN 2320 –7876 www.ijfans.org
Vol.11, Iss.11, Nov.2022
Research Paper UGC CARE Listed (Group -I) Journal

SOIL SALINITY ASSESSMENT AND MAPPING USING REMOTE SENSING AND GIS TECHNIQUES IN THE LOWER PART OF MULA-MUTHA RIVER BASIN, WESTERN MAHARASHTRA, INDIA.

Dr. Praveen Kamble[1] Prof. (Dr.) Sunil Gaikwad[2] Dr. Madhuri Gulave[3] Dr. Satyajit Gaikwad[4] Dr. Gajanan Dhobale[5]

[1] Assistant Professor, Dr. Babasaheb Ambedkar and M.V.R. Shinde College, Pune
[2]S.P. College, Pune
[3]Dada Patil College, Karjat, Ahmednagar
[4]Department of Geology, Savitribai Phule Pune University
[5]Arts, Science and Commerce College, Indapur
Email-praveennkamble@gmail.com,

Abstract: Soil salinity is a global problem. Soil salinization badly affects agricultural lands. It is negatively affecting plant growth, crop yields due to over-irrigation, monoculture of sugarcane, using polluted water of the river leading the further land degradation. It is also a major concern in the lower Mula-Mutha River basin in western Maharashtra, where the climate is arid and semi-arid. The objectives of this study were to estimate the salt affected area and delineate mapping variations in the study area using RS data. Traditional soil salinity assessments have been done by collecting soil samples and laboratory analyzing of collected samples for determining soil pH and electroconductivity (EC). Geographical Informatics Systems (GIS) and Remote Sensing (RS) technologies are used to provide more efficient, economic, and rapid tools and techniques for soil salinity assessment and soil salinity mapping. Using Landsat-8 OLI/TIRS satellite images, Soil Adjusted Vegetation Index (SAVI) and Normalized Difference Salinity Index (NDSI) are studied for finding out the soil saline area ofthe basin. It is found that more than 65% of the soil in the study area is moderate to highly saline as per SAVI while more than 50% area is covered by moderately to highly saline areas according to NDSI. The results support that geoinformatics techniques using RS data and technologies constitute an effective tool for detecting soil salinity by modeling and mapping the spatial distribution of saline soils. Use of gypsum, no use of polluted river water for agriculture, and avoid of over-irrigation are suggested to reduce the soil salinity problem in the lower Mula-Mutha River basin. Similar methodology can be used for the evaluation and mapping of soil salinity-affected areas in the arid and semi-arid parts of India.
Keywords: Soil salinity, land degradation, Remote Sensing, GIS, Salinity Index, Satelliteimage, Landsat-

Introduction

In recent times, the problem of land degradation has been increasing in many arid and semi – arid regions due to soil salinization. Soil salinization is the process of salts accumulation in the soil surface and in the root zone which causes harmful effects on plants and soil; it follows a decrease in yields, ultimately, soil sterilization. It reduces the area of farmland land 1 to 2% per year and continues to increase. Richards (1954), classified salt affected soils on the basis of its physical and chemical properties in three types: saline soils, saline alkaline soils and sodic soils. In the present study an effort has been made to delineate the salt affected area occurring in the lower Mula-Mutha river basin and suggesting some reclamation methods withthe help of geographic information system and remote sensing data. Soil salinity mapping is also done by calculating salinity indices like NDSI (Normalized Difference Salinity Index) and SAVI (Soil Adjusted Vegetation Index) are used for mapping soil salinity in the study area. Physicochemical parameters of soil like pH, EC, various cations and anions are also studied. Integration of remote sensing and geographic information system techniques helps in achievingbetter and fast results related to salt affected soils and its reclamation methods for effective useof agricultural land.

Study area

For the present research work, lower Mula-Mutha River basin is selected as the study area which comprises some part of Daund tehsil and some part of Haveli tehsil. Gandharv and Sangam Bridge is the area where Mula and Mutha rivers are joined together. Daund tehsil lies on the east side of Pune district and Haveli tehsil lies on the west side of Pune district. The latitudinal extent of the study area is 18◦24’19.21” N to 18◦36’40.03” N and longitudinal extent is from 73◦54’04.07” E to 74◦20’49.41” E. The study area covers about 756.44 sq.km total geographical area. Sugarcane is a major irrigated crop in the study area, where due to its intensive cultivation, water logging and soil salinization problems have engraved. The study area is known as sugarcane belt of eastern Pune.

Objectives of the study

a) To delineate the salt affected area and mapping of the same in the study area.
b) To suggest techniques and methods to minimise soil salinity.

Database and methodology

For the present research work the data has been collected from primary and secondary sources.The research work includes field survey to the study area for the collection of soil sample pointsusing GPS instruments and also for cross verification of image analysis (land use pattern).

Secondary data includes collection of data related to soil chemical properties of representative soil samples from the study area from soil analysis laboratory. It also includes collection of various toposheets and satellite image. Toposheets were obtained from Survey ofIndia (SOI) at a scale of 1:50,000. LANDSAT satellite image has been downloaded from USGS website. Every sample location has been traced by using Garmin, Montana 650 GPS instrument.

Scanning, geo-referencing and digitizing of toposheets is included in pre-processing step. Normalised Difference Salinity Index (NDSI) and Soil Adjusted Vegetation Index (SAVI)soil salinity indices used for better result of soil salinity.

Results and discussion

In the present research work NDSI and SAVI salinity indices have been calculated for detecting the salt affected soils and preparing salinity maps using LANDSAT 8 satellite image. While calculating the indices water class has not been included because water bodies are constant inall the indices maps.

Soil Adjusted Vegetation Index (SAVI)

SAVI is used to correct NDVI which is influenced by the soil brightness in areas wherevegetation cover is low. It is the ratio between the red and near infra-red values accompanied by (L) as a soil brightness correction factor having value of 0.5 to accommodate most land cover types. SAVI is calculated by using the following formula;

$$SAVI = ((NIR – R) / (NIR + R + L)) * (1 + L)$$

Where, NIR = reflectance value of near infrared band of Landsat 8 image R = reflectance value of red band of Landsat 8 image

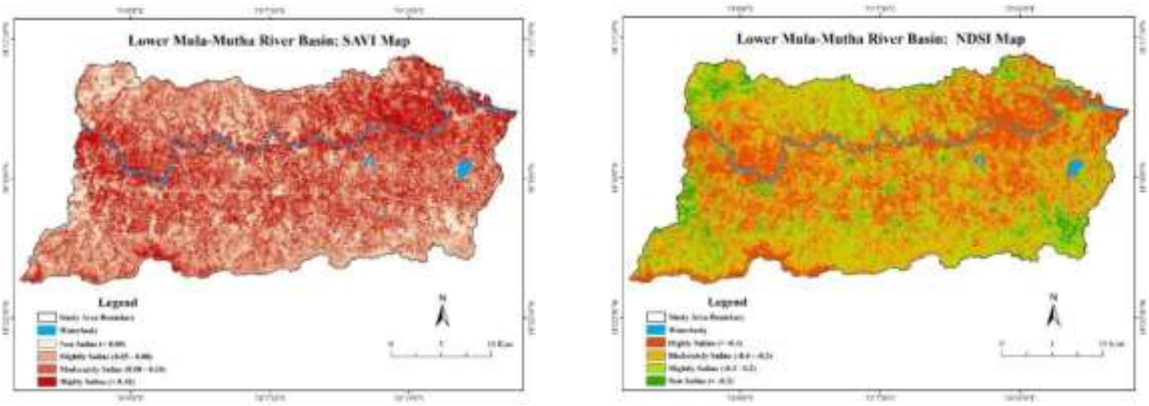
L = correction factor for soil brightness

It is observed that the salinity classes according to SAVI is divided into four categories including waterbody. The values of SAVI range from <0.05 to >0.10. The total area occupiedby moderately saline class is 35.11%. highly saline class has 30.24% area occupied which is mostly observed on both sides of the river in the east region.

In saline soils halophytic plants are capable of growing as they are adapted to high soilsalinity. To map and estimate soil salinity, halophytic plants can be used as an indirect indicator. To map and detect soil salinity, spectral reflectance of halophytic plants is considered in areas where salinity is high. SAVI helps in separating the spectral reflectance of soil and vegetation.

Table.1: Area under different salinity classes according SAVI

Sr. No.	Class	Area (sq.km)	Area (%)
1	> 0.10 (Highly Saline)	228.59	30.24
2	0.08 - 0.10 (Moderately Saline)	265.70	35.11
2	0.05 - 0.08 (Slightly Saline)	206.05	27.24
4	< 0.05 (Non-Saline Land)	40.24	5.32
5	Waterbody	15.86	2.09
Total		756.44	100



Source: Landsat 8 Satellite Image 2017

Normalized Difference Salinity Index

To assess the soil salinity NDSI considers red and near infrared band. The brightness values in white encrustation can be considered as salt encrusted land. NDSI is calculated usingthe following formula;

NDSI = (R – NIR) / (R + NIR)

Where, NIR = reflectance value of near infrared band of Landsat 8 image R = reflectance value of red band of Landsat 8 image

The classified image of NDSI is divided into 5 categories including waterbody. The analysis of NDSI (Table 2) shows that the area under slightly saline class is 31.37%, moderatelysaline class has 2.49% area and highly saline class has 21.86% area. The NDSI classes range from less than -0.40 (highly saline) to more than -0.20 (non- saline land).

It is observed that major part of the study area is covered by slightly saline land whichis seen spread in the lower part of the study area and some part on the north-west region. Highlysaline land is found on the north-east side and some part on the both sides of the river.

Table. 2: Area under different salinity classes according NDSI

Sr. No.	Class	Area (sq.km)	Area (%)
1	< -0.40 (Highly Saline)	165.38	21.86
2	(- 0.40 - -0.30) (Moderately Saline)	223.09	29.49
3	(-0.30 - -0.20) (Slightly Saline)	237.2	31.37
4	> -0.20 (Non-Saline Land)	114.91	15.19
5	Waterbody	15.86	2.09
	Total	756.44	100

High salinity is reported in the northern side of river while low salinity regions are in the south of the canals. In the eastern part of the study area, high salinity zones included villageslike Valki, Pimpalgaon, Delvadi, where dominated cash crop is sugarcane. In that region, polluted river water is directly used for agriculture. In the western part of the study area villageslike peri urban areas like Manjri Kh, Kolvadi, Manjri Bk, Kadamwak wasti, Fursungi, Uruli Devachi are also falling in high salinity zone. In addition, sewage water and leachate water from the solid waste dumping site accumulated in dug wells is also used for irrigation, which enhances the salinity of the soil many folds.

The third high salinity zones include villages like Khamgaon, Tambewadi, Dahitane, Kamatwadi where over irrigation using polluted Mula Mutha river is rampant. The fourth high salinity zones include Kunjirwadi, Naigaon, Uruli Kanchan, Loni Kalbhor are located adjoining to canals carrying water came from Mundhwa Jackwells. The polluted water of thiscanals is used for irrigation.

In some part of study area, flowing canal is located at higher elevation as compared to adjoining agricultural fields where water seeped from canal accumulate and this stagnant wateralso increasing the salinity of the soil.

High salinity in patches at many locations is due to the local source of pollution. So, High salinity of soil in the study area is due to over irrigation using polluted river water and extensive use of fertilisers. The semi-arid climatic condition and climate changes are also playing important role in it.

Conclusions

It seems, over irrigation is the main cause of soil salinization therefore; there is no substitute for drip irrigation. This will ultimately help in increasing of productivity of land. There should be a monitoring of the factory on quality of soils. Soil surveys and soil mapping should be undertaken every year to suggest the remedial measures to protect the saline lands. Bio fertilizers also increased the fertility of soils; farmers should be used of them for the crops,and reduce the use of chemical fertilizers.

Mapping and monitoring affected soils are a difficult study because salinization is a dynamic process. Yet, this study was conducted with the aim to assess the soil salinity area andmapping of the lower part of Mula-Mutha river basin. Thus, this approach can be used by decision-makers to develop effective programmes to reduce or prevent future increases in soilsalinity.

References

1. Abbas, A., and Khan, S. (2007) - Using remote sensing techniques for appraisal ofirrigated soil salinity. In International Congress on Modelling and Simulation. (MODSIM 2007).Modelling and Simulation Society of Australia and New Zealand, pp. 2632 - 2638.
2. Abbas, A., Khan, S., Hussain, N., Hanjra, M., and Akbar, S. (2013) – Characterizing soil salinity in irrigated agriculture using a remote sensing approach. Physics and Chemistry of the Earth, Parts A/B/C, Vol. 55, pp 43 - 52.
3. Gupta, S. (2010) - Management of alkali water. Central Soil Salinity Research Institute, KarnalIndia, Technical Bulletin, Vol. 1, pp 62.
4. Gurung, T., and Azad, A. (2013) - Best practices and procedures of saline soil reclamation systems in SAARC countries. SAARC Agriculture Centre, pp 40 - 104.
5. Huete, A. (1988) - A soil-adjusted vegetation index (SAVI). Remote sensing of environment, Vol. 25, pp 295 - 309.
6. Mandal, A., and Sharma, R. (2013) - Mapping and Characterization of Waterlogged and Salt affected Soils in Loonkaransar area of Indira Gandhi Nahar Pariyojona for Reclamation and Management. Journal of the Indian Society of Soil Science, Vol. 61, pp 29 - 33.
7. Singh, G., Bundela, D., Sethi, M., Lal, K., and Kamra, S. (2010) - Remote sensing and geographic information system for appraisal of salt-affected soils in India. Journal of environmental quality, Vol. 39, pp 5 - 15.