Mapping of Problem Soils

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Soil problems in relation to plant growth are mainly physical or chemical

- **Physical properties associated with plant growth are**
- **Soil texture and structure**
- **Infiltration**
- **Bulk density**
- **Hydraulic conductivity**
- **Porosity (capillary and non capillary**
- **Aggregates**

Soil physical constraints identified are

- Slow permeable soils
- Excessively permeable soils
- Subsoil hardening
- Surface crusting
- Fluffy paddy soils
- Shallow soils

Slowly permeable soils

- Have infiltration rates less than 6 cm/day due to high clay content
- Low infiltration rate and increasing the run-off
- Nutrient removal in the running water
- Impeded drainage and reduced soil conditions
- Toxicity of certain elements and nutrients made unavailable

Excessively permeable soils

- Have high amount of sand exceeding seventy percent
- Unable to retain nutrient and water
- Devoid of clay and organic matter,
- Aggregates are weakly formed
- Fertilizer nutrients are also lost in the drainage water.

Sub soil hardening

- Illuviation of clay to the sub soil horizon coupled with cementing action of oxides of Fe, Al and Calcium carbonate
- The soils bulk density to more than 1.8 Mg m^{-}
- Hard pan due to continuous cultivation of crops using heavy implements up to certain depth constantly.
- Higher exchangeable sodium content in black soils areas also result in compactness.
- Lowered infiltration and percolation rates
- Nutrient movement and free air transport within the soils profile
- Prevents root proliferation to the sub soil

Surface crusting

- Colloidal oxides of iron and Aluminium in Alfisols binds the soil particles under wet regimes which on drying forms a hard mass on the surface. Calcareous and degraded sodic soils also develop crusting

The ill effects of crusting are

- Prevents germination of seeds
- Retards/inhibits root growth.
- Results in poor infiltration.
- Accelerates surface run off
- Creates poor aeration in the rhizosphere
- Affects nodules formation in leguminous crops

Fluffy paddy soils

- Puddling, for paddy cultivation substantially breaks soil aggregates into a uniform structure less mass
- Continuous flooding and submergence of soil for rice cultivation in a cropping sequence of rice-rice-rice, the soil particles and always in a state of flux and the mechanical strength is lost leading to the fluffiness of the soils
- Fluffiness brings about sinking of drought animals and labourers during land preparation
- Increased cost of cultivation
- Very low bulk density and thereby leading to very rapid hydraulic conductivity
- Soil does not provide good anchorage to the roots and the potential yield of crops is adversely affected.

Shallow soils

- Characterized by the presence of the parent rock immediately below the soil surface at about 15-20 cm depth.
- Only shallow rooted crops can be grown
- Soil fertility rapidly exhausted in 2 or 3 seasons
- Crops which can withstand rocky substrata like cashew, tamarind can be grown

Chemical problems

Soil acidity

- Acid soils are those having high degree of adsorbed Aluminium and Hydrogen

Genesis of acid soils

- Acidic parent rook like granite, Rhyolite etc.are usually acidic in nature and produce acid soils
- Bases like Ca, Mg, K, Na et are removed from the soil by the water in high rainfall areas
- Organic soils release organic acids like carbonic acid and in some situations sulphuric acid
- Application of acid forming fertilizers like elemental sulphur, Ammonium sulphate, Ammonium chloride
- Industrial effluents containing sulphur produce sulphuric acid

Problems in acid soils

- Toxicity of aluminium and manganese
- Deficiency of calcium and magnesium
- Decreased availability of phosphorus due to fixation
- Retards nitrogen fixation by legumes and mineralisation of organic matter
- Poor structural development in soils

Liming

- Decreases the harmful effects of acidity.
- Reduces toxicity of aluminium and manganese
- Increase availability of phosphorus
- Alleviate deficiency of calcium and magnesium if dolomite is used as the liming material
- Improves structural development and thereby air and water movement.
- Stimulates microbial activity
- Improves nitrogen fixation and organic matter decomposition

Salinity and sodicity

- Saline soils / white/ alkali/ solonchak
- Soils with high amount of soluble salts have ESP < 15, pH < 8.5, EC > 4.0 dsm^{-1} and white encrustations on the surface called as. white alkali.

Sodic soils: Two types

Black alkali/ Solonetz

- These soils have PH> 8.5 and ESP > 15 and with precipitated $CaCO_3$. Dispersed clay with decomposed organic mater (humus) give black Colour to these soils and hence these soils are called as black alkali / Solonetz (Russian term)

Degraded sodic / degraded alkali / solodi soils

- **These soils have exchangeable sodium percentage > 15. But the pH alkaline with the sub surface horizon having PH>8.5. The sodium reacts with organic matter to form dark colour and the clay gets degraded and hence called black alkali.**

Genesis of Saline – Sodic soils

- ❑ **Parent material**
- ❑ **Low rainfall**
- ❑ **High Evaporation**
- ❑ **Poor drainage**
- ❑ **Poor quality irrigation waters**
- ❑ **Sea water intrusion**

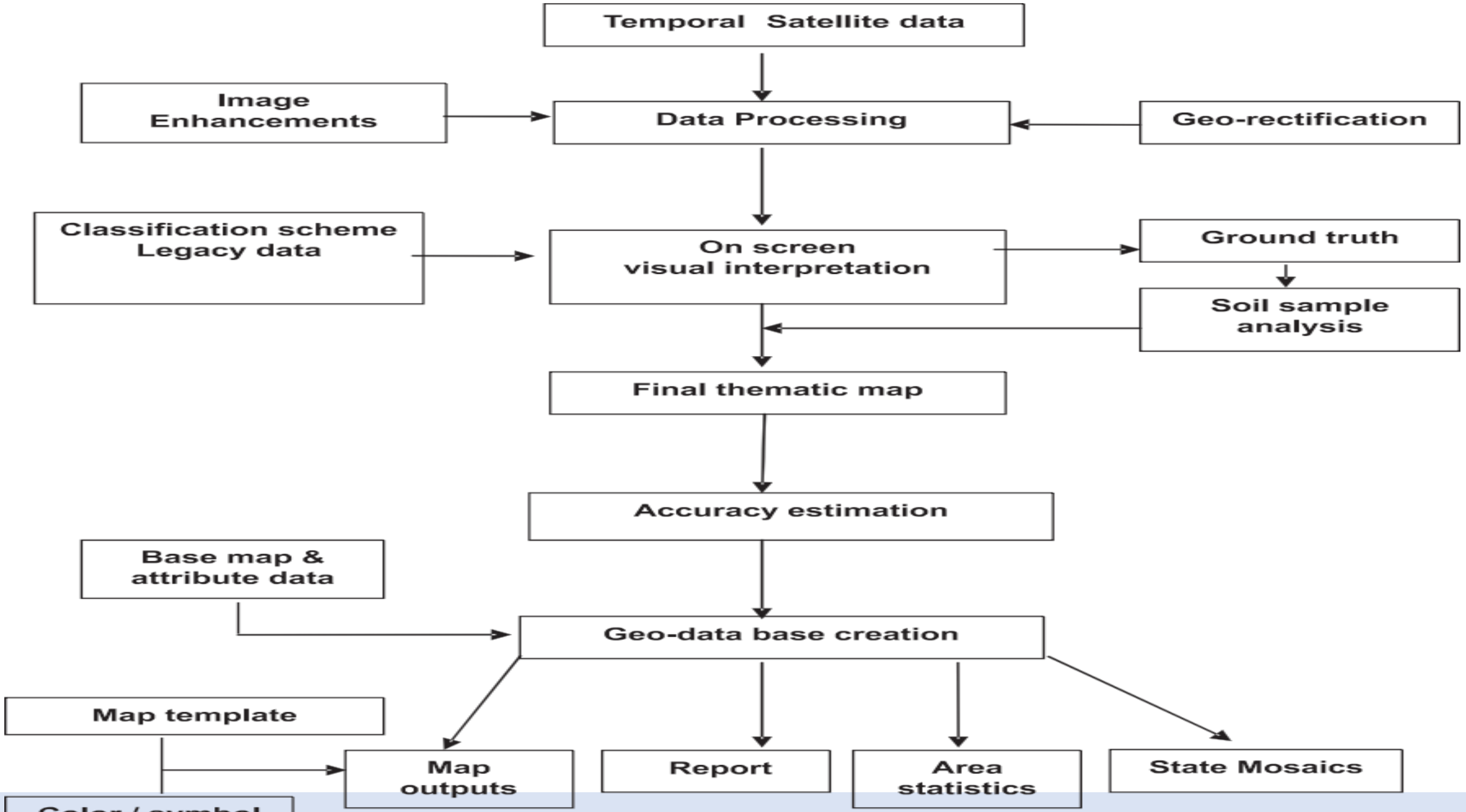
Reclamation of sodic /alkali soils is through gypsum (calcium sulphate) application

LAND DEGRADATION

- Land degradation in general implies temporary or permanent deterioration of physical, chemical and biological properties leading to crop productivity losses
- The information on the extent and spatial distribution of various kinds of degraded lands is thus essential for strategic planning and development of degraded lands

Remote Sensing and GIS in Land Degradation Studies

- Can provide a rapid, relatively inexpensive means to gather land information where no other sources are available or where the quality of available information is low.
- Permits an exact delineation or clear physiographic boundaries
- Gives the opportunity for repetitive, annual or seasonal multi-spectral images
- Interpretation of satellite imagery can be at several levels of intensity / scales.


Temporal Satellite data
Image Enhancements
Data Processing
Geo-rectification
Classification scheme Legacy data
On screen visual interpretation
Ground truth
Soil sample analysis
Final thematic map
Accuracy estimation
Base map & attribute data
Geo-data base creation
Map template
Color / symbol scheme
Map outputs
Report
Area statistics
State Mosaics

Methodology

- **Input and data preparation**
- **Multi-temporal geo-rectified data acquired during major cropping seasons like kharif and rabi seasons are used.**
- **Such a temporal data set helps to address the seasonal variability in intensity of problem in degraded lands**
- **The satellite data is geometrically corrected for further processing, like visual interpretation, ground truth collection and land degradation map preparation.**
- **Ancillary data in the form of topographic maps, existing land use land cover data, wasteland data, district and any other published relevant material are used as reference data**
- **Topographic maps at suitable scale are used for identification of base features and for planning ground data collection**

Interpretation Cues

- **Image interpretation key provides a critical reference base for advanced interpretation. It helps the interpreter in evaluating the information in an organized and consistent manner**
- **Image interpretation key for the study area has to be designed prior to interpretation, which can be further refined in course of interpretation**
- **After preliminary interpretation of satellite data, sample areas are identified for ground truth collection.**

Ground truth Collection

- **Identify and list all the doubtful areas for the ground verification**
- **Locate all such areas with respect to the topo sheet to know their geographical location and accessibility on the ground.**
- **Prepare field traverse plan to cover maximum doubtful areas in the field**
- **Ensure that each traverse covers, as many land degradation classes as possible, apart from the doubtful areas.**
- **Soil samples are collected from representative areas and are analysed for chemical & physico-chemical properties.**

Soil Sample Analysis

Soil samples are to be analysed for pH, EC, texture (sand, silt, clay), CEC, exchangeable cations, calcium carbonate %, organic carbon % using standard analytical procedures. Observations are required for signature extrapolation during interpretation.

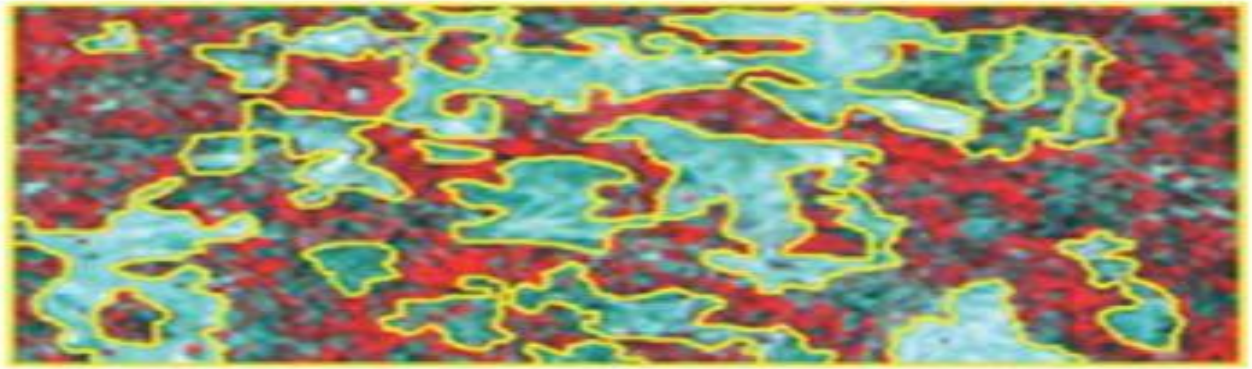
Final Map Generation

- The land degradation map needs to be finalized in light of the ground observations, visual interpretation keys, available ancillary and legacy data sets - (LDCM) Landsat data continuity mission
- Once map is finalized they need to be checked for topological and labelling errors
- For mapping units having more than one problem, the associated problem need to be given the mapping symbol in a separate attribute column
- Final map is tested for thematic accuracy and should have layout consisting of theme map, legend, scale bar, north arrow, sources of data, index map, agencies involved, project name and year of publication.

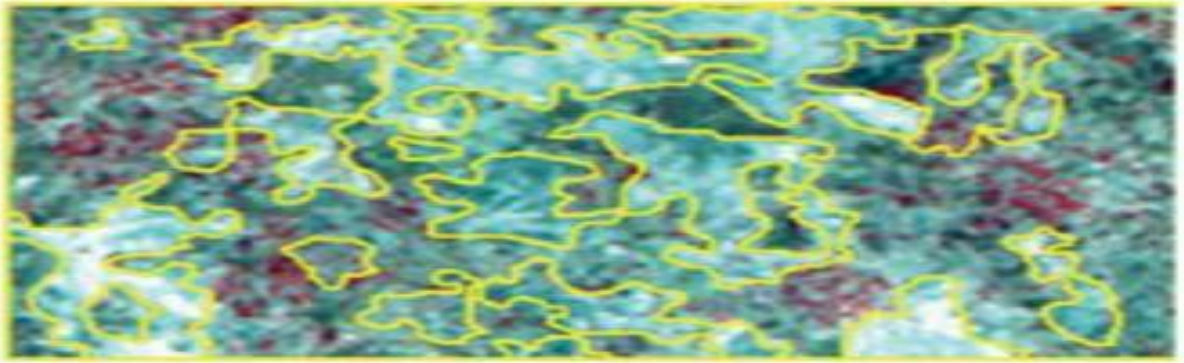
Validation

- **Information collected during the field visit is utilised in checking the final maps for which purpose a representative samples are collected on ground covering all the thematic classes**
- **In extreme cases, the finalised thematic maps are also be validated by verifying the mapping units in the field.**

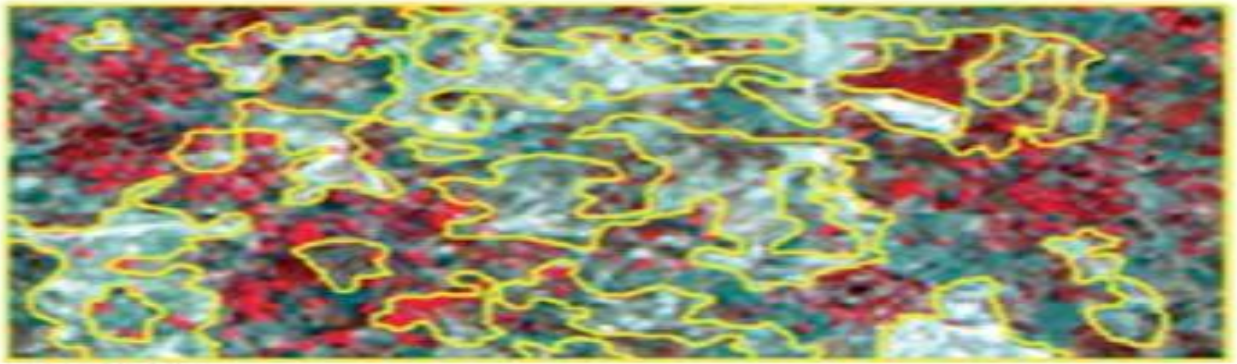
LAND DEGRADATION MAPPING – SALT AFFECTED SOILS



Feb, 06

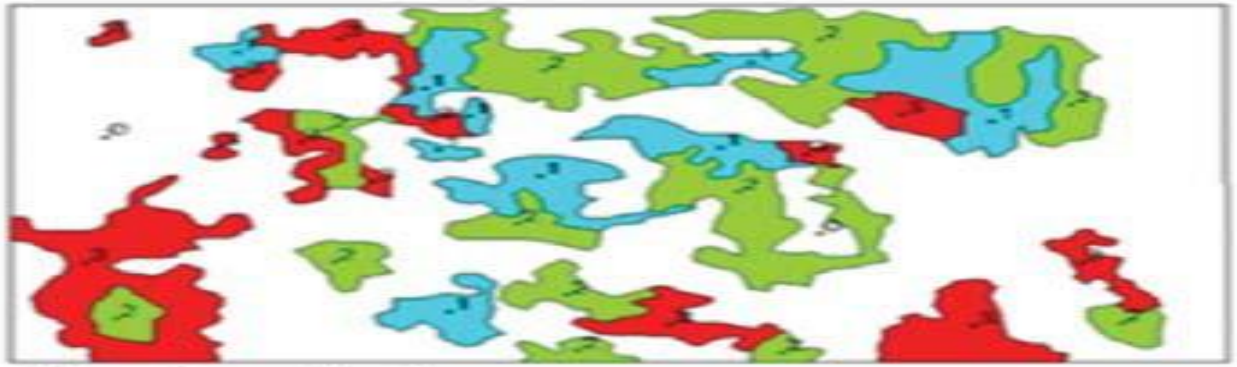


Apr, 06



Nov, 06

Salt affected soil with surface encrustation



Salt affected soil map

Slight Saline-sodic

Mod Saline- sodic

Strong Saline-sodic

Remote Sensing and GIS in land degradation studies

Theme	Geographical Representation	Attributes required	Method
Land Degradation	To show the major types of land degradation operating	• Type of land degradation • Severity / level • Cause description • Topography • Land Use type • Notes on solutions to tackle the problem	Visual interpretation of satellite imagery with adequate field verification / checks

Theme	Geographical Representation	Attributes required	Method
Land degradation hotspots	Show the extents of areas, which are degraded during period range, classified according to the degree of degradation	• Degradation type • Degradation level • Major causes • Current Land Use type. • Period elapsed to reach critical threshold of degradation • Notes on solutions to tackle the problem	• Preparation of land cover and NDVI maps of a historic and current year using multi-spectral remote sensing data • Identification of land degradation hot-spots based on type and degree of land transformation and NDVI change matrix in GIS domain • Classification of areas into various type and degree of degradation based on above information • Analysis of land transformations with available livestock and human census data details • Investigation and understanding of the desertification by domain experts and suggesting solutions

Theme	Geographical Representation	Attributes required	Method
Land degradation prediction	Show the extents of areas most likely to degrade in the near future and their classification according to the probability of its tendency to get degraded	▪Grade of expected land degradation ▪Level of Confidence ▪ Predicted period in to reach the threshold level of degradation ▪ Current Land Use ▪ Topography	• Main drivers of land degradation to be identified from land degradation change maps / hotspot maps • Using historical and current land degradation areas data, rate of desertification need to be studied and confidence levels will be estimated • Scope should be given to accommodate proposed alternate land utilization plans, if any, or land transformation policies to be implemented in near future • The general approach for prediction could be through spatial modeling

Visual interpretation cues for land degradation.

Land degradation process	**Land degradation type**	**Colour / Tone (On standard FCC)**	**Texture** (on LISS-III data)	**Pattern**	**Size**	**Shape**	**Association**	**Remarks**
Water erosion (W)	Sheet erosion (sh)	Slightly brighter than surrounding land of its class	Smooth to medium	Contiguous patches	Small to large	Irregular	Sloping cultivated / lands with poor vegetal cover during rainy season	Information need to be deduced from available soil information slope and satellite data in conjunction USLE can be used to quantify soil loss


Thank You