

## **Durability Assessment of Reclaimed Soil by using RS & GIS Applications under U.P. Sodic Lands Reclamation Project III**

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### **Abstract**

In India, about 6.9 million ha area is subjected to salt stressed, in which about 1.2 million ha is in Uttar Pradesh (Gupta *et al.*, 2014). Soils are termed as sodic when the concentration of salt in the root zone exceeds 4dS/m (Richards, 1954). These soils are generally encountered in an arid or semi-arid climate and are derived from weathering of indigenous minerals (Tanzi, 1990). Salt-affected soils are, more important economically in the irrigated commands areas where irrigation is practiced to produce crops (Carter, 1975). However, in certain areas, the reclamation has been reported to be unsustainable and the soils are reverting back to sodicity condition (Yadav *et al.*, 2010). The presence of sodium salt in the parent material, alternate wet and dry seasons with evapo-transpiration excessive precipitation, along with the introduction of canal irrigation have led to the development of soil sodicity in that particular region through secondary Sodic characters. Some of the most unfavorable properties of these soils include high salt content, poor structure, limited microbial activity, low percolation rates, and other characteristics which restrict plant growth and human settlement. Information on the nature, extent, and spatial distribution of salt-affected soils is a pre-requisite for planning and implementation of any reclamation and/or prevention measures. Once a reclamation program is underway, a mechanism is needed to monitor its success and progress. The project durability assessment of Uttar Pradesh Sodic land Reclamation Project envisages monitoring the effect of reclamation programme on a long term basis. Sodicland reclamation sites spread over in 32 district of Uttar Pradesh. Assessment goes through digital analysis of satellite data of a period prior to reclamation (zero year) and subsequently after a period of 5-7 year. This study highlighted the spatial progress of sodicland reclamation in selected villages. Based on high resolution satellite, IRS-LISS-IV FMX, 1C/1D a methodology is developed to monitor the effect of reclamation on the land use at plot level.

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## OBJECTIVE

The board objective of the durability study was to monitor the changes at plot level using satellite data of rabi (Jan-Feb) and kharif (Aug -Nov) cropping season after 5 to 7 years of reclamation, thereby indicating the project sustainability.

## METHODOLOGY:

1. Digitizing the reclaimed plots on cadastral map on 1:4000 scales.
2. Geo referenced using the geographic latitude/longitude WGS 84 coordinate system of digitizing layer & Satellite data.
3. **Generation of False Colour Composite (FCC) for the identification of crop and salt affected plot on satellite data** - IRS 1D LISS III data has four bands: blue (0.45- 0.52  $\mu\text{m}$ ), green (0.52-0.59  $\mu\text{m}$ ), red (0.62- 0.68  $\mu\text{m}$ ) and near infrared (0.77-0.86  $\mu\text{m}$ ). The FCC was generated by combination of three bands: infrared, red and green bands projecting as red, green and blue image planes. The standard false colour composite was used. The crop/vegetation was represented by red colour instead of green colour in the false colour composite.
4. **Satellite images classification**, categorization of pixels based on their spectral characteristics.
5. The enhanced false colour composite image of the study area (1:4000 scale) was displayed on monitor. Standard FCC was visually interpreted for salt affected soils and crop with the help of image elements like tone, texture, shape, size, pattern and NDVI. The salt-affected soils were depicted in tones of bright white to dull white with medium to coarse texture on Standard FCC as per the presence of salts on soil surface and crop were depicted in tones of dull red to high red.
6. **Digitizing & polygon delineation of crop and salt affected signatures on satellite data of Rabi season of 2008-09 by using FCC.**
7. **Superimposed of salt affected polygon of 2008-09 on satellite data of 2012, 2014 ,2016 ,2017 and 2019 of both season (Rabi & Kharif depends on availability of seen )and calculated how many plots are sustain after reclamation.**
8. Ground truthing (With GPS point) of satellite signature and NDVI value.

## DATA USED

1. Geo referenced Cadastral maps of village scale 1:4000
2. IRS-1C/1 D, satellite LISS IV (5.8 resolution) data of Rabi (Jan- Feb).
3. Sentinel-2, L1C+ L2A Multi Temporal Satellite Data of 2009, 2016 & 2017 2018 & 2019 downloaded from land viewer.

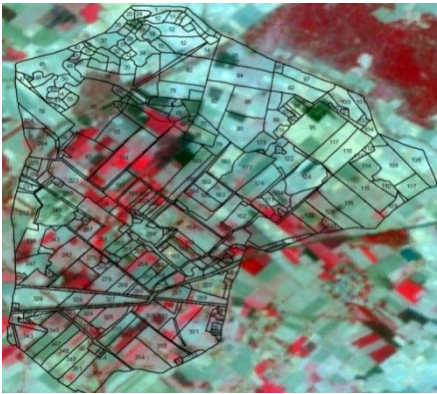
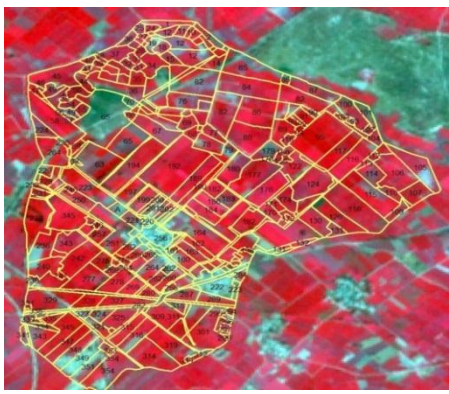
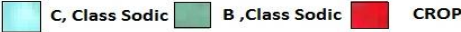
**INTERPRETATION KEY**

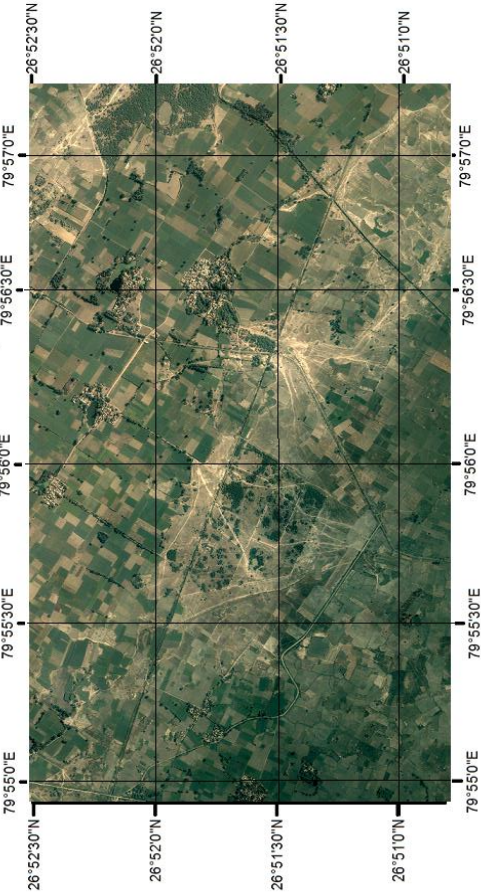
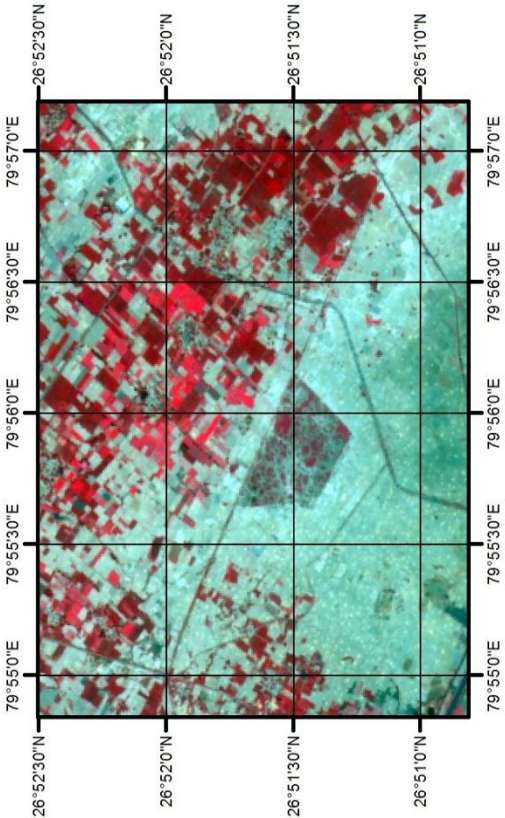
| <b>Signature on Satellite Image (LISS IV FCC) at Plot level</b> | <b>Status of Reclamation</b> | <b>Interpretation Class</b> |
|-----------------------------------------------------------------|------------------------------|-----------------------------|
| Pink/Red                                                        | Reclaimed                    | Cropped                     |
| Pink/Red colour in patches with white/light blue colour         | Reclaimed with patchy crop   | Cropped                     |
| White                                                           | Bare Sodic land              | No Crop                     |

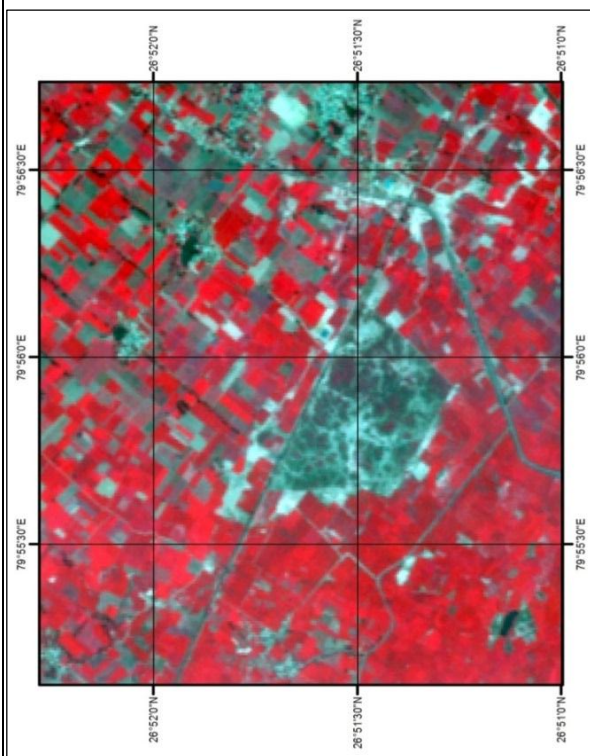
**STUDY AREA**

Total of selected 119 villages representing all the 32 project districts were taken up for the study.

**VILLAGE-HURSAINA , DISTRICT - ALIGARH**

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                                                                                                                                |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------|
| Identified & Classified of Sodic land for reclamation by using LISS IV Satellite data of Feb,2012 Before Reclamation <b>Plate-1</b> (Band combination - <b>color infrared</b> ) FCC                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | IMAGE OF FEB ,2016 ,Satellite –LISS IV After Reclamation (4th Years) Rabi Crop <b>Plate -2</b> (Band combination - <b>color infrared</b> ) FCC |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                                            |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                                                                                                                                |
| <ul style="list-style-type: none"> <li>○ 63.523 ha sodic land ( 49.738 ha C, Class (170 plots) + 8.886 ha B Class (47 plots) &amp; 4.899 ha B+ (44 plots ) was selected for reclamation in 2012 ,sodicity was clearly reflected in satellite images of feb 2012 .Sodic land identified and classified on satellite data by interpretation and pixel analysis object signature, NDVI value and field verification. <b>(plate-1)</b></li> <li>○ On the basis of field verification of interpretation and pixel analysis of satellite images of Feb 2016 , 95% plots of C class and 100% plots of B &amp;B+ class found under rabi crop . <b>(plate-2)</b></li> <li>○ Plot number 114, 82, 12,79 ,179 and some part of plot number 76 shows barren in 2016 but in images of feb 2019 these plot found under crop only one plot shows barren .</li> </ul> |                                                                                                                                                |

|                                                                                                                                                                         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|  <p>Google Image of 2009 selected sodic land Plate-1</p>                             |  <p>Plan Map of Village Sursai Plate-2</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
|  <p>Satellite Image of 2011 Sentinel-2 Band combination Color Infrared -Plate-3</p> | <ul style="list-style-type: none"><li>90.79 ha sodic land ( 63.93 ha C, Class (290 plots) + 12.94 ha B Class (53 plots) &amp; 13.91 ha B+ (54 plots ) ) was selected for reclamation in 2012, sodicity was clearly reflected in satellite images of feb 2011. Sodic land identified and classified by interpretation and pixel analysis of satellite data,NDVI value and field verification.</li><li>Plan Map of village Sursi given in <b>plate 2</b> black hatches area is forest and gram samaj.</li></ul> <p>In satellite data ,Signature of C Class is white ,Bluish white is B Class &amp; crop signature is Red <b>plate 3</b></p> <div><div>C, Class Sodic</div><div>B ,Class Sodic</div><div>CROP</div></div> |



**Satellite image of reclaimed soil Feb 21, 2019 Plate-4**

- On the basis of field verification of interpretation and pixel analysis of satellite images of Feb 2019, 93% plots of C class, 97% plots of B Class and 100% plots of B+ class found under rabi crop . **(plate-4)**
- Field photographs with GPS coordinate dated, Jan 18, 2019 of reclaimed plots given below (1 to 7).
- Crops are showing in red signature & found different NDVI of wheat, mustard & potato satellite data.
- Bright red is potato & NDVI value is .783, this signature verified in ground truth photographs with GPS coordinate given in number 7.
- Blackish Red is wheat, this signature verified in ground truth photographs with GPS coordinate given in number 6.
- Green signature with irregular texture are scrubland of forest department ,this land not taken in reclamation ,in all satellite images and in all are showing in photographs number 5 .We can consider this plot as control sample of the assessment.



| Village Name       | District     | Class of Selected Sodic Land |             |             |
|--------------------|--------------|------------------------------|-------------|-------------|
|                    |              | B+ Class (%)                 | B Class (%) | C Class (%) |
| Dhnwasad           | Lucknow      | 100.0                        | 98.1        | 92.0        |
| Khaira Kanku       |              | 100.0                        | 100.0       | 91.6        |
| Indara             |              | 99.0                         | 95.5        | 89.2        |
| Kumhrawa           |              | 100.0                        | 100.0       | 91.9        |
| Gulalpur           |              | 100.0                        | 98.1        | 92.0        |
| Abbasnaga          |              | 100.0                        | 98.0        | 91.8        |
| Amwa Murtaja       |              | 100.0                        | 97.7        | 92.0        |
| Singhpur           | Aligarh      | 97.0                         | 95.5        | 87.5        |
| Karsuva            |              | 100.0                        | 100.0       | 90.2        |
| Hursaina           |              | 100.0                        | 98.1        | 86.1        |
| Kandauli           |              | 98.0                         | 98.0        | 92.0        |
| Tanchi Abunasirpur |              | 100.0                        | 97.7        | 91.8        |
| Ukhlana            |              | 100.0                        | 99.1        | 91.5        |
| Rakheda            |              | 100.0                        | 99.1        | 87.5        |
| Barauli            | Kanauj       | 100.0                        | 97.2        | 90.2        |
| Alinagar           |              | 98.0                         | 97.7        | 91.8        |
| Umarda             |              | 99.0                         | 99.1        | 87.7        |
| Sikandarpur        |              | 100.0                        | 100.0       | 89.0        |
| Kasuwa             |              | 99.0                         | 89.4        | 90.7        |
| Boesee             |              | 100.0                        | 100.0       | 92.0        |
| Sarsai             |              | 100.0                        | 100.0       | 86.0        |
| Vilandpur Khadagpu |              | 99.0                         | 97.2        | 92.1        |
| Hisamudeenpur      |              | 100.0                        | 97.4        | 91.0        |
| Sursi              |              | 100.0                        | 100.0       | 92.0        |
| Mirjapur           | Kanpur Nagar | 100.0                        | 98.7        | 89.5        |
| Chandpura          |              | 99.0                         | 95.2        | 87.9        |
| Gauri Bagwantpur   |              | 100.0                        | 99.1        | 85.9        |
| Laxmanpur Tewariy  |              | 99.0                         | 97.0        | 92.2        |
| Gopalpur           |              | 97.0                         | 92.0        | 92.0        |

| Village Name        | District  | Class of Selected Sodic Land |             |             |
|---------------------|-----------|------------------------------|-------------|-------------|
|                     |           | B+ Class (%)                 | B Class (%) | C Class (%) |
| Tilsanda            |           | 100.0                        | 87.0        | 89.0        |
| Baraigarh           |           | 100.0                        | 100.0       | 91.8        |
| Aurangpur Sambhi    |           | 100.0                        | 88.0        | 91.2        |
| Meerpur             | Ghazipur  | 99.0                         | 95.6        | 87.0        |
| Khajuwa             |           | 100.0                        | 100.0       | 91.7        |
| Mirjapur            |           | 100.0                        | 93.0        | 89.8        |
| Gahni               |           | 100.0                        | 94.9        | 92.0        |
| Taraw               |           | 100.0                        | 93.6        | 86.9        |
| Kudachawar          |           | 97.0                         | 92.0        | 92.0        |
| Siyawa              |           | 100.0                        | 99.0        | 92.0        |
| Kaithwaliya         |           | 99.0                         | 99.0        | 89.3        |
| Mangari             |           | 100.0                        | 100.0       | 92.0        |
| Meerpur             |           | 100.0                        | 96.3        | 91.7        |
| Chaurabojh          |           | 100.0                        | 94.0        | 91.7        |
| Kathirava           | Bhadoi    | 100.0                        | 100.0       | 92.0        |
| Nagla Ranjeet       | Etah      | 100.0                        | 93.5        | 86.9        |
| Nagla Khangar       |           | 98.0                         | 93.0        | 87.0        |
| Bhujpura Sathanavpr |           | 99.0                         | 97.3        | 92.0        |
| Nayanpur            |           | 100.0                        | 95.0        | 89.3        |
| Batmaee             |           | 100.0                        | 100.0       | 90.2        |
| Jariya              | Raebareli | 100.0                        | 98.0        | 87.9        |
| Mustababad Bailhani |           | 98.0                         | 95.0        | 91.8        |
| Sarai Damu          |           | 100.0                        | 100.0       | 92.8        |
| Taajudeenpur        |           | 100.0                        | 95.6        | 91.9        |
| Rahimkheda          |           | 97.0                         | 95.0        | 92.0        |
| Paidriya            |           | 100.0                        | 100.0       | 86.9        |
| Dehli               |           | 100.0                        | 95.4        | 87.0        |
| Khairani            |           | 99.0                         | 95.5        | 92.0        |
| Pakhrauli           |           | 100.0                        | 95.0        | 89.3        |

| Village Name      | District | Class of Selected Sodic Land |             |             |
|-------------------|----------|------------------------------|-------------|-------------|
|                   |          | B+ Class (%)                 | B Class (%) | C Class (%) |
| Charuhaar Jiyayak |          | 100.0                        | 100.0       | 92.0        |
| Pothai            |          | 99.0                         | 95.9        | 86.9        |
| Bansinghpur       |          | 100.0                        | 96.0        | 89.0        |

## CONCLUSION

The study has been completed in 119 villages which represent all the 32 project units in all project districts and the project period from PY-1 to PY-8. The satellite data used in the study indicate 89-92% C-class sodic plots, 94-96% B-class sodic plots and 97-100% B+ class sodic plots under crops after reclamation. The average of all years, all villages and all sodic plots under crops are 93%.

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