SEMINAR REPORT

Characterization and management of saline soils using remote sensing

By

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DECLARATION

I, Neha Unni (2018-11-048) hereby declare that the seminar report titled 'Characterization and management of saline soils using remote sensing' has been completed by me independently after going through the reference cited here and I haven't copied from any of the fellow students or previous seminar reports.

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25/01/2020 (2018-11-048)

CERTIFICATE

Certified that the seminar report entitled 'Characterization and management of saline soils using remote sensing' is a record of seminar presented by Neha Unni (2018-11-048) on 15/11/2019 and is submitted for the partial fulfilment of the course SOILS 591.

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1.Introduction

Salt affected soils are designated as problem soils. They are unproductive unless salts are reduced or removed. These soils occur more extensively in arid climates, but these soils are also found in coastal areas where soils are inundated by ocean or sea water. Soils are said to be saline if they contain an excess of soluble salts, and sodic or alkaline if they contain excess of sodium. Soluble salt contamination of soil has caused problems for all of recorded history, especially in arid regions. These effects of salt devastation are apparent in many areas and are increasingly prevalent and serious as land use intensifies and water supplies become more limited and increasingly polluted with soluble salts. Modern population densities make it imperative to use salt affected land using appropriative management and to avoid further salt damage to lands now in use.

Land degradation due to the presence of salt in soils is one of the major problems around the world. It is not only environmental hazard, but also an economy hazard for any country. Salt affects the crop productivity, soil and water quality. These soils with high concentration of soluble salts affect plant growth and its development due to osmotic effect as it interferes with plants ability to extract water from soil. So the plants grown in these soils often appear drought stressed even when adequate water is available. Salt-affected areas can be found in all the continents and under almost all climatic conditions, but the distribution is extensive in arid or semi-arid regions compared with humid regions. Salt accumulates when the loss of salt via leaching is less than the addition of salt through rainfall or irrigation, or as a result of a rise of saline groundwater. The global extent of primary salt affected soils is about 955 million (m) ha, while secondary salinization affects 77 m ha, with 58% of these in irrigated areas (Metternicht and Zinck, 2003). Traditional methods for mapping of salt affected soils include ground-based geophysics and laboratory analyses which are labour intensive, and time-consuming. Ghabour and Daels (1993) suggested that detection of soil degradation including salt-affected areas by conventional means of soil surveying requires a great deal of time, but remote sensing data and techniques offer the possibility for mapping and monitoring these processes more efficiently and economically.

2.Soil salinity

Soil salinity is a measure of the concentration of all the soluble salts in soil water, and is usually expressed as electrical conductivity (EC). The major soluble mineral salts are the cations: sodium (Na^+), calcium (Ca^{2+}), magnesium (Mg^{2+}), potassium (K^+) and the anions:

chloride (Cl^-), sulfate (SO_4^{2-}), bicarbonate (HCO_3^-), carbonate (CO_3^{2-}), and nitrate (NO_3^-). Hyper-saline soil water may also contain boron (B), selenium (Se), strontium (Sr), lithium (Li), silicon (Si), rubidium (Rb), fluorine (F), molybdenum (Mo), manganese (Mn), barium (Ba), and aluminum (Al), some of which can be toxic to plants and animals (Tanji 1990). From the point of view of defining saline soils, when the electrical conductivity of a soil extract from a saturated paste (ECe) equals, or exceeds 4 deci siemens per meter (dS m^{-1}) at 25 °C, the soil is said to be saline (USSL Staff 1954).

3.Causes of soil salinity

There can be many causes of salts in soils; the most common sources are listed below: Inherent soil salinity (weathering of rocks, parent material), brackish and saline irrigation water , sea water intrusion into coastal lands as well as into the aquifer due to over extraction and overuse of fresh water, restricted drainage and a rising water-table, surface evaporation and plant transpiration, sea water sprays, condensed vapours which fall onto the soil as rainfall, wind borne salts yielding saline fields, overuse of fertilizers (chemical and farm manures), use of soil amendments (lime and gypsum), use of sewage sludge and/or treated sewage effluent and dumping of industrial brine onto the soil.

4.Classification of salt-affected soils

The US Salinity Laboratory Staff (1954) suggests three classes of salt-affected soils: saline, sodic and saline-sodic soils.

I. Saline Soils: Saline soils have electrical conductivity of saturation paste (ECe) greater than 4 dS m^{-1} and Sodium Adsorption ratio (SAR) less than 13 (or Exchangeable Sodium Percentage (ESP) less than 15). Salinity is measured in units of (EC) using a range of soil/water ratios (1:1, 1:2 or 1:5) and saturated paste of soil (ECe). There are two forms of salinity:

(a) Primary Salinity caused by soluble salts originating from the weathering of primary minerals, aeolian recycling or cyclic accession, where salts are transported inland by winds off the ocean.

(b) Secondary salinity results from human activities such as irrigation and land clearing in areas that are not irrigated (dryland salinity) which causes a change in the salt and water balance.

II. Sodic soils: These soils typically have low ECe (< 4 dS m^{-1}), high sodium adsorption ratio (SAR>13) or exchangeable sodium percentage (ESP>15) and high pH values (>8.5). These soils are very hard when dry, sticky when wet and nearly impervious to roots, water, and air (Qadir and Schubert, 2002). Sodic soils have high concentration of sodium in relation to calcium and magnesium which causes the soil to become dispersed, and destroys the soil structure. As sodic soils dry out, they become very hard and the decrease of macropores and pore connectivity reduces the capacity of roots to penetrate the soil.

III. Saline- sodic soils: These soils have an ECe greater than 4 dS m^{-1} and SAR greater than 13 (or ESP>15) but their pH is less than 8.5. In general, these soils have good soil structure and water movement through the soil profile is adequate. They can have the characteristics of either a saline or a sodic soil, depending on whether sodium or calcium dominates.

5.Damage caused by soil salinity

Some of the damages caused by increasing the soil salinity (Shahid 2013) are listed below: Loss of biodiversity and ecosystem disruption, declines in crop yields, abandonment or desertification of previously productive farm land, increasing numbers of dead and dying plants, increased risk of soil erosion due to loss of vegetation, contamination of drinking water, roads and building foundations are weakened by an accumulation of salts within the natural soil structure, lower soil biological activity due to rising saline water table.

6.Delineation of saline soils

1. Field assessment

Visual assessment of salinity only provides a qualitative indication; it does not give a quantitative measure of the level of soil salinity. That is only possible through EC measurement of the soil. In the field, collection of soil saturation extract from soil paste is not possible. Therefore, an alternate procedure is used, e.g. a soil:water suspension (1:1, 1:2.5, 1:5) for field salinity assessments.

2. Laboratory methods

The soil salinity measurements made using geo-referenced (using GPS) field sampling and laboratory analysis of extracts from saturated soil paste by an EC meter are accepted as the standard way of assessing soil salinity. The amount of water that a soil holds at saturation is related to soil texture, surface area, clay content, and cation exchange capacity. The lower soil:water ratios (1:1, 1:2.5, 1:5) are also used in many laboratories, though the results require calibration with ECe if they are going to be used to select salt tolerant crops.

3. Salinity Probe

An activity meter with a salinity probe is very convenient and gives instant apparent electrical conductivity (ECa) information, which is expressed in mS cm^{-1} and g l^{-1}. There are many models of equipment available to measure in-situ salinity. One is the German-made PNT3000 COMBI + model; it is commonly used in agriculture, horticulture and on landscape sites for rapid salinity assessment and monitoring. It provides an extended EC measuring range from 0 to 20 mS cm^{-1} and from 20 to 200 mS cm^{-1}. The unit includes a 250 mm long stainless steel electrode for direct soil salinity measurements; an EC-plastic probe with platinum plated ring sensors methods which can be used quickly and effectively in field salinity mapping, e.g. electromagnetic induction (EMI) using the EM38. EM38 is the most commonly used instrument in agricultural surveys, and gives a rapid assessment of the soil's apparent electrical conductivity (ECa), expressed in mS m^{-1}. The EM38 has a transmitter coil and a receiving coil. The transmitter coil induces an electrical current into the soil and the receiving coil records the resultant electromagnetic field. The EM38 allows for a maximum of 150 cm or 75 cm depth of exploration in the vertical and horizontal dipole modes, respectively. EC mapping using EMI is one of the simplest and least expensive salinity measurement tools. Integration of GIS information with salinity data yields salinity maps which can help farmers interpret crop yield variations, and provide a better understanding of the subtle salinity differences across agricultural fields. These salinity maps may allow farmers to develop more precise management zones and ultimately obtain higher yields.

4. Salinity Sensors and Data Logger

The most modern salinity data logging system is the Real Time Dynamic Automated Salinity Logging System (RTASLS). Here, ceramic salinity sensors are buried in the root-zone, each sensor being fitted with an external smart interface with a resolution of 16 Bits. This interface consists of an integrated microprocessor which contains all the required information to allow for autonomous operation of the sensor, including power requirements and logging interval. The smart interface is connected to a DataBus which leads to the Smart Data Logger which automatically identifies each of the salinity sensors and begins logging them at predetermined intervals. Instantaneous readings from sensors can be viewed in the field on the data logger's display. Data can also be accessed in the field with a memory stick or remotely using a smart mobile phone. Due to technology advancements, there are diversified sensors available. Such a real time data logging system has been installed in the grass plots at the experimental station of ICBA, Dubai (Shahid *et al*. 2008). A useful feature of the salinity data logging system is that it does not require knowledge of electronics or computer programing. For custom configuring the Smart Data Logger or the salinity sensors, a simple menu system can be accessed through HyperTerminal. This provides complete control over each individual sensor's setup. Data from the Smart Data Logger can be graphed using Excel.

5. Electromagnetic Induction

Salinity assessment and management at the farm level must help the farmers to improve crop productivity. The conventional field sampling followed by laboratory analysis is a tedious, expensive and time consuming process. There are other modern methods which can be used quickly and effectively in field salinity mapping, e.g. electromagnetic induction (EMI) using the EM38. EM38 is the most commonly used instrument in agricultural surveys, and gives a rapid assessment of the soil's apparent electrical conductivity (ECa), expressed in mS m^{-1}.

6. Remote Sensing

Remote sensing is the science and art of obtaining information about an object through the analysis of data acquired by a device that is not in contact with the object (Lillesand and Keifer, 1994).

The term "remote sensing" was first used in the United States in the 1950s by Ms. Evelyn Pruitt of the U.S. Office of Naval Research. Father of remote sensing in India: Pisharoth Rama Pisharoty (1909 –2002) a physicist and meteorologist. It is the acquisition of information about an object or phenomenon without making physical contact with the object and thus in contrast to on-site observation, especially the earth. As the source emits the radiation it travels through the atmosphere and interacts with the target depending on the properties of both the target and the radiation. After the energy has been scattered by, or emitted from the target, the sensor collect and record the electromagnetic radiation . The energy recorded by the sensor has to be transmitted, often in electronic form, to a receiving and processing station where the data are processed into an image.

7.Principle of RS

- Interaction with matter:
  - Transmission
  - Absorption
  - Emission
  - Scattering
  - Reflection
- Detection and record of changes in EMR by magnitude, direction, wavelength and polarization

8.Processes in remote sensing

A. Emission of EMR
B. Transmission of energy from source to object
C. Interaction with object and subsequent reflection
D. Transmission of energy from object to sensor and record
E. Transmission of recorded information to ground based system
F. Processing and analysis
G. Application

9.Sensors

Sensors are the mechanical devices which collect information about objects or scenes from a distance. eg: LISS, MSS, TM

Main characteristics of sensors are the resolution. Resolution is the ability of the sensor to record the smallest change that can be detected in the quantity that is measuring.

There are four types of sensors : Spatial resolution, spectral resolution, radiometric resolution, temporal resolution.

Spatial resolution- It refers to the size of the smallest possible object that can be detected. It depends on the Instantaneous Field Of View (IFOV) and the height of the satellite orbit. It tells the pixel size on the ground surface

Spectral resolution- It describes the ability of a sensor to define fine wavelength ranges and the width and number of spectral intervals in the electromagnetic spectrum to which a remote sensing instrument is sensitive. It is determined by the number of spectral bands, spectral response function of each band and full-width at half-maximum (FWHM).

Radiometric Resolution- It is number of digital levels that a sensor can use to express variability of brightness within the data and it determines the information content of the image. It describes the ability of sensor to discriminate very slight differences in energy.

Temporal Resolution- It is the frequency of data acquisition over an area and it depends on the orbital parameters of the satellite, latitude of the target, swath width of the sensor and pointing ability of the sensor.

10.Spectral reflectance of soil

In order to interpret the satellite imagery it is necessary to have knowledge about the reflectance properties of different objects present on earth surface. Typical ground scene consists of various forms of soil, water and vegetation. Spectral reflection curve is a graph of spectral reflectance as a function of wavelength. It depends on soil colour, mineral content, organic matter, particle size, soil texture, soil structure and roughness.

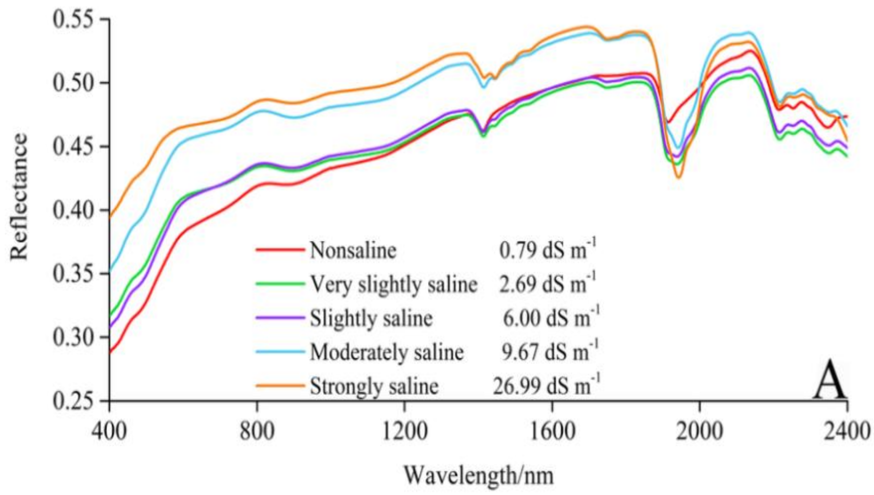

Fig. 1. Spectral reflectance of soil

11.Methods of remote sensing used for soil salinity assessment

Aerial photographs, visible near infrared remote sensing, multispectral remote sensing, hyperspectral remote sensing and radar microwave remote sensing

11.1 Aerial photographs

Aerial photographs are acquired using a camera mounted on aircrafts. The photos taken in high altitude covers more area but fewer details. Low altitude gives more details. High resolution synoptic view clarity and ease of interpretation made aerial photographs very useful for natural resources appraisal. Factors affecting quality of photographs include atmospheric interference, photo films, filters in camera, air craft flying, tilt and drift. Surface salt crusts are easily detected. It is the earliest method of remote sensing.

11.2 Visible near infrared remote sensing

This method makes use of visible, near infrared sensors in the range of 0.4 – 3.0 μm eg. CMOS. Most commonly used in saline soil assessment.

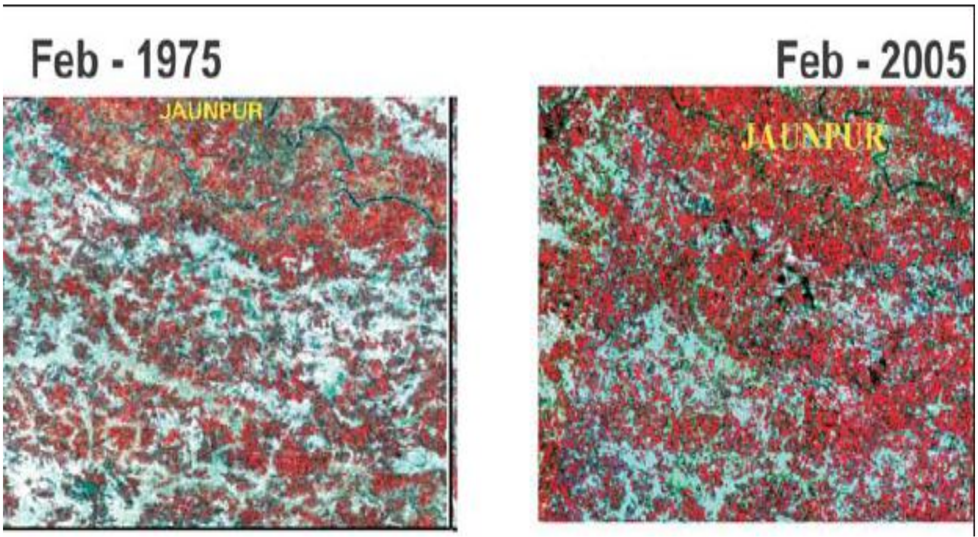

Plate 2. Visible near infrared remote sensing

11.3 Multispectral remote sensing

Multispectral imagery is produced by sensors that measure reflected energy within several specific sections (also called bands) of the electromagnetic spectrum. Multispectral sensors usually have different band measurements between 3 and 10 in each pixel of the images they produce. Examples of bands in these sensors typically include visible green, visible red, near infrared, etc. Landsat, Quickbird, and Spot satellites are well-known satellite sensors that use multispectral sensors.

11.4 Hyperspectral remote sensing

Hyperspectal sensors that measure reflected energy in many narrow contiguous spectral bands, involves breaking a broad band from the visible and infra-red into hundreds of spectral parts. Hyperspectral data sets are generally composed of about 100 to 200 spectral bands of relatively narrow bandwidths each of 10- 20 nm. Hyperspectral sensors measure energy in narrower and more numerous bands than multispectral sensors. Hyperspectral images can contain as many as 200 (or more) contiguous spectral bands. The numerous narrow bands of hyperspectral sensors provide a continuous spectral measurement across the entire electromagnetic spectrum and therefore are more sensitive to subtle variations in reflected energy. Images produced from hyperspectral sensors contain much more data than images from multispectral sensors and have a greater potential to detect differences among land and water features. For example, multispectral imagery can be used to map forested areas, while hyperspectral imagery can be used to map tree species within the forest.

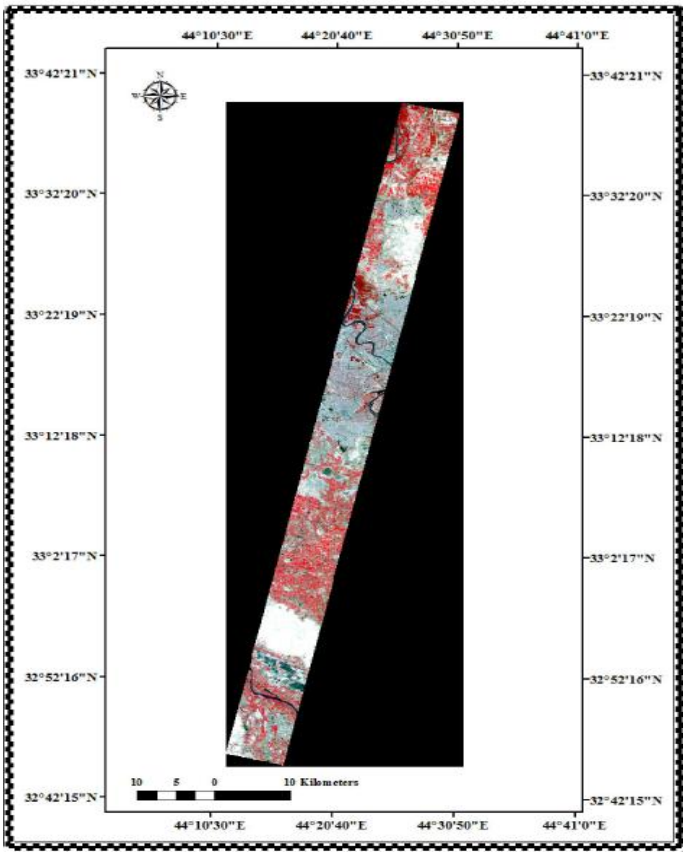

Plate 3. Hyperspectral remote sensing

11.5 Radar and microwave remote sensing

Being an active sensor it can be used to image the surface at any time, day or night. It has the capability of the radiation to penetrate through cloud cover and most weather conditions, day/night and all weather conditions. Microwave region is 1mm - 1cm. eg. SAR

12. Desertification and land degradation atlas of India

Land degradation due to salinity is a major problem. ISRO monitors desertification of entire country using remote sensing. Based on this study they have prepared state wise desertification and land degradation status atlas. These outputs are helpful in prioritising areas to be taken up for minimising impact of desertification and land degradation.

13.Wasteland atlas of India

National Remote Sensing Centre and Ministry of Rural Development developed waste land atlas as a part of the "National Wasteland Monitoring Project". In this atlas saline soil are included as one of the class of wasteland.

14.Case studies:

14.1Mapping of waterlogged areas and salt affected soils in the IGNP command area

Indira Gandhi Canal Project was introduced in northwest (NW) part of Rajasthan to fulfil the demand for food production against the increasing population growth. Although irrigation enhanced considerable food production, it also brought problems such as waterlogging and secondary salinisation. The IRS-LISS II imageries were used for the identification of the waterlogged areas and salt affected soils and soil samples were characterized from the area. Visual interpretation of data was done, in which dark blue indicates the stagnant ponded water, yellowish white patch around waterlogging indicates the surface salt efflorescence, greyish red with red mottling indicates the saline profile with patchy crop, light grey to dark grey indicates the high water table, red to dark red indicates the healthy vegetation.By this study they have concluded that 11% of total area are saline, and grouped into 5 classes of salinity and 25% of total area is under potential waterlogging. (Mandal and Sharma, 2001).

Plate 4. Visible near infrared image

14.2 Mapping and characterization of salt affected soils for reclamation and management: A case study from the transgangetic plain of India

The use of poor quality groundwater for irrigation increased salt build up in soil profiles, which caused reduced productivity. Canal irrigation in undrained areas has also accentuated waterlogging, formation of high water table and secondary salinization in soils of that area. The study area was selected is Kaithal district of Haryana under the old alluvial plains. It consists of two administrative sub-divisions viz, Kaithal and Guhla and six blocks viz, Kaithal, Pundri, Rajaund, Guhla, Kalayat and Siwan. Indian Remote Sensing (IRS) (Resourcesat) LISS III data and The Survey of India Topographical Maps on 1:50,000 scale were utilised for the study. Soil samples, ground water samples and soil profile samples were collected. Visual interpretation of data was done. Grey to yellowish white colour indicates the salt crust, greyish red with red mottling indicates the patchy crop stand, dark blue indicates waterlogging. Along with this Normalised difference vegetation index and Vegetation index were used to distinguish between healthy and stressed crops. Sodic soils were found in northern and central parts of Kaithal district and saline soils accumulated in the southern part of Kaithal district. Total area of 26301 ha (11.3 %) were found to be salt affected, out of which sodic soil constitutes 17570 ha (7.3 %) and saline soil is 9388 ha (4 %) (Mandal *et al*., 2010).

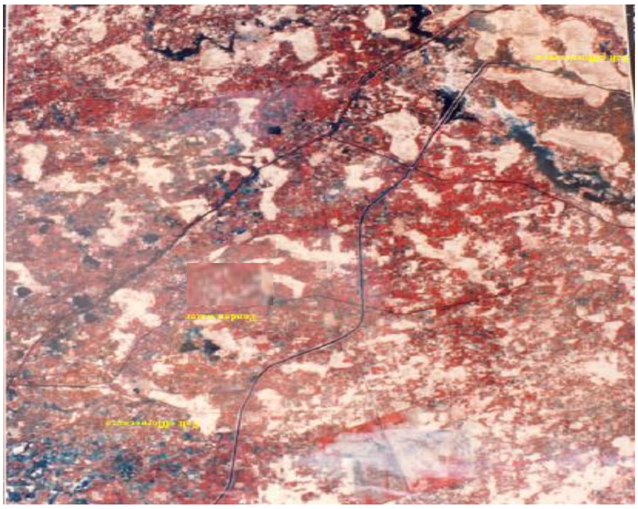

Plate 5. Visible near infrared image

14.3 Hyperspectral remote sensing data derived spectral indices in characterizing salt-affected soils: a case study of Indo-Gangetic plains of India

Hyperspectral remote sensing (Hyperion EO-1) data has emerged as most promising tool in quantifying severity of salt-affected soils. The study deals with identifying sensitive spectral bands for salinity parameters and thereafter used to compute spectral indices viz. Salinity index (SI), Brightness index (BI), Normalized Differential Salinity Index (NDSI), Combined Spectral Response Index (COSRI) and Coloration index (CI). Six sensitive hyperspectral bands (Band 9, 20, 22, 28, 29 and 46) of Hyperion-1 satellite data were identified to generate the spectral indices. The relationship between these spectral indices and salinity parameters of electrical conductivity (EC), sodium adsorption ratio (SAR) and exchangeable sodium percentage (ESP) were established to generate maps showing severity of salt-affected soils of the area. The severity maps were categorized into classes of normal, slight, moderate and highly showing the spatial distribution of severity of salt affected soils. Among these spectral indices, SI showed highest correlation coefficient (r^2) with the parameters of ECe (r2 = 0.777), SAR (r^2 = 0.801) and ESP (r^2 = 0.804) followed by BI, COSRI and CI (Kumar *et al*., 2015).

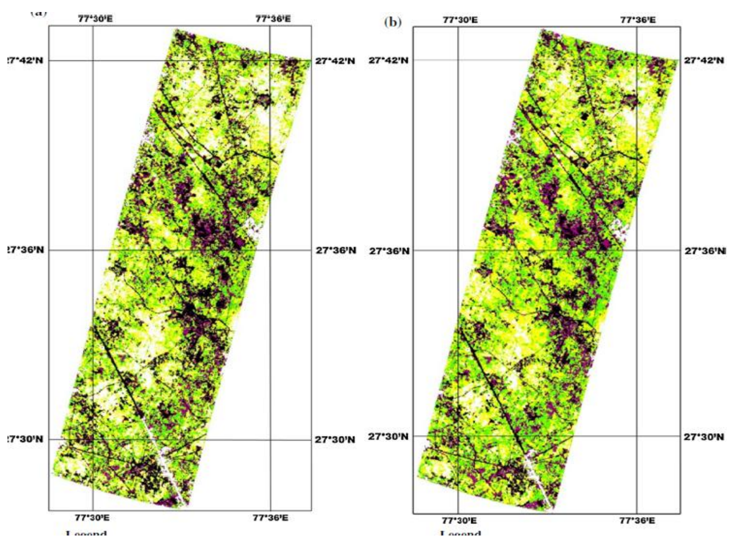

Plate 6. Hyperspectral image

14.4 Soil salinity characterization using hyper-spectral remote sensing data

The complexity of salinization processes, spatial and temporal variability caused soil salinity mapping a difficult proposition. Severely salt affected soils (SAS) can be easily detected due to high reflectance from salt crust on soil surface, whereas, detection of low and medium SAS is difficult due to intricate association of salt, soil, water and vegetation. An attempt is made to characterize such SAS using hyper-spectral remote sensing data. A methodology was developed at CSSRI Karnal integrating hyper-spectral (HRS) data with limited ground truth and further quantifying through a statistical model. The variability of salinity and sodicity attributes such as EC, Na^+, Cl^-, CO_3^{2-} and HCO_3 of the saturated soil extract were related quantitatively (r^2=>90%) by hyper-spectral data (Barman *et al*., 2017).

15.Advantages of remote sensing

- Repetitive coverage
- Synoptic view
- Accurate and unbiased
- Extent of coverage
- Time saving
- Multidisciplinary uses
- Permanent record
- Less cost per unit area

16.Management of saline soils

- Leaching
- Drainage
- Mulching materials
- Irrigation
- Flushing
- Selection of crops
- Scraping

Leaching

It is the process of application of excess water to leach down salts. During leaching salts are dissolved by water and they are pushed down below root zone. Leaching requirement is the quantity of water that must pass through the root zone to maintain the EC level at or below a specified level. Khoshgoftarmanesh *et al*., (2003) studied the effect of leaching in soil salinity management in Iran; crop selected is barley which is a salt sensitive crop. They found that excess leaching before planting increased crop yield and reduced soil salinity.

Drainage

Subsurface drainage is more important for soil salinity management. It controls groundwater level and leaches excess salts from the plant root-zone. Ritzema *et al*., 2008 studied the effect of drainage in soil salinity management in different irrigated areas in Uttar Pradesh, Rajasthan, Gujarat, Karnataka and Andhra Pradesh. Four different crops were selected rice, cotton, sugarcane and wheat. Open and pipe type of subsurface drainage systems were installed in farmers field. They found that after the introduction of sub surface drainage the crop yield increased and reduced soil salinity.

Mulching materials

Mulching prevents evaporation losses. Rahaman *et al*., 2004 conducted a study in mulching effect in soil salinity. The crop selected is potato and several treatments were selected by no mulch, rice straw mulch, water hyacinth mulch and wastage of rice straw mulch. The salinity was lower in treatment having rice straw mulch and crop yield was found higher.

Irrigation

Irrigation methods to reduce salinity are ; conjunctive use of saline water along with fresh water; alter the method of irrigation to drip irrigation. Frequency of irrigation is very important.

Flushing

It is the washing of the surface salts by flushing with water to reduce salinity. It includes 3 steps, application of excess water and flooding. Then the flooded soil is puddled. Then the water is drained off. It is only possible when soils are of a heavy texture and ponding can be done.

Selection of crops

Table 1. Crops suitable for saline soils

Class of salinity	**Crops**
High salt tolerant crops	Barley, Sugarcane, Sugar beet, Oats, Sesbania
Moderately salt tolerant crops	Wheat, Rice, Cotton, Sorghum, Maize, Pearlmillet
Slightly salt tolerant crops	Pulses, Peas, Beans, Sesame, Radish, Sunhemp
Salt sensitive crops	Tomato, Onion, Potato, Carrot

Scraping

Scraping removes the top few cm of soil. It provides a temporary relief for 1-2 years. So it is considered as a wasteful process. Major problem is the disposal of scraped salty soil.

17. Biosaline Agriculture

It is the economic utilization of salt affected soils for agricultural purposes like use of salty water for irrigation. e.g. growing of salt tolerant crops of economic importance. Locations where biosaline agriculture is to be practiced must be studied carefully and potential problems should be diagnosed and based on the diagnostics results, one must choose appropriate measures for maximizing economic returns under each specific situation. A misconception about biosaline agriculture, is that this is a complete solution. International Center for Biosaline Agriculture (ICBA) headquarters at Dubai, UAE mainly aims in increasing food and nutritional security, improving water security, and helping building more resilient environments and income in the marginal environment areas.

Dagar and Tomar (2002) conducted a study on a long term field experiment for biosaline agriculture in Central soil salinity research institute Karnal, Haryana. They have formulated agroforestry and silvipastoral model suitable for biosaline agriculture for that area.

Breeding of salt tolerant crops, eg. introgression of saltol gene to rice variety Jyothi and released as Jyotsna (VTL 11) by KAU; cultivating salt tolerant varieties of crops in saline areas eg. rice varieties - VTL 1 - VTL 11 and Land configuration in water logged salt affected areas eg. formation of raised and sunken beds are some of the areas in biosaline agriculture.

18.Conclusion

Remote sensing is an important tool to assess soil salinity**.** By providing fast, relatively cheap, and repetitive data, remote sensing plays an important role for monitoring salt-affected areas. Appropriate management measures can be adopted based on the remote sensing data**.** Biosaline agriculture can be practiced in saline areas more economically. By providing fast, relatively cheap and repetitive data, remote sensing plays an important role in detecting, mapping, and monitoring salt-affected surface features. The best monitoring results are obtained when integrating field and laboratory data with remote sensing data.

19.Discussion

1. How drip irrigation helps to reduce soil salinity?

In arid areas where there is scarcity of water, the available water for irrigation will be saline water. Drip irrigation utilises very less amount of water for irrigation as compared to conventional irrigation. So using saline water for drip irrigation will result in decreasing severity of salinity.

2. How can you distinguish between saline soils and sodic soils in satellite images?

Both saline and sodic soils appears white color in satellite imagery. By doing soil sample analysis we can find the saline and sodic soils. Also by hyperspectral remote sensing saline and sodic soils can be clearly distinguished by their change in spectral characteristics.

3. Why have you used the term biosaline agriculture?

It is the cultivation of salt tolerant crops of economic importance in saline soils. Plants are used for management of saline soils.

4. Which is the easy method of soil salinity delineation?

Remote sensing is the most easy method of delineation of soil salinity. For large areas we prefer remote sensing, it is most cost effective and easy.

5. Kerala soils have rich in iron content, so what will the colour depicted in satellite image?

The soils having higher iron content can be identified using remote sensing due change in spectral characteristics. So Kerala soils also have the specific spectral cheracter in the satellite images.

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21.Abstract

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SOILS 591: Masters Seminar

Student	: Neha Unni	Venue	: Seminar hall
Admission no.	: 2018-11-048	Date	: 15 -11-2019
Major Advisor	: Dr. A. K. Sreelatha	Time	: 9.15 am

Characterization and management of saline soils using remote sensing

Abstract

Salt affected soils are designated as problem soils. These soils are unproductive unless salts are reduced or removed. Salt-affected soils (SAS) are found in all continents under different climatic conditions and are major threat to agriculture. These soils are present most extensively in arid and semiarid regions of the world and cover approximately 7 percent of the total land area of the earth.

According to FAO/UNESCO soil map of the world, 831 m ha are salt affected out of which 397 m ha are saline and 434 m ha are sodic. An estimated area of 6.73 m ha SAS are in India, where in Indo-Gangetic plain accounts for about 2.5 m ha (Mandal *et al*., 2010). Irrigation-induced SAS cover an area larger than naturally occurring SAS and both are widespread in the arid and semiarid agro-ecological regions (Smedema and Shiati, 2002).

The US Salinity Laboratory Staff suggests three classes of salt-affected soils: saline, sodic and saline-sodic soils. Accurate and reliable measurements are essential for better understanding of soil salinity problems in order to provide better management. There are different methods to delineate SAS which includes laboratory methods, salinity probe, salinity sensors and data logger, electromagnetic induction and remote sensing (Shahid, 2013). The choice of the method for soil salinity assessment depends on the objective, size of the area, depth of soil to be assessed, number and frequency of measurements, degree of accuracy required and the available resources.

Remote sensing technology, with its unique characteristics of systematic, synoptic, rapid and repetitive coverage, has emerged as a cost-effective approach for studying and mapping SAS and other degraded lands in space and time domains (Metternicht and Zinck, 2003). The use of remote sensed data has improved the mapping accuracy because different types of SAS exhibits distinctive patterns on standard false color composites. Wu *et al*., (2008) conducted a study at Inner Mongolia, China with archived remote sensing data of seven years and found that the overall accuracy of remote sensing in detecting soil salinity and cropped area was 90.2 percent and 98 percent, respectively, as compared to the conventional methods.

Several studies have underscored the importance of remote sensing in soil salinity delineation. Mandal and Sharma (2001) mapped soil salinity in the Indira Gandhi Nahar Pariyojona (IGNP) command area using IRS 1B LISS 2 data and soils were characterized as

moderate to highly saline. Kumar *et al*., (2015) characterized saline soils at Indo-Gangetic plains of India using hyperspectral remote sensing and classified into four classes. Potential waterlogging and three classes of soil salinity were identified in the Trans-Gangetic plain of India using Resourcesat LISS 3 data (Singh *et al*., 2017).

Different management practices for reclamation of saline soils include leaching, providing drainage, micro irrigation, selection of salt tolerant crops and varieties, use of mulching materials to reduce evaporation, flushing, scraping of surface soil and biosaline agriculture.

By providing fast, relatively cheap and repetitive data, remote sensing plays an important role in detecting, mapping, and monitoring salt-affected surface features. The best monitoring results are obtained when integrating field and laboratory data with remote sensing data.

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